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SPORTS PERFORMANCE

A systematic review on small-sided games in football players: Acute and chronic adaptations

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ABSTRACT

Small-sided games (SSG) are played on a small pitch, often using modified rules and involving a smaller number of players. This article aimed to critically analyse the literature to determine how small-sided games affect the performance of football players in the short- and long term. Electronic databases were searched for literature dating from January 2000 to July 2018. The methodological quality of the studies was evaluated using the modified Downs and Black Quality Index (cross-sectional studies) and the Physiotherapy Evidence Database (PEDro) scale (intervention studies). Fifty-three studies, 44 cross-sectional and 9 intervention studies, met the inclusionary criteria for review. Most of the cross-sectional studies focused on describing the differences between SSG protocols, whereas 4 studies focused on making a comparison between "interval" and "continuous" SSG training regimes. On the other hand, intervention studies focused on making a comparison between SSG-based protocols and high-intensity intermittent training (HIIT)-based running protocols, in addition to determine the effect of a SSG-based training programme alone. SSG-based football plans (2 to 4 SSG sessions per week) show athletic performance improvements in football players by improving sprint, repeated sprint ability (RSA) and change of direction (COD) along with muscular and physiological adaptation.

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KEYWORDS
Amateur and professional players; external load; physiological response; technical/tactical indexes; training methodology; training regime

1. Introduction

Football has an intermittent nature that encompasses brief bouts of high-intensity running and longer periods of low-intensity exercise (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007). Although aerobic energy production dominates energy provision in football, elite senior players perform up to 250 brief high-intensity actions during a match. This indicates the high anaerobic demands during intense periods of play (Bangsbo, 1994). In particular, for high match performance, it is essential to increase players' ability to maintain intense levels of activity and to limit fatigue at the same time, which means that players require well-developed aerobic endurance (Köklü, Sert, Alemdaroğlu, & Arslan, 2015). High-intensity intermittent training (HIIT) allows the improvement of aerobic capacity (Billat, Hamard, & Koralsztein, 2002) and the ability to perform high-intensity actions and directional changes (Dellal et al., 2010). In a previous study (Dellal, Varliette, Owen, Chirico, & Pialoux, 2012), this method of training induced similar effects on the recovery capacity and on the ability to repeat directional changes of 180° that small-sided games (SSGs) demand. SSGs are therefore a HIIT method that allows the improvement of specific physical capacities of football, besides working with the ball, in a certain area of the pitch with their teammates, including game conditions played with fewer players in smaller field dimensions.

In high performance sports, it has been well documented that the maximum benefits are achieved when the training stimuli are similar to competitive demands (Bompa, 1983). The principle of specificity justifies the use of these kinds of drills in training (Reilly, Morris, & Whyte, 2009), so SSGs are thought to be more suitable than traditional interval training for the development of particular physical characteristics required for matches as they involve the actual movement patterns used in football (Impellizzeri et al., 2006; Köklü, Ersöz, Alemdaroğlu, Aşç, & Özkan, 2012). Considering the lack of time for football coaching (especially at amateur level), SSGs also seem to be a time-efficient strategy. Furthermore, coaches can modify the intensity of SSGs according to the aims of training (Aguiar, Botelho, Gonçalves, & Sampaio, 2013) by changing several variables such as the number of players taking part (Brandes, Heitmann, & Müller, 2012; Hill-Haas, Dawson, Coutts, & Rowsell, 2009; Köklü, Aşçi, Koçak, Alemdaroğlu, & Dündar, 2011), dimensions of the playing area (Aslan, 2013; Casamichana & Castellano, 2010; Kelly & Drust, 2009), rules of the game (Hill-Haas, Coutts, Dawson, & Rowsell, 2010), the use of "floater" players (Mallo & Navarro, 2008), the number of touches (Román-Quintana et al., 2013), the game format (Castellano, Casamichana, & Dellal, 2013) or the number and duration of task repetitions (Casamichana, Castellano, & Dellal, 2013; Fanchini et al., 2011; Hill-Haas, Rowsell, Dawson, & Coutts, 2009). This type of exercise allows the attainment of maximal heart rate (HRmax) in an equivalent proportion to that observed during match play, that is, ranging from 80 to 90% of HRmax (Stølen, Chamari, Castagna, & Wisløff, 2005). However, some results suggested that when

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compared with large SSG formats or match play, small SSGs (under certain conditions) do not simulate the high-intensity efforts and repeated sprints that the full game demands (Casamichana, Castellano, & Castagna, 2012).

In light of the above, it is necessary to have a global understanding of the stimulus imposed on football players during SSGs, in order to optimise the training adaptation. It has been demonstrated that SSGs containing smaller numbers of players elicit greater HR, blood lactate accumulation (BLa) and perceptual responses (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011), that were also higher on medium and large pitch sizes compared with small pitches (Hill-Haas et al., 2011; Rampinini, Impellizzeri, et al., 2007). In this regard, recent studies reported that the largest game format is associated with a greater range of distances travelled at high speeds (Casamichana & Castellano, 2010; Hill-Haas et al., 2011). On the other side, the smaller game formats increase the individual technical actions (Jones & Drust, 2007; Owen, Twist, & Ford, 2004). Likewise, it has been found that SSGs without goals and with coaches' encouragement increased the intensity of SSGs (Casamichana, Castellano, González-Morán, García-Cueto, & García-López, 2011; Rampinini et al., 2007). In addition, the total distance covered at high speed was higher when the number of ball contacts allowed was reduced (Dellal, Chamari, et al., 2011b). Also, SSG football training is typically completed in the form of intervals as opposed to continuous duration play, which is more typical of actual game play (Aguiar, Botelho, Lago, Maças, & Sampaio, 2012). There are several studies that focused on the influence of interval or continuous SSG training that show that neither training regimen appears to offer any major advantage over the other, supporting the use of both for football-specific training (Hill-Haas, Rowsell, et al., 2009a; Köklü, 2012).

Modern elite football is characterised by the capacity of players to play with fewer ball contacts per possession (Dellal, 2008). Sampaio et al. (2007) reported an increase in ratings of perceived exertion (RPE) when a SSG was played in free-play form versus a SSG played with a maximum of two touches per possession with youth players. However, they observed no change in the percentage of HRmax. Similarly, Aroso, Rebelo, and Gomes-Pereira (2004) compared SSGs played in free play and played with a maximum of three touches per possession in amateur football players, and reported a significant increase in BLa. Dellal et al. (2011) showed that modification of the number of ball contacts allowed per individual possession influenced the technical activities, physical demands, and physiological responses of elite football players during SSGs.

Also, evidences have been provided about differences between elite and amateur players concerning their physical, physiological and technical profiles (Dellal, Hill-Haas, Lago-Penas, & Chamari, 2011). SSGs might not be an ideal solution for all playing standards and levels because **Dellal, Owen, et al.,** (2012) revealed that the physiological responses to SSGs were skill and level dependent. There is a lack of studies evaluating injury occurrence when modifying the variables within SSGs. Moreover, the effects of SSGs on markers related to risk of injury are still unknown, so further studies to associate the incidence of injury with SSGs are necessary.

To the best of the authors' knowledge, 10 reviews have so far been written about SSGs (Aguiar et al., 2012; Clemente, Couceiro, Martins, & Mendes, 2012; Clemente, Lourenço Martins, & Mendes, 2014; Clemente, Martins, & Mendes, 2014; Halouani, Chtourou, Gabbett, Chaouachi, & Chamari, 2014; Hammami, Gabbett, Slimani, & Bouhlel, 2017; Hill-Haas et al., 2011; Little, 2009; Michailidis, 2013; Morgans, Orme, Anderson, & Drust, 2014), of which only 3 (Halouani et al., 2014; Hammami et al., 2017; Hill-Haas et al., 2011) were systematically performed and included information about literature search strategies. Six of these 10 studies focused on the effects of SSG formats on physiological parameters (Clemente, Lourenço Martins, et al., 2014; Clemente et al., 2014; Halouani et al., 2014; Hill-Haas et al., 2011; Little, 2009; Morgans et al., 2014) whereas the other 4 considered different SSG formats on physiological, kinematics and technical parameters (Aguiar et al., 2012; Clemente et al., 2012; Hammami et al., 2017; Michailidis, 2013). As for the type of population, all studies combined athletes of different levels of game (did not focus on professional or amateur football players). Altogether, it exists an abundance of SSG research in the literature with new variables and training methodologies used. Therefore, a systematic review that summarises findings and new evidence about how SSGs affect football players from a multidisciplinary perspective (physiological, external load, technical/tactical and neuromuscular) in the short- and long-term is needed, and this is the main purpose of the current work. The insights gained from this review should assist the prescription of SSG training sessions and programmes to improve the performance of football players. Finally, it helps to identify areas for future research, as well as it serves to provide valuable information to coaches for the design and promotion of the use of SSGs as part of a periodised conditioning programme for football players.

2. Material and methods

2.1 Search strategy

Electronic databases, including PubMed, ScienceDirect, Web of Science, and SPORTDiscus, were searched for literature dating from January 2000 to July 2018. The keywords used were "small-sided games" or "small-sided football games" or "small-sided soccer games" and "football players" or "soccer players". The search was limited based on publication date (from January 2000 to July 2018), species (humans), language (English), and age (≥16 years). Duplicates between searches were removed. Results of the search procedures are summarised in Figure 1.

2.2 Selection criteria

Studies were included in the review if they met the following criteria: (1) published in peer-reviewed journals; (2) included participants 16 years or older; (3) involved amateur or professional football players; (4) used methods of quantification perfectly validated (e.g. HR monitor, lactate analyser, Borg's RPE scale, global positioning system (GPS)); (5) used SSG-based testing sessions for cross-sectional studies and, in the case of intervention studies, SSG-based training programmes; and (6) all intervention lasted a

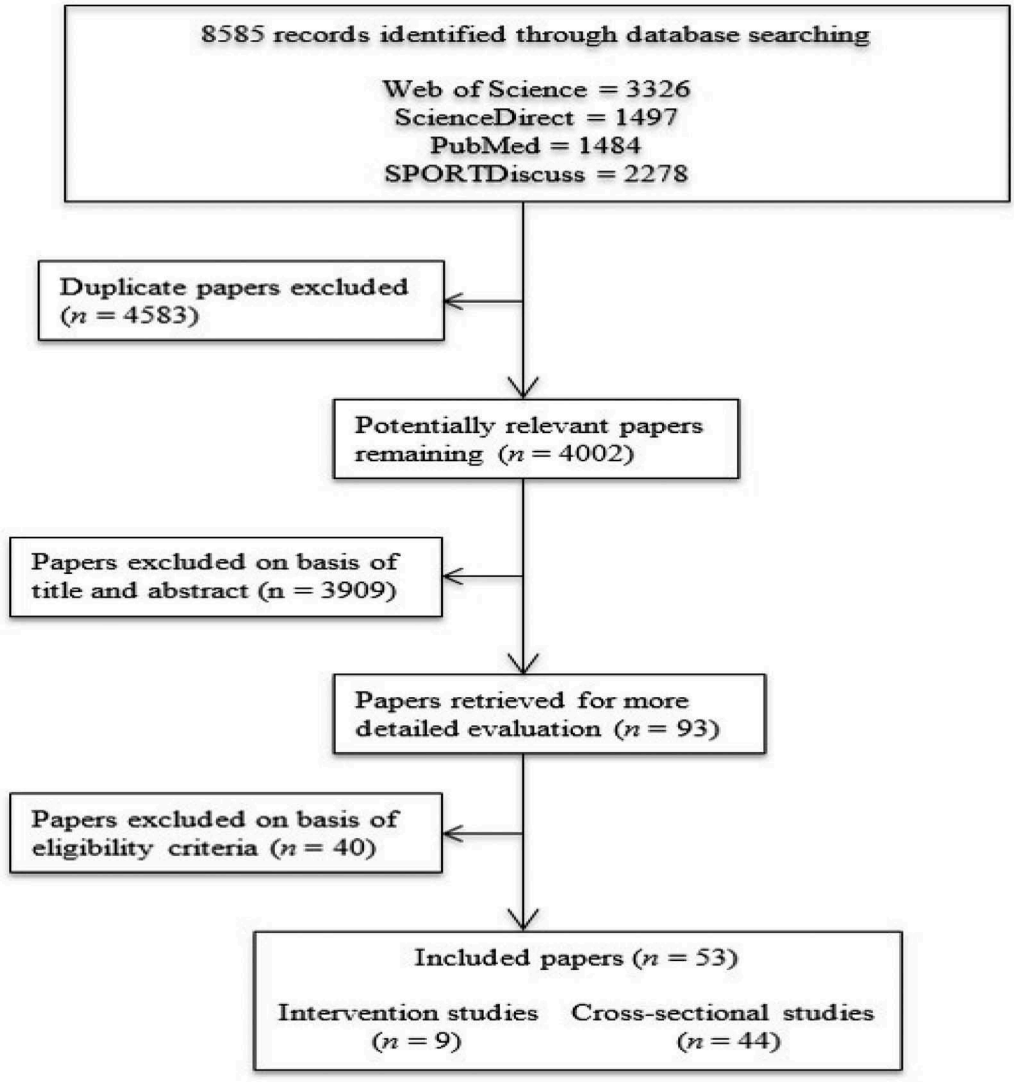

Figure 1. Flowchart illustrating the different phases of the search and selection of the studies.

minimum of 4 weeks (only intervention studies). Studies were excluded if they (1) did not meet the minimum requirements of an experimental study design (e.g. case reports), (2) did not meet the minimum requirements regarding training design (e.g. lack of information on volume, frequency, game format and/or training methodology), (3) were not written in English, or (4) involved untrained subjects (e.g. sports sciences undergraduate subjects), team sports athletes other than football (e.g. basketball players, rugby players), or non-male football players. Additionally, review articles were not included in this systematic review. Based on the inclusion and exclusion criteria, two independent reviewers (PBM and FGP) screened the citations of potentially relevant publications. If the citation showed any potential relevance, it was screened at the abstract level. When abstracts indicated potential inclusion, full-text articles were reviewed. A third-party consensus meeting was held with a third author (PALR) if the two reviewers were not able to reach agreement on inclusion of an article.

2.3 Quality assessment

For cross-sectional studies (those focused on examining the acute effects of SSG protocols on physiological, metabolic, and time-motion measurements), quality was assessed using the modified version of the Quality Index developed by Downs and Black (Downs & Black, 1998). The original scale was reported to have good test-retest (r = 0.88) and inter-rater (r = 0.75) reliability and high internal consistency (Kuder-Richardson Formula 20 (KR-20) = 0.89). Reliability of the subscales varied from good (bias) to poor (external validity). The Quality Index correlated highly with an existing, established instrument for assessing randomised studies (r = 0.90). The modified version of the Downs and Black Quality Index is scored from 1 to 14, with higher scores indicating higher-quality studies.

For intervention studies (those focused on the impact of SSG-based programmes on physiological and neuromuscular measurements), methodological quality was assessed

using the Physiotherapy Evidence Database (PEDro) scale (Maher, Sherrington, Herbert, Moseley, & Elkins, 2003), an 11-item scale that rates randomized controlled trials from 0 to 10, with 6 representing the cutoff score for high-quality studies. One question was used to establish external validity and was not included in the score. Only studies with PEDro scores of 6 or higher were considered for the systematic review (Maher et al., 2003). Maher et al. (2003) demonstrated fair-to-good inter-rater reliability with an intraclass correlation coefficient of 0.68 when using consensus ratings generated by 2 or 3 raters. Nine studies met the inclusion criteria (Bujalance-Moreno, García-Pinillos, & Latorre-Román, 2017; Dellal et al., 2008; Dellal, Varliette, et al., 2012; Faude, Steffen, Kellmann, & Meyer, 2014; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Owen, Wong, Paul, & Dellal, 2012; Paul, Marques, & Nassis, 2018; Rodríguez-Fernández, Sánchez, Rodríguez-Marroyo, Casamichana, & Villa, 2017). Consensus was achieved on scores given to the 9 articles.

For both cross-sectional and intervention studies, 2 independent reviewers (PBM and FGP) performed quality assessments of the included studies, and disagreements were resolved through a consensus meeting or a rating by a third assessor (PALR).

3. Results

The results for cross-sectional and longitudinal studies are presented separately. Table 1 (cross-sectional studies, n = 44) and Table 2 (intervention studies, n = 9) summarize the essential parameters of the selected studies.

3.1 Cross-sectional studies

Results from Downs and Black scale are shown in Table 3. Scores for the Downs and Black scale ranged from 7 to 9 of a possible 14. Of particular note was that no study described the main outcomes in the introduction or methods section (Item 2), included a sample size representative of the entire population (Item 12) or considered confounding factors (Item 25), and only in two studies the subjects were randomised to intervention groups (Item 23).

Regarding to the cross-sectional studies (Table 1, n = 44), most articles focused on describing the differences between SSG protocols (Aasgaard & Kilding, 2018; Aguiar et al., 2013; Arslan et al., 2017; Bach Padilha, Guilherme, Serra-Olivares, Roca, & Teoldo, 2017; Brandes & Elvers, 2017; Casamichana, Suarez-Arrones, Castellano, & San Román-Quintana, 2014; Casamichana & Castellano, 2015; Casamichana, Román-Quintana, Castellano, & Calleja-González, 2015; Castellano et al., 2013; Cihan, 2015; Clemente, Dellal, Wong, Lourenço Martins, & Mendes, 2016; Clemente, Wong, Martins, & Mendes, 2014; Coutts, Rampinini, Marcora, Castagna, & Impellizzeri, 2009; Dellal et al., 2012; Dellal et al., 2011; Dellal, Jannault, Lopez-Segovia, & Pialoux, 2011; Dellal, Lago-Penas, Wong, & Chamari, 2011; Edis, Vural, & Vurgun, 2016; Fanchini et al., 2011; Gaudino, Alberti, & Iaia, 2014; Giménez et al., 2018; Hill-Haas, Dawson, et al., 2009c; Hodgson, Akenhead, & Thomas, 2014; Hulka, Weisser, & Belka, 2016; Jastrzębski & Radzimiński, 2015; Kelly & Drust, 2009; Köklü et al., 2015, 2012; Mallo & Navarro, 2008; Ngo et al., 2012; Rampinini et al., 2007; Sampaio, Lago, Gonçalves, Maçãs, & Leite, 2014; Sanchez-Sanchez et al., 2017), some others focused on making a comparison between the responses to SSG and running drill protocols (Ade, Harley, & Bradley, 2014; Dellal et al., 2008; Selmi et al., 2018), whereas others between the responses to SSGs and friendly matches (Casamichana et al., 2012; **Dellal et al., 2012**), between "interval" and "continuous" SSG training regimes (SSG^{I} and SSG^{C}) (Casamichana et al., 2013; Hill-Haas et al., 2009; Köklü, 2012; Köklü, Alemdaroğlu, Cihan, & Wong, 2017; Sanchez-Sanchez et al., 2018), or even between the physiological responses, and the technical and physical activities of amateur and professional players during various SSGs (Dellal et al., 2011). In a study by Aguiar et al. (2013) participants completed different SSG formats, with the same duration of bouts (6 min), rest (1 min of active recovery), and the same volume (20 min), moreover, formal goals and a goalkeeper per team were used with unlimited touches. Similarly, Casamichana and Castellano (2015) utilised SSG formats with the same duration of bouts but only one set per SSG format and different durations of rest periods (5 min of passive recovery), varying the rules of the game (possession play, regular goals and goalkeepers and small goals but not goalkeepers). On the other hand, Casamichana et al. (2012) and Castellano et al. (2013) focused on the manipulation of SSG format and different design of the game but maintained work and rest intervals, with area per player constant, whereas Casamichana et al. (2014), Dellal et al. (2011), **Dellal et al. (2012)** and Giménez et al. (2018) maintained the same SSG format and constant work and rest intervals but modified the design of the game (free play and two touches per possession; one touch, two touches and free play; one touch, two touches and free play; and one touch, two touches and free play with four mini-goals, respectively). In the studies by Casamichana et al. (2013) and Köklü et al. (2017) the same SSG format was utilised with the same volume but different set and durations of work periods, with area per player constant, however Dellal et al. (2011), Dellal et al. (2011), Dellal et al. (2012) and Fanchini et al. (2011) in addition to changing the volume, set and durations of work and rest periods also changed the SSG formats and the design of the game. For its part, Arslan et al. (2017) utilised different SSG formats with the same set but different work periods, varying the resting regimes (passive or active rest). As well, Casamichana et al. (2015), Cihan (2015), Ngo et al. (2012) and Aasgaard and Kilding (2018) based their SSG protocols on the defensive strategies (man-marking or no man-marking; free play, man-marking or double-man pressure; man-marking with goal or no goal and no man-marking with goal or no goal; and man-marking or no man-marking with small goals and verbal encouragement, respectively). Hodgson et al. (2014), Hulka et al. (2016), Kelly and Drust (2009) and Rampinini, Impellizzeri, et al. (2007) compared SSG protocols with identical volume and work-rest ratio but different pitch size. Meanwhile, Bach Padilha et al. (2017) and Sanchez-Sanchez et al. (2017) evaluated the influence of wildcard players on the performance during SSGs. Finally, Brandes and Elvers (2017) focused on the type of coach feedback, keeping the same SSG

Table 1. Studies (n = 44) examining the acute effects of SSGs on the performance of football players.

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Aasgaard and Kilding (2018)	*n* = 8 males 23.6 ± 3.3 years Height 175.7 ± 8.6 cm BM 75.5 ± 8.0 kg - Amateur soccer players - Minimum of 5 years of experience - 2–3 ss/wk	An acute crossover design. All participants performed twice each SSG (2 v 2, 3 v 3, and 4 v 4), one with NMM and other with MM. - On natural grass pitch	Each SSG was preceded by a 10-min standardized warm-up. Three different formats of SSGs were performed with NMM and MM conditions: - 4 v 4: 4 × 4 min/2 min passive rest (33.25 x 26 m) - 3 v 3: 4 × 4 min/2 min passive rest (30 x 21 m) - 2 v 2: 4 × 4 min/2 min passive rest (20 x 20 m) - Small goals and verbal encouragement	*Time-motion*: - Workload - TD - $Speed_{peak}$ and $speed_{ave}$ - Distance covered (speed zones) *Physiological responses*: - HR (average and maximum) - Time spent ≥ 90% HR_{peak} - RPE (Borg´s CR10 scale)	- $\%HR_{ave}$ induced small to moderate effects with MM compared with NMM. - Comparison between MM formats indicated a ↓ in $\%HR_{ave}$ with increased players numbers. - Perceptual load ↑ with MM compared with NMM, whereas increases in player numbers (MM only) ↓ RPE output. - ↑ total distance covered in MM irrespective of player number.
Ade et al. (2014)	*n* = 16 males 17 ± 1 years 1.80 ± 0.06 m BM 75.3 ± 8.5 kg - Elite football players	Repeated measures. All participants completed 4 drills: SEP 1 v 1 SSG, SEP running drill, SEM 2 v 2 SSG, SEM running drill. - A field-based study (on a pitch)	- SEP and SEM running drills involved 8 runs for 30 and 60 s, with 120 and 60 s recovery between runs, respectively. - SEP and SEM football drills involved 1 v 1 and 2 v 2 SSGs consisting of 8 games of 30 and 60 s, with 120 and 60 s recovery between games, respectively. - SSG with minigoals	*Physiological response*: - HR and BLa *Perceived exertion*: - RPE *Time-motion*: - Total distance covered - High-speed running distance - Very-high-speed running distance - Sprint distance - High and máximum acceleration distance - High and máximum deceleration distance	SEP and SEM running drills ↑ HR, BLa and RPE than the respective SSG. - SEP SSGs = HR but ↑ BLa and RPE than SEM SSGs. - SEM running drill ↑ HR but ↓ BLa than SEP protocol. - ↑ very high-speed-running and sprint distance during SEP running drill than respective SSG. - ↑ distance covered in total running, high- and very-high-speed running, and sprinting during SEM running drill versus the SSG equivalent. - SEM SSG produced ↑ high- to máximum-acceleration and – deceleration distance than the respective running drill.
Aguiar et al. (2013)	*n* = 10 males 18.0 ± 0.67 years BM 69.7 ± 5.66 kg Height 1.79 ± 0.06 m HR_{max} 193.9 ± 5.0 -Professional - 5 ss/wk - ≥ 7 years of experience	Repeated measures. All participants completed 4 SSG format: 2-, 3-, 4- and 5-a-side players.	4 SSG formats were used (2-, 3-, 4- and 5-a-side players) with 20-minutes duration (3x6-min bouts with 1-min of active recovery). -After 6 min teams changed the attack direction -Formal goals and a goalkeeper per team -Unlimited touches	*Perceived exertion*: -RPE *Physiological response*: - HR (zones: 1, 2, 3 and 4) *Activity profile*: -6 speed zones (m) -Total distance covered (m) - Sprints/athlete - Body load	- ↑ % HR in 2- and 3-a-side formats. - ↓ RPE at the 5-a-side and ↑ at the 2-a-side. - Distance covered ↓ in the 2-a-side than in all other formats. - 2-a-side format ↓ sprints and the 3-a-side ↑. - ↑ body load in the 4-a-side and ↓ in the 5-a-side.
Arslan et al. (2017)	*n* = 16 males 16.87 ± 0.34 years Height 176.69 ± 3.21 cm BM 62.40 ± 2.59 kg - Elite youth players - 5 ss/wk	Repeated measured. All participants performed three SSG formats under the SSGpr and SSGar conditions.	Each SSG was played after a standardized 20-min warm-up. The SSG formats used were: - 2 v 2: 4 × 2 min/3 min (SSGpr and SSGar) 12 × 24 m - 3 v 3: 4 × 3 min/3 min (SSGpr and SSGar) 18 × 30 m - 4 v 4: 4 × 4 min/3 min (SSGpr and SSGar) 24 × 36 m - No GK and maintain ball possession	*Physiological response*: - HR - $\%HR_{max}$ - BLa - RPE (CR-20) *Time-motion characteristics*: - Four speed zones (W, LIR, MIR and HIR).	- All SSGpr ↑ RPE and BLa compared to SSGar. - 2 $_v$ 2 SSGpr ↓ $\%HR_{max}$ and total distance covered than 2 v 2 SSGar. - Distance covered at HIR ↑ in 4 v 4 SSGar than 4 v 4 SSGpr.
Bach Padilha et al. (2017)	*n* = 168 males 16.61 ± 0.56 years - Amateur players - 3 ss/wk	Repeated measures. All participant performed 2 different SSGs (without and with floaters). The participants played first "floaters off" followed by "floaters sidelines".	Two different SSGs ("floaters off" and "floaters sidelines"): - GK + 3 v 3 + GK - GK + 3 v 3 + GK + 2 floaters Each SSG lasted 4 min (5 min of rest between SSG). - Pitch size: 27 × 36 m - The official rules, except for the offside rule - Floater: only offensive actions and free to cooperate with both teams (free touches) - No feedback during SSG	*Tactical behaviour*: - FUT-SAT	- In "floaters off" SSG, players more frequently performed the principles of concentration during the defensive phase and penetration for the offensive phase of play (↑ 1 v 1 situation). - In "floaters sidelines" SSG, players made more effective use of playing space during the offensive phase and limited the space for the opponent (defensive unity).

(*Continued*)

Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Brandes and Elvers (2017)	*n* = 16 males 17.2 ± 0.7 years Height 182.3 ± 7.3 cm BM 73.5 ± 6.7 kg - Elite youth players - 4 ss/wk	Repeated measured. All participants performed 2 different SSG formats (SSG-SP and SSG-M). - On an artificial grass pitch.	Each SSG was played after a standardized 15-min warm-up. The SSG format used were: - 4 v 4 (SSG-SP): 3 × 4 min/2 min passive rest - 4 v 4 (SSG-M): 3 × 4 min/2 min passive rest - Free touches, regular goals and without offside. - Pitch size: 40 × 40 m	*Physiological responses*: - HR, BLa and RPE *Time-motion characteristics*: - TD - Distance in speed zones - Number of sprints - WR *Game performance*: - 6 tactical actions (CBs, RBs, LBs, number of neutral balls, P and S).	- No differences were found for the physiological response and time-motion characteristics, but ES demonstrated an increase in RPE (+ 0.4) and a decrease in game performance (e.g. volume of play, −2.5) under SSG-SP.
Casamichana and Castellano (2015)	*n* = 14 males 21.3 ± 2.3 years height 174 ± 4.0 cm BM 73.4 ± 5.1 kg - Semi-professional - Mean of 12.5 years of experience - 3–4 ss/wk	Repeated measures. All participant completed 9 SSG formats (each played three times, 27 in total) - Artificial grass pitch	Each sesión began with a 15-min standard warm-up, followed 3 different SSG lasting 6 min/ 5 min passive recovery. 9 SSG format were (3 v 3, 5 v 5 and 7 v 7): - Possession play - Regulation goals and goalkeepers - Small goals but not goalkeepers	*Internal indicators of intensity*: - HR and RPE *External training load*: - TD, DHS, DSS, FHS and FSS - PL	- A significant moderate correlation (r = 0.506) between %HRmean and RPE. - PL was significantly correlated with the internal load indicators (r = 0.331 with % HRmean and r = 0.218 with RPE).
Casamichana et al. (2012)	*n* = 27 males 22.8 ± 4.5 years height 177 ± 5.3 cm weight 74.4 ± 4.8 kg -Semiprofessional -Mean of 12.5 years of experience	Repeated measures. All participant performed 7 different 11-a-side FMs and 9 training sessions (3 SSGs format per sessions).	—7 different 11-a-side FMs - 9 trainning sessions: Each training sesión involved 3 SSG format (3 v 3, 5 v 5, and 7 v 7). - Different design (without goals, with 2 regulation goals and goalkeepers, and with 2 small goals but no goalkeepers) - 3 × 4 min/2 min passive rest	*Physical demands*: - DC_m, DC_h and %T spent in each of the speed zones (5 zones). - V_{max} *Physical response*: - WR - Players´workload - Exertion index *RHIEs*: - number of RHIEs - mean and máximum number of efforts per RHIE	- Overall workload and distance covered in 7.0–12.9 km/h ↑ SSG than FM - Distance covered > 21 km/h ↑ FM than SSG. - Time spent in speed zones (0.0–6.9, > 21 and 7.0–12.9 km/h) ↑ FM than SSG. - FMs ↑ improvements in sprint variables - ↑ frequency of RHIEs in FMs
Casamichana et al. (2013)	*n* = 10 males 21.3 ± 3.4 years Height 180 ± 7 cm Weight 73.9 ± 6.6 kg - Semi-professional - Mean of 12.5 years of experience - 3–4 ss/wk	Repeated measures. All participant completed 3 different format of a 5 v 5 SSG. - Artificial grass pitch	3 training sessions (in 3 different weeks) of 5 v 5 SSG (without goalkeepers): - SSG2: 2 × 8 min/2 min passive recovery - SSG4: 4 × 4 min/1 min passive recovery - SSG1: 1 × 16 min - Maintain ball possessions - 4-minute period analysis (0–4, 4–8, 8–12 and 12–16)	*Physiological demands*: - HR *Physical profile*: - Total distance covered - Distance covered in speed zones	- SSG2: distance covered at a speed of 7–12.9 km/h ↑ in the 0–4 minute period than in the 12–16 minute period and distance covered at a speed of 7–12.9 km/h during the 8–12 minute period ↑ in SSG2 than in SSG1.
Casamichana et al. (2015)	*n* = 18 23.4 ± 4.5 years Height 178.7 ± 5.6 cm BM 74.4 ± 6.1 kg - Amateur players - Mean of 12.5 years of experience - 3 ss/wk	Repeated measures. All participant completed 12 training sessions of SSG (3 v 3, 6 v 6 and 9 v 9).	Each sessions began with a 15-min standard warm-up, followed by a SSG of 6 min duration: - Type of marking: MM or NMM - Number of players: 3 v 3, 6 v 6 and 9 v 9. - Maintain ball possession (no goals)	*Physiological profile*: - HR (6 HR intensity zones) - % time spent in each zone *Physical profile*: - Total distance covered - Distance covered in speed ranges - Number of accelerations in intensity ranges - WR, V_{max}, and PL	- ↑ Total distance, PL and WR when MM was used in the 3 v 3 and 6 v 6. - ↑ time being spent at the < 80% HR_{max} in the 9 v 9 and 6 v 6 compared with the 3 v 3.

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Casamichana et al. (2014)	*n* = 12 males 22.7 ± 4.3 years Height 177.5 ± 4.9 cm BM 74.9 ± 6.3 kg - Semi-professional - 3–4 ss/wk - Mean of 12.5 years of experience	Repeated measures. All participant completed 4 sessions that involved a SSG in two different ways. - Artificial grass pitch	4 training sessions (15-min standard warm-up followed by a SSG lasting 12 min): - Sessions 1 and 3: 6 v 6 without goalkeepers (free play) - Sessions 2 and 4: 6 v 6 without goalkeepers (two touches per possession) *Maintain possession	*Physiological profile*: - HR (time spent in 4 HR zones) *Time-motion*: - TD - V_{max} - WR - PL - Distance covered in speed zones - Number of acceleration	- SSG_{FP} ↓ intensity of physical parameters in the second 6-min period (6–12 min), no decrease SSG_{2T}. - SSG_{2T} ↑ HR and the time spent in high exercise intensity zones during the second period (6–12 min), but not in SSG_{FP}.
Castellano et al. (2013)	*n* = 14 males 21.3 ± 2.3 years Height 174 ± 4.0 cm Weight 73.4 ± 5.1 kg - Semiprofessional - Mean of 12.5 years of experience - 3–4 ss/wk	Repeated measures. All participant completed 9 training sessions. - Artificial grass pitch	Each sessions began with a 15-min standard warm-up, followed by 3 SSGs (3 v 3, 5 v 5 and 7 v 7) lasting 6 min with a different game format (SSG-P, SSG-G and SSG-g) interspaced by 5 min passive recovery between the 3 types of SSGs. - Standard rules (except offside rule)	*Physiological profile*: - HR (4 intensity zones) *Physical profile*: - Total distance covered - V_{max} - Distance covered in speed categories - Number of accelerations - WR and PL	- SSG-P ↑ physiological and physical demands on players and ↓ number of players ↑ only physiological load. - 7 v 7 = HR changing the game format. - SSG-P: changing the number of players no differences in HR but physical demands ↓ with a ↓ in the number of players.
Cihan (2015)	*n* = 18 19.6 ± 0.5 years BM 71.9 ± 7.5 kg Height 178.3 ± 4.6 cm - National elite academy league - Mean of 6 years of experience	Repeated measures. All participant performed 3 SSG protocols (defensive strategy) in a randomized order.	15 min standard warm-up, 3 SSG protocols (FP, MM and DMP): 3 v 3 3 × 4 min/5 min passive recovery - Day 1: Group A (FP), Group B (MM) and Group C (DMP) - Day 2: Group A (DMP), Group B (FP) and Group C (MM) - Day 3: Group A (MM), Group B (DMP) and Group C (FP) - No goalkeeper	*Physiological responses*: - HR, BLa *Time-Motion characteristics*: - TD and distance covered in speed categories *Perceived exertion*: - RPE	- DMP ↑ BLa, HR, $\%HR_{max}$ and sessions-RPE compared to FP and MM. - Significant differences between MM and FP. - During the DMP, players covered ↑ distances in the high-intensity running zone compared to MM and FP.
Clemente et al. (2016)	*n* = 10 males 26.4 ± 5.3 years Height 179.0 ± 5.4 cm Weight 71 ± 7.1 kg - Amateurs - 8.0 ± 3.2 years of practice	Repeated measures. All participant completed 3 SSG in one sesión per week during two week (2 sessions and 6 SSG total). *Artificial grass pitch	First sessions (1 v 1 with neutral players) with three task conditions: - T1, ball possessions and no goal - T2, cross opponents´ endline and no goal - T3, small goal without goalkeepers Second sessions (1 v 1 without neutral player) with the aforementioned different task conditions - 3 min duration	*Physiological response*: - HR ($\%HR_{reserve}$) *Physical profile*: - Distance coverage	- Neutral player ↑ HR and distance coverage in very small-sided game.
Clemente et al. (2014)	*n* = 10 males 26.4 ± 5.3 years Height 179.3 ± 5.2 cm Weight 71.2 ± 7.1 kg - Amateur - 8.4 ± 3.2 years of practice - 3 ss/wk	Repeated measures. All participant performed 9 SSG. - 3 scoring methods was randomized for each format	- First week: 2 v 2 + 2 neutral players - Second week: 3 v 3 + 2 neutral players - Third week: 4 v 4 + 2 neutral players - 3 × 5 min/3 min passive recovery	*Physiological profile*: - HR ($\%HR_{reserve}$) *Physical profile*: - Distance coverage - Speed *Assessment of technical/tactical performance*: - TSAP	-–2 v 2 ↑ technical/tactical indexes compared with other formats. - 3 v 3 ↑ $\%HR_{reserve}$ value. - 4 v 4 ↑ distance coverage and speed.
Coutts et al. (2009)	*n* = 20 25 ± 5 years BM 73.0 ± 9.0 kg Height 178.8 ± 5.2 cm - Amateur - 2–3 ss/wk	Repeated measures. All participants performed 67 team-training sessions.	SSG consisted of 3 × 4 min/3 min active recovery: - 3 v 3 –4 v 4 –5 v 5 –6 v 6 - Without goalkeepers, using small goals and free touches	*Physiological responses*: - $\%HR_{peak}$ and BLa *Perceived exertion*: - RPE (Borg´s CR 10-scale)	- The combination of BLa and $\%HR_{peak}$ is better related to RPE than either $\%HR_{peak}$ or BLa measures alone.

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Dellal et al. (2011)	*n* = 20 27.4 ± 1.5 BM 79.2 ± 4.2 kg Height 1.81 ± 0.02 - International	Repeated measures. All participants performed 3 SSG formats over the 6 weeks of the study.	SSG formats (2 v 2, 3 v 3 and 4 v 4) and number of ball contacts (1T, 2T and free play): - 2 v 2: 4 × 2 min/3 min recovery - 3 v 3: 4 × 3 min/3 min recovery - 4 v 4: 4 × 4 min/3 min recovery - 4 support players (maintain possession)	*Physiological demands*: - %HR_{max} and %$HR_{reserve}$ - BLa - RPE *Physical demands*: - Total distance covered, the total distance covered in sprinting and the total distance covered in high-intensity running.	- % of successful passes and number of duels ↓ in SSG played with 1T, whereas ↑ number of balls lost in 2 v 2 and 3 v 3 and 4 v 4. - SSG played with 1T ↑ BLa and RPE, and ↑ total distance covered in sprinting and high-intensity runs.
Dellal et al. (2008)	*n* = 10 males 26.0 ± 2.9 years Height 181.4 ± 5.9 Weight 17.1 ± 0.8 km/h - Elite	Repeated measures. All participant performed 2 study-related sessions per week: running and SSG sessions - Natural grass pitch	Short-duration intermittent running: - 30–30 PR 2 × 10 min (100% VO_{2max}) - 30–30 AR 2 × 10 min (100% VO_{2max}) - 15–15 2 × 10 min (100% VO_{2max}) - 10–10 2 × 7 min (110% VO_{2max}) - 5–20 1 × 7 min, 5s (120% VO_{2max}) SSG: - 1 v 1 4 × 1 min, 30 s/1 min, 30 s - 2 v 2 6 × 2 min, 30 s/2 min, 30 s - 4 v 4 GK 2 × 4 min/3 min - 8 v 8 GK 2 × 10 min/5 min - 8 v 8 4 × 4 min/3 min - 10 v 10 GK 3 × 20 min/5 min - Playing a match or maintain the ball	*Physiological response*: - %$HR_{reserve}$	- %$HR_{reserve}$ in the 30–30 AR ↑ than the 30–30 PR, but also ↑ than the 1 v 1, 4 v 4, 8 v 8 and 10 v 10 SSG. - %$HR_{reserve}$ was 2-fold less homogeneous in SSG than short-duration intermittent running. - 8 v 8 GK ↑ %$HR_{reserve}$ and ↓ homogenity compared to games without GK.
Dellal et al. (2012)	*n* = 20 males 27 ± 2 years Height 180.6 ± 2.3 cm Weight 79.2 ± 4.2 kg - Internationals	Repeated measures. All participant performed the 3 different SSGs	20 min standardized warm-up. SSGs formats were: - 2 v 2 4 × 2 min/3 min passive recovery - 3 v 3 4 × 3 min/3 min passive recovery - 4 v 4 4 × 4 min/3 min passive recovery - 2T - 4 support players (maintain possession)	*Physiological demands*: - HR (%HR_{max} and % $HR_{reserve}$), BLa and RPE. *Physical demands*: - Total distance covered, and the total distances covered in HIR and VHIR. *Technical demands*: - Duels, % of successful passes, total number of balls lost and total number of individual ball possessions.	- ↓ HIR and VHIR, ↑ BLa, RPE and HR, and a significant alteration of technical activities from B1 to B4 in each SSG. - The greatest differences from B1 and B4 were observed for the 2-a-side game when compared to the 3-a-side and 4-a-side games.
Dellal et al. (2011)	*n* = 20 international 27.4 ± 1.5 years BM 79.2 ± 4.2 kg Height 180.6 ± 2.3 cm - 5–7 ss/wk + 1–2 matches *n* = 20 amateur 26.3 ± 2.2 years BM 77.1 ± 5.3 kg Height 178.2 ± 2.8 cm *3–4 ss/wk + 1 match	Repeated measures. All players performed 3 different SSG formats (2 v 2, 3 v 3 and 4 v 4) - Natural grass pitch	SSGs with rules changes (1T, 2T and FP) were performed: - 2 v 2 4 × 2 min/3 min recovery - 3 v 3 4 × 3 min/3 min recovery - 4 v 4 4 × 4 min/3 min recovery - 4 support players (maintain possession) - Maintain possession of the ball - Without goalkeepers	*Physiological measurements*: - HR and BLa *Perceived exertion*: - RPE *Physical performance*: - Distance covered both in sprinting and during HIR *Technical performance*: - Duels, % of successful passes, the amount of lost balls per possession and the total number of possessions.	- Amateurs ↓ % of successful passes, ↑ RPE and BLa, lost ↑ amount of ball possessions and covered ↓ total distance in sprinting and HIR. - %HR_{max} and %$HR_{reserve}$ = in both (amateur and international players).

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Dellal et al. (2011)	*n* = 27 16.5 ± 0.5 years Height 174.5 ± 5.5 cm Weight 62.9 ± 8.3 kg - Elite - 5 ss/wk + 1 match - 8.1 ± 2.5 years of experience	Repeated measures. All participants performed a MAS test (VAMEVAL) and then 24 of them were submitted to 3 different SSG. - Natural grass pitch	An standardized warm-up, followed of the 3 SSG situations (no goalkeeper, no goal): - 2 v 2 8 × 2 min/1 min PR - 3 v 3 6 × 3 min/1 min, 30 s PR - 4 v 4 4 × 4 min/2 min PR - SSG played with "stop-ball" rules	*Physiological responses*: - During the SSG: mean % $HR_{reserve}$, % of time spent above 60, 65, 70, 75, 80, 85, 90 and 95% of $HR_{reserve}$. - $\%HR_{reserve}$ measured 30 s after the end of each SSG (indicator of post-exercise cardiac recovery) - BLa (post-exercise)	- The mean $\%HR_{reserve}$ ↓ during 4 v 4 compared to 2 v 2 and 3 v 3 SSG. - 4 v 4 ↓ % of time than 3 v 3 and 2 v 2 of the time spent above the different intensities % of $HR_{reserve}$. - $\%HR_{reserve}$ after 30s of recovery ↑ for 3 v 3 compared to 2 v 2 and 4 v 4.
Dellal et al. (2011)	*n* = 20 males 27.4 ± 1.5 years Height 180.6 ± 2.3 cm BM 79.2 ± 4.2 kg - Internationals - Goalkeepers were excluded	Repeated measures. All participant performed simultaneously three 4 v 4 SSG over a 3 week.	20 min standardized warm-up, followed by three 4 v 4 SSG (1T, 2T and FP) - 4 × 4 min (B1, B2, B3 and B4)/3 min passive recovery - Pitch size is the same for all SSGs - Maintain possession of the ball - 4 support players (maintain possession: 1T)	*Physiological responses*: - RPE (in each bout), BLa and HR *Technical performance*: - Number of duels, % of successful passes, number of ball losses and total number of ball possessions *Physical performance*: - total distance covered, total distance covered in sprinting and total distance covered in HIR	- The FP ↑ number of duels, ↓ decreases of the sprint and high-intensity performances, and affected ↓ in the successful passes and number of ball losses from B1 to B4 as compared with 1T and 2T forms. - SSG played in 1T ↑ high-intensity actions but players presented more difficulty to perform a correct technical action.
Dellal et al. (2012)	*n* = 40 25.3 ± 2.4 years Height 182.4 ± 2.3 cm BM 77.3 ± 4.1 kg - International - CD = 8, FB = 8, CDM = 12, WM = 7 and FW = 5 - Goalkeepers were excluded	Repeated measures. All participant performed three different 4 v 4 SSG and two 11-a-side friendly matches (4 weeks).	20 min standardized warm-up, followed by three 4 v 4 SSG (1T, 2T and FP) - 4 × 4 min/3 min of passive recovery - 4 support players (maintain possession) - Two 11-a-side friendly matches (no substitution)	*Physiological responses*: - HR ($\%HR_{max}$ and $\%HR_{reserve}$), BLa and RPE. *Time-motion characteristics*: - Total distance, sprint distance and HIR distance covered. *Technical activity*: - Duels, % of successful passes, total number of lost balls and total number of ball possessions	- Compared to match-play, total distance covered per minute of play, high-intensity running activities, total numbers of duels and lost ball possessions ↑ in SSG for all playing positions. - BLa, % of successful passes and number of ball possessions ↓ in SSG (particularly with 1T and 2T) compared to match-play. - HR ↑ in SSG for all playing positions, and RPE ↓ during the FP SSG for CDM, WM and FW.
Edis et al. (2016)	*n* = 16 17.2 ± 1.02 years BM 67.67 ± 13.27 kg Height 176.25 ± 0.07 m - Amateur - 4 ss/wk + 1 match - Minimum of 6 years of experience	Repeated measures. All participant completed a postural control test protocols and 3 different formats SSG.	3 different formats of SSG (total of 12 games): - 1 v 1 4 × 1 min/1 min recovery (15x10 m) - 2 v 2 4 × 2 min/2 min recovery (18x24 m) - 3 v 3 4 × 3 min/3 min recovery (30x40 m) - Oficial competition rules	*Technical variables*: - T_s, T_{us}, DP_s, DP_{us}, S_s, S_{us}, ST_s and ST_{us} for 1 v 1 games. - For 2 v 2 and 3 v 3 games; variables of P_s, P_{us} and assist were added to the technical variables used in 1 v 1 games.	- ↑ postural control levels are among the important variables that affect success in the performance of technical skills under rival pressure and suddenly changing conditions.

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Fanchini et al. (2011)	*n* = 19 males 24 ± 4 years BM 74 ± 4 kg Height 180 ± 5 cm - Amateur and profesional - 7 ss/wk (both teams)	Repeated measures. All participant completed three bouts of a 3-a-side drill at three different bout durations.	20 min standardized warm-up, followed by a 3-a-side SSG: - 3 v 3 3 × 2 min/4 min active recovery - 3 v 3 3 × 4 min/4 min active recovery - 3 v 3 3 × 6 min/4 min active recovery *With goalkeepers (not allowed to take the ball with their hands) and 2T	*Physiological response*: - HR - RPE (CR-10 Borg´s scale) *Technical actions*: - Pass, successful pass, unsuccessful pass, tackle, header, turn, interception, dribbling, shoot and shoot on target.	- HR of bout 1 ↓ than bout 2 and bout 3. - Effect of duration was close to significance for HR with 6-min SSG significantly ↓ than 4-min SSG. - RPE ↑ along the bouts but was not affected by duration. - No effect of duration for number of technical actions per minute. - A significant effect of bout for successful passes.
Gaudino et al. (2014)	*n* = 26 males 26 ± 5 years Height 182 ± 7 cm BM 79 ± 5 kg - Profesional players	Repeated measures. All participant performed 2 different formats of SSGs with 3 variations of each SSG format.	20 min standardized warm-up before SSGs. Two SSG formats: SSG-G and SSG-P. - 3 variations for each SSG format (aforementioned): - 5 v 5, area per player 75 m^2 (SSG-G) and 73 m^2 (SSG-P) - 7 v 7, area per player 98 m^2 (SSG-G) and 98 m^2 (SSG-P) - 10 v 10, area per player 135 m^2 (SSG-G) and 135 m^2 (SSG-P) - Continuous regime - Maximum of two touches of the ball	*Mechanical demands*: - TD, TS, HS, VHS and MS. - Total changes in velocity (No.), MA, HA, MD, HD and, máximum acceleration and deceleration. *Metabolic demands*: - EC and P_{met} - TP distance, HP distance, EP distance and MP distance.	- TD, distances run at high speed (> 14.4 km/h), máximum velocity, máximum acceleration and máximum deceleration ↑ with pitch size (10 v 10 > 7 v 7 > 5 v 5). - Total distance, very high and maximal speed distances, absolute maximal velocity and máximum acceleration and deceleration ↑ in SSG-G than in SSG-P. - MA and MD, and the total number of changes in velocity ↑ as the pitch dimensions decreased in both SSG-G and SSG-P.
Giménez et al. (2018)	*n* = 14 males 23.2 ± 2.7 years Height 178 ± 6 cm BM 73.2 ± 6.9 kg - Professional players	Repeated measured. All participants performed 3 trials of 4 v 4 SSGs with variation of ball touches (1T, 2T and FP). - On an artificial grass pitch	Each session began with the same 20-min standardized warm-up, followed by the same soccer-specific passing game. The SSGs were: - 4 v 4: 3 × 4 min/3 min active recovery (1T) - 4 v 4: 3 × 4 min/3 min active recovery (2T) - 4 v 4: 3 × 4 min/3 min active recovery (FP) - Four mini-goals - Without GK and pitch size: 30 × 24 m	*Physical response*: - PL, exertion index and maximum velocity reached (m/s). - Total distance covered (m). - Distance covered at different thresholds/ zones (m). - Time spent at different intensities (%). - Distance covered with different acceleration bands (m).	- Significant effects for distance covered at low speed between FP and 2T. - Significant effects for time walking between FP and 1T. - Significant effects for time at moderate and low speed between FP and 2T. - Significant effects for accelerations of > 4 m/s^2 between FP and 1T.
Hill-Haas et al. (2009)	*n* = 16 males 16.2 ± 0.2 years Height 173.7 ± 2.1 cm BM 65.0 ± 2.5 kg - Minimum of 8 years of experience	Repeated measures. All participant performed both "interval" and "continuous" SSG training regimes that involved 3 SSG formats (9 weeks).	10-min standardized warm-up, followed by 3 SSG formats (2 v 2, 4 v 4 and 6 v 6) performed in two SSG training regimes (SSG^C and SSG^I): - SSG^C: 24 min/no rest interval - SSG^I: 4 × 6 min/1.5 min passive rest - Relative pitch size per player remained constant	*Physiological responses*: - HR (%HR_{max} and % time spent in four intensity zones) - RPE (6–20 Borg´s scale) - BLa *Time-motion characteristics*: - Total distance and distance covered in four speed zones. - Time-motion variables of higher speed running (Sprints)	- No significant differences between SSG^C and SSG^I for total distance covered or for distance travelled while walking, jogging, or running at moderate speed. - Players covered a ↑ distance at 13.0–17.9 km/h, a ↑ total distance at higher running speed, and a ↑ total number of sprints (> 18 km/h) with SSG^I compared with SSG^C. - Global RPE and %HR_{max} ↑ in SSG^C than in SSG^I.

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Hill-Haas et al. (2009)	*n* = 16 males 16.3 ± 0.6 years Height 1.74 ± 0.08 m BM 65.0 ± 9.8 kg - Minimum of 8 years of experience	Repeated measures. All participant performed three SSG formats (9 weeks) played in duplicate. - Players selected on same teams against same opposition	15-min warm-up, followed by SSG formats (2 v 2, 4 v 4 and 6 v 6). - All games were 24 min continuous duration - Area per player constant - 2 x per week, 48 h between sessions - No goalkeepers - Unlimited touches, no offside rule - Mini-goals	*Physiological responses*: - RPE (6–20 Borg´s scale) - BLa - HR (%HR_{max} and % time spent in four intensity zones) *Time-motion characteristics*: - Total distance and distance covered in four speed zones. - Time-motion variables of higher speed running (Sprints)	- The 2 v 2 games ↑ BLa, HR and RPE responses compared to 4 v 4 and 6 v 6 games. - The players travelled ↓ distance at speeds of 0–7 km/h in the 4 v 4 compared to 2 v 2 games. - Average maximal sprint distances above 18 km/h were ↓ in 2 v 2 than in 4 v 4 and 6 v 6 games, and in 4 v 4 compared with 6 v 6 games.
Hodgson et al. (2014)	*n* = 8 20 ± 1 years Height 1.81 ± 0.04 m BM 75 ± 7 kg - Minimum of 5 years of experience - ≥ 2 ss/wk + ≥ 1 match/wk	Repeated measures. All participant completed 3 experimental sessions on consecutive weeks separated by 7 days.	3 SSG sessions of 5 v 5 (including goalkeepers) in different pitch size: - 5 v 5 on small pitch size (30x20 m) - 5 v 5 on medium pitch size (40x30m) - 5 v 5 on large pitch size (50x40 m) - 4 × 4 min/3 min recovery - 15-min standardised warm-up before each game	*Time-motion analysis*: - TD and distance covered at HSR and during SPD. - Distance covered during low, moderate and high acceleration and deceleration ranges. - Total acceleration and deceleration distance covered. *Physiological responses*: - HR *Technical analysis*: - Pass, tackle, header, turn, interception, dribbling and shots.	- SSGs played on medium and large pitches ↑ physical demand than on small pitches, with ↑ distance covered in all movement categories. - SSGs played on small pitches ↑ technical demands on players (passes, shots and tackles) compared to medium and large pitches.
Hulka et al. (2016)	*n* = 29 18.11 ± 1.31 years BM 21.04 ± 2.58 kg/m^2 HR_{peak} 199.53 ± 7.51 bpm - Junior football players	Repeated measures. All participants completed YYIRT1 (HR_{peak}) and 6 practice sessions of SSGs - On an artificial grass pitch	Warm-up, followed by a SSG (5 v 5) with or without a goalkeeper on small, medium or large pitch: - S_{with} (28x20 m) - $S_{without}$ (28x20 m) - M_{with} (25x35 m) - $M_{without}$ (25x35 m) - L_{with} (42x30 m) - $L_{without}$ (42x30 m) - 3 × 4 min/3 min active recovery - Standard goals (3 x 2 m)	*External load*: - Distance covered *Physiological demands*: - HR (%HR_{peak} and HR zones) - RPE (CR-10 Borg´s scale)	- ↑ HR of players in 5 v 5 SSGs without goalkeepers than with them on a small pitch. - Significant differences in the time spent in 65–85% of the peak heart rate zone and < 65% of the peak heart rate zone on the small pitch. - ↑ distance covered by players during 5 v 5 SSGs with goalkeepers than without them played on the small pitch.
Jastrzębski and Radzimiński (2015)	*n* = 13 27.1 ± 5.2 Height 182.5 ± 5.2 cm BM 77.2 ± 6.2 kg - Professional players - 5–7 ss/wk + 1 match	Repeated measures. Only 13 players completed all eight games. - Natural grass pitch	10-min warm-up followed by dynamic exercises with balls, and after SSGs were performed. - 1 sessions (First week): 4 SSGs (4 v 4) on a 40 × 30 m pitch - 2 sessions (Second week): 4 SSGs (5 v 5) on a 43 × 33 m pitch - Goalkeepers - 4 × 4 min/2 min active recovery	*Pysical demands*: - Distance covered and Speed zones (divided individually). *Physiological responses*: - HR	- The mean V/LT of the player was 3.8 ± 0.16 m/s and the S_{max} speed was 8.26 ± 0.65 m/s. - The total distance covered during the 4 v 4 games ↑ than that covered during the 5 v 5 games.
Kelly and Drust (2009)	*n* = 8 males 18 ± 1 years Height 1.80 ± 0.1 m BM 73.3 ± 6.2 kg HR_{max} 204 ± 9 bpm - Professional players	Repeated measures. All participant performed 4 testing sessions (sessions 2, 3 and 4 were 3 different formats of SSGs) - On an natural grass pitch	All games were proceeded by a 20-min standardised warm-up, then 3 formats of SSG (5 v 5 + 2 goalkeepers): - SSG1: 30 × 20 m - SSG2: 40 × 30 m - SSG3: 50 × 40 m - 4 × 4 min/2 min active recovery (SSG lasted 24-min total) - No rules were utilised	*Physiological responses*: - HR *Technical demands*: - Pass, Receive, turn, dribble, Header, tackle, interception, shot and target pass.	- Mean ± S.D. HR for the three games were not significantly different between conditions (SSG1, SSG2 and SSG3). - The number of tackles and shots were significantly different between conditions. - Changes in pitch size do not alter HR or the majority of technical requirements observed within SSGs.

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Köklü (2012)	*n* = 20 16.6 ± 0.5 years Height 176.2 ± 4.6 cm BM 65.9 ± 5.6 kg HR_{max} 197.5 ± 6.7 bpm - Minimum 5 years of experience	Repeated measures. All participant completed the YYIRT1 and intermittent and continuous 2 v 2, 3 v 3 and 4 v 4 SSGs (2-week study period). - On a artificial grass pitch	Each SSG was played after a 20-min warm-up. Three differents SSGs: - 2 v 2: SSG^I 3 × 2 min SSG^C 6 min - 3 v 3: SSG^I 3 × 3 min SSG^C 9 min - 4 v 4: SSG^I 3 × 4 min SSG^C 12 min - No specific rules were utilized - Without goalkeepers - Coach encouragement	*Physiological responses*: - HR and $\%HR_{max}$ - BLa	- The 3 v 3 SSG^I and SSG^C measurements ↑ than the 2 v 2 and 4 v 4 games in terms of HR and $\%HR_{max}$, whereas the 2 v 2 SSG^I and SSG^C ↑ BLa compared to other SSG types. - SSG^I and SSG^C are similar in terms of physiological responses except for 2 v 2 game BLa responses.
Köklü et al. (2012)	*n* = 32 16.2 ± 0.7 years Height 172.9 ± 6.1 cm BM 64.1 ± 7.7 kg HR_{max} 198.1 ± 5.7 bpm - Average training age 6.2 ± 2.0 years - 5 ss/wk	Repeated measures. All participant performed 4 v 4 SSGs that were created using 4 different methods (CE, TS, AP and CG). - On a artificial grass pitch	Each 4 v 4 was performed after a 20-min warm-up. SSG4 were: CE, TS, AP and CG. - 4 × 4 min/2 min passive recovery - Pitch size: 36 × 24 m - No specific rules were used - Without a goalkeeper and used small goals	*Physiological responses*: - HR ($\%HR_{max}$ and HR zones) - BLa - RPE (CR-10 Borg´s scale) *Time-motion characteristics*: - Total distance - Total distance at speed zones	- $\%HR_{max}$, BLa and RPE ↑ for teams chosen according to AP and CG. - Teams chosen by AP and CG spent ↑ time in zone 4 (> 90% HR_{max}) and covered ↑ distance in the high-intensity running zone than teams formed according to TS. - AP teams ↑ total distance than TS teams.
Köklü et al. (2017)	*n* = 15 males 17 ± 1 years Height 172.5 ± 7.2 cm BM 67.6 ± 7.2 kg - Elite youth players - 5 ss/wk	Repeated measured. All participants performed 12 SSG training sessions (2 v 2, 3 v 3, and 4 v 4) with different bout duration. - On an artificial grass	Each SSG was played after a 20-min standardized warm-up. The SSGs were 2 v 2 (16 x 25 m), 3 v 3 (20 x 30 m), and 4 v 4 (25 x 32 m) with different bout duration: - CON: 1 × 12 min - SBD: 6 × 2 min/2 min passive rest - MBD: 3 × 4 min/2 min passive rest - LBD: 2 × 6 min/2 min passive rest - No GK and maintain ball possession - Verbal encouragement	*Physiological responses*: - $\%HR_{max}$ - BLa - RPE (CR-10) *Time-motion characteristics*: - Four speed zones (W, LIR, MIR, and HIR).	- The SBD elicited ↓ $\%HR_{max}$ compared to LBD and CON in all formats. - The SBD format also showed significantly shorter distances covered in W and ↑ distances covered in MIR, as well as, significantly ↑ total distance covered compared to LBD and CON in all formats. - The LBD format produced ↓ BLa and RPE than SBD and CON in all formats.
Köklü et al. (2015)	*n* = 16 16.5 ± 1.5 years Height 175.5 ± 5.2 cm BM 63.0 ± 6.9 kg - Training experience 6.3 ± 1.3 years - 5 ss/wk	Repeated measures. All participant completed the YYIRT1 and 3 formats of SSG (with or without goalkeepers). - On a artificial grass pitch.	20-min a standardized warm-up. Three formats of SSG: - 2 v 2 games: 4 × 2 min/2 min passive recovery (15 x 27 m) - 3 v 3: 4 × 3 min/2 min passive recovery (20 x 30 m) - 4 v 4: 4 × 4 min/2 passive recovery (25 x 32 m) - Relative pitch size remained constant: 100 m	*Physiological responses*: - HR ($\%HR_{max}$) - BLa - RPE (CR-10) *Time-motion characteristics*: - Total distance - Total distance at speed zones	- During the SSG-P player showed ↑ $\%HR_{max}$, BLa, and RPE, ↑ distance covered in LIR, MIR, HIR and total distance compared with the SSG-G during the 2 v 2, 3 v 3, and 4 v 4.
Mallo and Navarro (2008)	*n* = 10 males 18.4 ± 0.6 years Height 178.2 ± 5.1 cm BM 71.5 ± 1.4 kg - Average practice 9.3 ± 1.4 years - Elite players - 4 ss/wk + 1 match	Repeated measures. All participant performed 3 formats of SSG (3 v 3). - On an artificial grass pitch	A standardized match-day warm-up, followed by three formats of SSG (3 v 3): - D1: maintain the ball - D2: maintain the ball (with 2 outer players that can pass the ball) - D3: with goalkeepers (3 v 3 + 2) and ordinary football rules - Pitch size: 33 × 20 m - 3 × 5 min/10 min active recovery	*Kinematic analysis*: - Speed zones - Time spent moving at different velocities *Physiological responses*: - HR ($\%HR_{max}$ and $\%HR_{max}$ zones) *Technical analysis*: - Total number of contacts with the ball, short distance passes (< 15m) and shots on goals.	- The overall intensity of SSG ↑ than the experienced during competitive matches. - Distance covered and HR ↑ in the drills without goalkeepers. - SSG with goalkeepers ↓ the tempo of the game as players performed ↓ high-intensity running and ↑ low-intensity activities. - Time spent at intensities between 76–85% HR_{max} ↓ in the game without goals, whereas the SSG with goalkeepers ↓ activities exceeding 86% HR_{max}.

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Ngo et al. (2012)	*n* = 12 16.2 ± 0.7 years BM 55.7 ± 6.4 kg Height 1.70 ± 0.07 m HR_{max} 205 ± 6 bpm - 2 ss/wk	Repeated measures. All participant performed eight 3 v 3 SSG sessions within 6 weeks (each participant completed each of the 4 SSG formats twice). - On an artificial grass pitch	10-min a standardized warm-up before SSG training sessions. 4 different formats of SSGs (3 v 3): - MM with goal - MM with no goal - NMM with goal - NMM with no goal - 3 × 4 min/4 min passive recovery - Pitch size: 18 × 25 m	*Physiological responses*: - HR (%$HR_{reserve}$) - RPE (CR-10 Borg´s scale)	- Defensive rule had significant effect on intensity. - MM during SSG ↑ %$HR_{reserve}$ compared to NMM, irrespective of the presence or absence of goals. - MM with goals ↑ RPE compared to NMM, whereas no difference in RPE was observed between MM and NMM without goals.
Rampinini et al. (2007)	*n* = 20 24.5 ± 4.1 years Height 1.79 ± 0.05 m BM 73.1 ± 8.6 kg - Experience 15 ± 5 years - Amateur players - 2–3 ss/wk + 1 match	Repeated measures. All participant performed 4 formats of SSG on 3 differently sized playing areas and with and wihout coach encouragement.	20-min warm-up, followed by a SSG training session. SSGs: - 3 v 3: Small (12x20 m), medium (15x25 m) and large (18x30 m) dimensions. - 4 v 4: Small (16x24 m), medium (20x30 m) and large (24x36 m) dimensions. - 5 v 5: Small (20x28 m), medium (25x35 m) and large (30x42 m) dimensions. - 6 v 6: Small (24x32 m), medium (30x40 m) and large (36x48 m) dimensions. -3x4min/3 min active recovery - Without goalkeepers, small goals and free touches.	*Physiological measures*: - HR - BLa - RPE (Borg´s CR10 scale)	- Main effect were found for exercise type, field dimensions, and coach encouragement. - 6 v 6 on a small pitch without coach encouragement, exercise intensity was 84 ± 5% of HR_{max}, BLa was 3.4 ± 1.0 mmol/l, and the RPE was 4.8. - 3 v 3 on a larger pitch with coach encouragement, exercise intensity was 91 ± 2% of HR_{max}, BLa was 6.5 ± 1.5 mmol/l, and the RPE was 7.2.
Sampaio et al. (2014)	*n* = 24 males 20.8 ± 1.0 years Height 173.2 ± 6.3 BM 9.4 ± 2.0 - Playing experience 5.2 ± 1.3 years	Repeated measures. All participant performed 7 different SSGs. Four balanced teams (with four goalkeepers). - Natural grass pitch	20-min standardized warm-up followed by a testing session. The first 3 games: - 5 v 5 at normal pace - 5 v 5 at slow pace - 5 v 5 at fast pace The remaining 4 SSGs: - 5 × 4 Superiority (wining) - 5 × 4 Superiority (losing) - 4 × 5 Inferiority (wining) - 4 × 5 Inferiority (losing) - Continuous 5 min period/3 min passive rest between games. - Pitch size: 60 × 40 m	*Time-motion*: - Speed - Distance covered (speed zones) *Physiological responses*: - HR (%HR_{max} and time spent in %HR_{max} zones) *Tactical behaviour*: - Team centroid	- The fast paced games ↑ mean speed value, followed by normal and slow paced games. - The stronger predictor variables of pacing were the randomness in distance to team centroid and the distances covered above 13 km/h. - The strongest predictor variables were distance covered bellow 6.9 km/h, distance and randomness to team centroid, with higher values when winning in superiority conditions.
Sanchez-Sanchez et al. (2017)	*n* = 22 males 17.2 ± 0.9 years Height 175.3 ± 5.4 cm BM 66.8 ± 5.9 kg - 16 players participated in the analyses of SSG (6 players participated as wildcards and goalkeepers) - Elite youth players - 5 ss/wk + 1 match	Repeated measured. A total of 16 football players randomly completed 6 SSG situations. - On an artificial grass	Before SSG, a standardized 15-min warm-up was completed. The SSGs were a 4 v 4 in different conditions: - CTR: NO and GK - 2 IW: 4 v 4 + 2IW-NO and 4 v 4 + 2IW+ GK - 2 IEW: 4 v 4 + 2IW+ 2IEW- NO and 4 v 4 + 2IW + 2IEW-GK - Pitch size: 30 × 40 m - Free touch and official football-rules (except the offside rule) - 4 × 4 min/2 min passive recovery	*Physiological response*: - HR - HR intensity-zones - RPE (CR-10) *Technical-tactical actions*: - Pass - Dribbling - Collective success - Game pause	- During 4 v 4 + 2IW+ 2IEW-NO ↑ time was recorded in zone 1 compared with 4 v 4-NO and 4 v 4 + 2IW-NO. - During 4 v 4 + 2IW+ 2IEW-GK, ↑ time was recorded in zone 1and ↓ in zone 3 compared with 4 v 4-GK. - ↑ RPE was recorded in 4 v 4-NO and 4 v 4 + 2IW-NO compared with 4 v 4 + 2IW + 2IEW-NO, and during 4 v 4-GK than 4 v 4 + 2IW+ 2IEW-GK. - ↑ dribbling situations were recorded during 4 v 4-NO compared with 4 v 4 + 2IW+ 2IEW-NO.

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Table 1. (Continued).

Study (year)	Subject description	Study design	Exercise protocol	Outcome measures	Results
Sanchez-Sanchez et al. (2018)	*n* = 12 males 17.2 ± 0.44 years Height 1.72 ± 0.5 cm BM 64.81 ± 7.17 kg - Junior football players - 3 ss/wk + 1 match	Repeated measures. All participants performed 4 types of SSGs. - On an artificial grass	Four types of 4 v 4 SSGs (Teams A, B and C) with 4 × 4 matches: - BF: A v B, B v C, C v A and A v B (played for 2 min) - BV: The same pattern was used (athletes kept playing until a goal or up to 2 min if no goals) - EF: the same as BF - EV: the same as BV Team that rested, acting as the external wildcard (40 x 30 m, goals and GK)	*Time-motion characteristics*: - TD - Drel - HID - V_{max}	- TD and Drel ↑ in the BF and BV compared to EF and EV (small to moderate effect sizes). - Distance at various speed ranges (i.e. 13–18 km/h and > 18 km/h) ↑ at the BV than EV. - Distance > 18 km/h ↑ at the BV than BF and at the EV than EF.
Selmi et al. (2018)	*n* = 16 males 24 ± 0.9 years Height 1.80 ± 0.06 m Weight 73.03 ± 8.86 kg - Professional players - 6–7 ss/wk - Minimum of 10.5 years of experience	Repeated measured. All participant performed the two protocols (SSG and HIT). - Competitive period	Each form of training was preceded by a standardized warm-up. After 3 min of recovery and the training conditions: - SSG (4 v 4): 4 × 4 min/3 min passive recovery (lasted 28 min) Pitch size: 25 × 35 m/Maintain ball possession - HIT: 15 s runs at 110% maximal aerobic speed/ 15 s passive recovery in-between (lasted 28 min)	*Physiological responses*: - HR - RPE - BLa *Psychological measures*: - POMS	- Both HIT and SSG sessions induced similar physiological responses (HR, RPE and BLa). - HIT produced a mood disturbance while SSG ensured mood balance.

Notes: ↑ to increase or to obtain a higher value; ↓ to impair or to obtain a lower value; ~ approximately.

Abbreviations: BM = body mass; ss/wk = sessions per week; SSG = small-sided game; MM = man-marking; NMM = no man-marking; TD = total distance covered; $Speed_{peak}$ = maximum speed; $Speed_{ave}$ = average speed; HR = heart rate; $\%HR_{peak}$ = percentage of peak heart rate; RPE = rate of perceived exertion; $\%HR_{ave}$ = percentage of average heart rate; SEP = speed-endurance-production drills; SEM = speed-endurance-maintenance drills; BLa = blood lactate accumulation; HR_{max} = maximum heart rate; SSGar = small-sided games with active rest; SSGpr = small-sided games with passive rest; GK = presence of goalkeepers; $\%HR_{max}$ = percentage of maximum heart rate; W = walking; LIR = low-intensity running; MIR = moderate-intensity running; HIR = high-intensity running; FUT-SAT = System of Tactical Assessment in Soccer; SSG-SP = small-sided games with a strongly pushed coach encouragement; SSG-M = small-sided games with only mild, unobtrusive feedback; ES = effect size; CBs = number of conquered balls; RBs = number of received balls; LBs = number of lost balls; P = number of passes; S = number of successful shots on goal; DHS = distance covered at high speed without limit (> 18 km/h); DSS = distance covered at sprint speed without limit (> 21 km/h); FHS = frequency of effort at high speed without limit (> 18 km/h); FSS = frequency of effort at sprint speed without limit (> 21 km/h); PL = player load; %HRmean = mean heart rate with respect to the individual maximum; FMs = friendly matches; DC_m = distance covered per minute; DC_h = distance covered per hour; %T = percentage of time; V_{max} = maximum speed; WR = work:rest ratio; RHIEs = repeated high-intensity efforts; %time = percentage of time; SSG_{FP} = small-sided games with free play; SSG_{2T} = small-sided games of two touches per individual possession; SSG-P = small-sided games involving possession play; SSG-G = small-sided games with goalkeepers; SSG-g = small-sided games with small goals; FP = free play; DMP = double-man pressure; T1 = maximize the ball possession time and there was no goal; T2 = players were asked to cross opponents' endline with the possession of the ball and there was no goal; T3 = a small goal was placed on the team's end line and the aim was to score; $\%HR_{reserve}$ = percentage of reserve heart rate; TSAP = team sport assessment procedure; 1T = 1 touch; 2T = 2 touch; PR = passive recovery; AR = active recovery; VO_{2max} = maximum oxygen consumption; VHIR = very high-intensity running; B1 = bout one; MAS = maximal aerobic speed; VAMEVAL = continuous aerobic running test; CD = central defenders; FB = full-backs; CDM = central defensive midfielders; WM = wide midfielders; FW = forwards; T_s = successful tackle; T_{us} = unsuccessful tackle; DP_s = successful dribbling past; DP_{us} = unsuccessful dribbling past; S_s = successful shot; S_{us} = unsuccessful shot; ST_s = successful sliding tackle; ST_{us} = unsuccessful sliding tackle; P_s = successful pass; P_{us} = unsuccessful pass; TS = total high speed running; HS = high speed; VHS = very high speed; MS = maximal speed; MA = moderate accelerations; HA = high accelerations; MD = moderate decelerations; HD = high decelerations; EC = energy cost; P_{met} = metabolic power; TP = total high power; HP = high power; EP = elevated power; MP = maximal power; SSG^I = small-sided games intermittent regime; SSG^C = small-sided games continuous regime; HSR = distance covered at high speed; SPD = distance covered during sprinting; bpm = beats per minute; YYIRT1 = Yo-Yo intermittent recovery test 1; S_{with} = SSGs on the small pitch with a goalkeeper; $S_{without}$ = SSGs on the small pitch without a goalkeeper; M_{with} = SSGs on the medium pitch with a goalkeeper; $M_{without}$ = SSGs on the medium pitch without a goalkeeper; L_{with} = SSGs on the large pitch with a goalkeeper; $L_{without}$ = SSGs on the large pitch without a goalkeeper; V/LT = lactate threshold running velocity; S_{max} = maximal running speed; CE = coaches' subjective evaluation; TS = technical scores; AP = VO_{2max}; CG = VO_{2max} multiplied by technical score; SBD = short bout duration; MBD = medium bout duration; LBD = long bout duration; CON = continuous bout duration; D1 = drill 1; D2 = drill 2; D3 = drill 3; CTR = played without wildcard players; NO = goals scored without goalkeeper; IW = internal wildcard players; IEW = internal and external wildcard players; BF = at the beginning of the session with fixed recovery; BV = at the beginning of the session with variable recovery; EF = at the end of the session with fixed recovery; EV = at the end of the session with variable recovery; Drel = relative distance; HID = high-intensity distance; HIT = high-intensitive training with running exercises; POMS = Profile of mood state.

Table 2. Studies (n = 9) examining the chronic effects of SSGs on the performance of football players.

Study (year)	Subject description	Training programme (treatment and control groups)	Outcome measures	Results
Bujalance-Moreno et al. (2017)	*n* = 23 males 20.9 ± 4.5 years BM 22.6 ± 2.0 kg/m^2 - Semi-professional football academy and amateur players - 3 ss/wk + 1 match	- *Intervention period*: For a 6 weeks (season). All players were tested during 2 sessions, 6 weeks apart (pre-test and post-test). - *Groups*: SSGs (*n* = 12) and CG (*n* = 11). - *Training*: 12 SSG-based sessions were performed during the 6 weeks (twice per week). SSG: - Weeks 1–2: 4 v 4 (4x4 min/2 min recovery) - Weeks 3–4: 4 v 4 (5x3 min/2 min recovery) - Weeks 5–6: 2 v 2 (5x2 min/2 min recovery) - Number of touches ilimited - Possession play - Without GK or goals/score - The pitch size was modified	*Anthropometrical assessment*: - Height - Body mass *Neuromuscular response*: - Sprint - COD ability test - RSA shuttle test	- SSG training intervention ↑ performance in COD ability test and improve the t_{vmax} and RSAaverage.
Dellal et al. (2008)	*n* = 10 males 26.0 ± 2.9 years Height 181.4 ± 5.9 cm BM 78.3 ± 4.4 kg - Elite football players	- *Intervention period*: For a 7 weeks (season). Two sessions were implemented per week: 1 short-duration intermittent running and 1 SSG. - *Groups*: All subject performed all the different SSGs and the short duration intermittent running sessions. - *Training*: Short-duration intermittent running: - 30–30 PR (100% VO_{2max}) 2 × 10 min/IR 10 min (PR) - 30–30 AR (100% VO_{2max}) 2 × 10 min/IR 10 min (PR) - 15–15 PR (100% VO_{2max}) 2 × 10 min/IR 8 min (PR) - 10–10 PR (110% VO_{2max}) 2 × 7 min/IR 6 min (PR) - 5–20 PR (120% VO_{2max}) 1 × 7 min, 5 s SSGs characteristics: - 1 v 1 (10 x 10 m) 4 × 1 min, 30 s/1 min, 30 s (PR) - 2 v 2 (20 x 20 m) 6 × 2 min, 30 s/2 min, 30 s (PR) - 4 v 4 + GK (30 x 25 m) 2 × 4 min/3 min (PR) - 8 v 8 + GK (60 x 45 m) 2 × 10 min/5 min (PR) - 8 v 8 (60 x 45 m) 4 × 4 min/3 min (PR) - 10 v 10 + GK (90 x 45 m) 3 × 20 min/5 min (PR)	*Physiological response*: - HR (%$HR_{reserve}$)	- %$HR_{reserve}$ in the 30–30 AR ↑ than 30–30 PR, but also ↑ than the 1 v 1, 4 v 4, 8 v 8, and 10 v 10 SSGs. - %$HR_{reserve}$ was ↓ homogeneous in SSGs than in short-duration intermittent running. - During the 8 v 8, the GK induced an ~ 11% ↑ in %$HR_{reserve}$ and reduce homogeneity when compared to games without GK.
Dellal et al. (2012)	*n* = 22 males 26.3 ± 4.7 years BM 79.1 ± 5.6 kg Height 180 ± 4 cm - Amateur football players - 3–4 ss/wk + 1 match - GK were excluded	- *Intervention period*: For a 10 weeks (including a 6-week training period and 2 × 2 weeks of testing before and after the 6-week training sessions). - *Groups*: SSGs (*n* = 8), HIT (*n* = 8) and CG (*n* = 6). - *Training*: SSG (9 sessions): - 2 v 2 5 × 2 min, 30 s/2 min recovery (20 x 20 m) - 1 v 1 5 × 1 min, 30 s/1 min, 30 s recovery (15 x 10 m) Without a GK (maintain ball possessions) and on a synthetic grass field. HIT (9 sessions performed over 40-m shuttles): - 30s-30s (95%V30–15_{IFT}) 2x 2x10/6 min IR passive - 15s-15s (100%V30–15_{IFT}) 2x 2x8/5 min IR passive - 10s-10s (95%V30–15_{IFT}) 2x 2x7/5 min IR passive	*Physiological responses*: - HR (%$HR_{reserve}$) - RPE (Borg CR-10 scale)	- HIT and SSG groups ↑ in Vameval test (5.1 and 6.6%, respectively) and the 30–15_{IFT} with CODs (5.1 and 5.8%, respectively), whereas not change in the performance of the CG. - HIT and SSG groups = ↑ in their performance in the two test during the 6-week training period compared to CG.
Faude et al. (2014)	*n* = 19 males 16.5 ± 0.8 years Height 1.79 ± 0.06 m BM 70.7 ± 5.6 kg - Professional players - 4–5 ss/wk + 1 match	- *Intervention period*: For a 4 weeks (in-season). Two endurance sessions were implemented per week: SSG and HIT sessions. Before and after the training periods all players were tested. - *Groups*: All subject performed all the different SSGs and HIT sessions. - *Training:* – HIT sessions: 2x12-15/15 s runs (rest-to-run ratio = 1:1)/10 min rest between series. Intensity for the runs was set at 140% of IAT. - SSG sessions: - 3 v 3 (35 x 25 m) 4 × 4 min/4 min recovery - 4 v 4 (40 x 30 m) 4 × 4 min/4 min recovery - With goalkeepers	*Physiological responses*: - BLa - HR_{peak} - Urea - Creatine Kinase - IAT *Neuromuscular responses*: - CMJ - DJ - Straight Sprinting - COD performance *The Recovery-Stress Questionnaire for Athletes*: - The RESTQ-Sport	- Significant time effects were observed for IAT (+ 1.3%), HR_{peak} (−1.8%), and CMJ (−2.3%), with no significant interaction between groups. - Players with low baseline IAT values (+ 4.3%) showed greater improvements than those with high initial values. - A significant decrease was found for total recovery (−5.0%), and an increase was found for urea concentration (+ 9.2%).

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Table 2. (Continued).

Study (year)	Subject description	Training programme (treatment and control groups)	Outcome measures	Results
Impellizzeri et al. (2006)	*n* = 29 males 17.2 ± 0.8 years BM 69.1 ± 4.7 kg Height 178.1 ± 5.8 cm - Mean of 9.6 ± 1.5 years of experience - Professional junior players	- *Intervention period*: For a 18 weeks (from August to December) and consisted of 2 weeks of test (pre-test), 4 weeks of pre-season training, 2 weeks of test (mid-test), further 8 weeks of training followed by 2 weeks for testing (post-test). - *Groups*: GTG (*n* = 15) and STG (*n* = 14). - *Training*: 2 training sessions per week of aerobic interval training that consist of 4 bouts of exercise lasting 4 min with 3 min active recovery (60–70% of HR_{max}). GTG characteristics: - Runs at an intensity of 90–95% of HR_{max}. STG characteristics: SSGs selected were: - 3 v 3 + GK (25 x 35 m)/2–3 ball-touches - 4 v 4 + GK (40 x 50 m)/2 ball-touches - 4 v 4 and 5 v 5 (see article) - 4 v 4 and 5 v 5 (see article) - 4 v 4 and 5 v 5 (see article)	*Aerobic fitness*: - VO_{2max} - Lactate threshold (Tlac) - RE at Tlac *Football specific endurance*: - Ekblom´s circuit *Match performance and intensity*: - Total distance - Time spent: standing, walking, and at low- and high-intensity running speed.	- There were significant improvements in aerobic fitness and match performance in both groups of football players (specially in response to the first 4 weeks of pre-season training). - No significant differences between specific and generic aerobic interval training were found in any of the measured variables including football specific test.
Mohr and Krustrup (2016)	*n* = 18 males 19 ± 1 years Height 1.79 ± 0.06 m BM 79.4 ± 4.4 kg - 2 ss/wk + 2 match - Mean of 8 years of experience - Sub-elite players	- *Intervention period*: For a 4 weeks (season period). Two different types of anaerobic speed endurance training were implemented: speed endurance production (SEP) or speed endurance maintenance (SEM). Pre and post test were performed. - *Groups*: SEP (*n* = 9) and SEM (*n* = 9). - *Training*: Each training group performed 8 sessions (twice a week for a 4 weeks) of either SEP or SEM. SEP: individual drills with balls (work-rest ratio: 1:5) - 1 Week: 8 × 30 s/150 s passive rest - 2 Week: 8 × 30 s/150 s passive rest - 3 Week: 8 × 30 s/150 s passive rest - 4 Week: 10 × 30 s/150 s passive rest SEM: included SSGs of 2 v 2 + GK (20 x 20 m). Work-rest ratio: 1:1. - 1 Week: 8 × 45 s/45 s passive rest - 2 Week: 8 × 45 s/45 s passive rest - 3 Week: 8 × 45 s/45 s passive rest - 4 Week: 10 × 45 s/45 s passive rest	*Neuromuscular response*: - YYIR2 - RSA *Time-motion*: - Peak speed - Average running speed - Total distance covered *Physiological response*: - HR	- YYIR2 performance increased by 50 ± 8% and 26 ± 5% in SEP and SEM, respectively, with greater improvement in SEP. - RSA performance improved by 2.1 ± 0.3% and 1.3 ± 0.4% in SEP and SEM, respectively, while the RSA fatigue index decreased (4.4 ± 0.8 to 3.4 ± 0.5%) in SEP only. - Peak and average speed during training were higher in SEP than in SEM (24.5 ± 0.3 vs 19.2 ± 0.3 and 15.5 ± 0.1 km/h vs 9.4 ± 0.1 km/h).
Owen et al. (2012)	*n* = 15 males 24.5 ± 3.45 years Height 181.1 ± 5.78 cm BM 78.7 ± 7.67 kg - Professional football players (elite)	- *Intervention period*: For a 4 week period. - *Groups*: SSGs (*n* = 15) - *Training*: All SSGs were played in a 3 v 3 format with 3 outfield players + 1 GK on each side (7 SSG training sessions): - SSGs 1: 5 × 3 min/2 min passive recovery - SSGs 2: 6 × 3 min/2 min passive recovery - SSGs 3: 7 × 3 min/2 min passive recovery - SSGs 4: 8 × 3 min/2 min passive recovery - SSGs 5: 9 × 3 min/2 min passive recovery - SSGs 6: 10 × 3 min/2 min passive recovery - SSGs 7: 11 × 3 min/2 min passive recovery *Pitch size: 30 × 25 m *No specific tactical conditions	*Anthropometrical assessment*: - Skinfold *Physical assessment*: - RSA (FST, TST and % Decre) *Aerobic performance*: - VO_2 - RER - RR - HR - BLa	-–4 week SSG training intervention induced significant improvement in RSA (FST, TST and %Decre). - SSGs improve in RE (reduced significantly VO_2 and HR at running speed 9, 11, and 14 km/h).

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Table 2. (Continued).

Study (year)	Subject description	Training programme (treatment and control groups)	Outcome measures	Results
Paul et al. (2018)	*n* = 19 males - Team 1: 16.2 ± 0.8 years Height 170.8 ± 7.7 cm BM 58.2 ± 7.6 kg - Team 2: 16.4 ± 0.7 years Height 171.2 ± 7.5 cm BM 57.9 ± 7.2 kg - 5 ss/wk + 1 match - Professional players	- *Intervention period*: For a 4 weeks (in-season). One team (SSG & HIT) performed four SSG sessions and one HIT session per week (5 sessions in total). The other team (REG) continued their regular training organisation: 1 (total) SSG and HIT sessions as well as training of strength/power and speed and agility, respectively. - *Groups*: SSG & HIT (*n* = 12), and REG (*n* = 7). - *Training*: SSG & HIT: - SSG: 4 × 4 min/1 min passive recovery (4 v 4) Pitch area of 30 × 25 m - HIT: 2 × 6 min (30/15 s) at 110% of 30–15 IFT test performance and 2 × 4 min (15/15 s) at 120% of 30–15 IFT performance (rest period of 90 s between sets). REG: - 1 combined SSG & HIT session per week: 4 × 4 min/1 min passive recovery (no goal and only maintain ball possession) and 2 × 6 min (30/15 s) at 110% 30-15 IFT test performance. - 2 strength and power sessions; 1 speed and agility session; and 1 injury prevention (FIFA 11+) session per week.	*Neuromuscular responses*: - The 30-15 IFT - CMJ - COD (modified L run COD test) *Physiological response*: - HR	- Average % of maximum HR were 83% for the SSG & HIT vs 73% for the REG. - 30-15 IFT improved for the SSG & HIT (from 17.0 ± 1.1 to 18.4 ± 0.8 km/h) with no difference for the REG group (pre: 17.9 ± 1.3, post: 18.2 ± 1.6 km/h). - CMJ and COD were unchanged in both groups.
Rodríguez-Fernández et al. (2017)	*n* = 24 males 18.7 ± 1.7 years Height 175.6 ± 6.2 cm BM 66.7 ± 8.5 kg - Amateur players - Mean of 6.1 ± 2.0 years of experience	- *Intervention period*: For a 5 weeks (pre-season). Three test were performed at the beginning and the end (RSA, JUMP and SAR). - *Groups*: SSGs (*n* = 24) - *Training*: 5 training sessions/week (4 SSGs sessions + 1 technical-tactical session). SSGs: - Week 1: 8 v 8 (3x20 min/3 min recovery) - Week 2: 6 v 6 (3x20 min/3 min recovery) - Week 3: 6 v 6 + GK (4x12 min/1 min recovery) - Week 4: 4 v 4 (2x4x4 min/1 min recovery) - Week 5: 4 v 4 + GK (2x1x12 min) - The pitch size was modified	*Neuromuscular response*: - SAR - SJ and CMJ - RSA	- SSGs training (pre-season) ↑ RSA and flexibility performance. - No significant improvements during the vertical jump test. - WG improved significantly their fastest sprint and the total time during the RSA.

Notes: ↑ to increase or to obtain a higher value; ↓ to impair or to obtain a lower value; ~ approximately.

Abbreviations: BM = body mass; ss/wk = sessions per week; SSGs = small-sided games; CG = control group; GK = goalkeeper; COD = change of direction; RSA = repeated sprint ability; t_{vmax} = time to reach the maximal running velocity; $RSA_{average}$ = average speed of repeated sprint ability; AR = active recovery; PR = passive recovery; IR = interseries recovery; VO_{2max} = maximal oxygen uptake; $\%HR_{reserve}$ = percentage of reserve heart rate; HIT = high-intensitive training with running exercises; $V30\text{-}15_{IFT}$ = velocity at 30-15 intermittent fitness test; RPE = rate of perceived exertion; Vameval test = continuous aerobic test; IAT = individual anaerobic threshold; BLa = blood lactate accumulation; HR_{peak} = peak heart rate; CMJ = countermovement jump; DJ = drop jump; RESTQ-Sport = Recovery-Stress Questionnaire for Athletes; GTG = generic training group; STG = specific training group; HR_{max} = maximum heart rate; Tlac = Lactate threshold; RE = running economy; SEP = speed endurance production; SEM = speed endurance maintenance; YYIR2 = Yo-Yo intermittent recovery level 2 test; HR = heart rate; FST = fastest sprint time; TST = total sprint time; %Decre = percentage decrement score; VO_2 = oxygen uptake; RER = respiratory exchange ratio; RR = respiratory rate; REG = regular training organisation; FIFA = Federation international of football association; SAR = sit-and-reach test; SJ = squat jump; WG = worst players group.

Table 3. Modified downs and black scale.

Study	Item 1	Item 2	Item 3	Item 6	Item 7	Item 10	Item 12	Item 15	Item 16	Item 18	Item 20	Item 22	Item 23	Item 25	Total score (out of 14)
Aasgaard and Kilding (2018)	1	0	1	1	1	0	0	U	1	1	1	U	1	0	**8**
Ade et al. (2014)	1	0	1	1	1	0	0	U	1	1	1	U	0	0	**7**
Aguiar et al. (2013)	1	0	1	1	1	1	0	U	1	1	1	U	0	0	**8**
Arslan et al. (2017)	1	0	1	1	1	0	0	U	1	1	1	U	0	0	**7**
Bach Padilha et al. (2017)	1	0	1	1	1	0	0	U	1	1	1	U	0	0	**7**
Brandes and Elvers (2017)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Casamichana et al. (2015)	1	0	1	1	1	1	0	U	1	1	1	U	0	0	**8**
Casamichana et al. (2012)	1	0	1	1	1	0	0	U	1	1	1	U	0	0	**7**
Casamichana et al. (2013)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Casamichana et al. (2015)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Casamichana et al. (2014)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Castellano et al. (2013)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Cihan (2015)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Clemente et al. (2016)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Clemente et al (2014)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Coutts et al. (2009)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Dellal et al. (2011)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Dellal et al. (2008)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Dellal et al. (2012)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Dellal et al. (2011)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Dellal et al. (2011)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Dellal et al. (2011)	1	0	1	1	1	0	0	1	1	1	1	1	0	0	**9**
Dellal et al. (2012)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Edis et al. (2016)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Fanchini et al. (2011)	1	0	1	1	1	1	0	U	1	1	1	U	0	0	**8**
Gaudino et al. (2014)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Giménez et al. (2018)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Hill-Haas et al. (2009)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Hill-Haas et al. (2009)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Hodgson et al. (2014)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Hulka et al. (2016)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Jastrzębski and Radziminski (2015)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Kelly and Drust (2009)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Köklü (2012)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Köklü et al. (2012)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Köklü et al. (2017)	1	0	1	1	1	1	0	U	1	1	1	U	1	0	**9**
Köklü et al. (2015)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Mallo and Navarro (2008)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Ngo et al. (2012)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Rampinini et al. (2007)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Sampaio et al. (2014)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**
Sanchez-Sanchez et al. (2017)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Sanchez-Sanchez et al. (2018)	1	0	1	1	1	0	0	U	1	1	1	1	0	0	**8**
Selmi et al. (2018)	1	0	1	1	1	1	0	U	1	1	1	1	0	0	**9**

Notes: 0 = no; 1 = yes; U = unable to determine. Item 1: clear aim/hypothesis; Item 2: outcome measures clearly described; Item 3: patient characteristics clearly described; Item 6: main findings clearly described; Item 7: measures of random variability provided; Item 10: actual probability values reported; Item 12: participants prepared to participate representative of entire population; Item 15: blinding of outcome measures; Item 16: analysis completed was planned; Item 18: appropriate statistics; Item 20: valid and reliable outcome measures; Item 22: participants recruited over same period; Item 23: randomised; Item 25: adjustment made for confounding variables.

format and constant work and rest intervals, as well as, the rules of the game.

Most studies used HR, BLa, RPE and GPS to control the exhaustion level reached, to monitor the physical profile and to monitor the physiological and metabolic response to SSGs. Technical and tactical variables (such as pass, receive, turn, header, shoot, etc) were controlled in some of the aforementioned work (Bach Padilha et al., 2017; Brandes & Elvers, 2017; Clemente et al., 2014; Dellal et al., 2012; **Dellal et al., 2012**; Dellal et al., 2011; Dellal et al., 2011; Edis et al., 2016; Fanchini et al., 2011; Hill-Haas et al., 2009; Hodgson et al., 2014; Kelly & Drust, 2009; Mallo & Navarro, 2008; Sampaio et al., 2014; Sanchez-Sanchez et al., 2017).

3.1.1 Physiological parameters

A different training response, in terms of RPE and %HRmax, was found after three SSG formats performed in two SSG training regimes: SSG^C (24 min without rest interval) and SSG^I (4 × 6 min with 1.5 min passive rest), with an increase of RPE value and %HRmax after SSG^C compared with SSG^I. Moreover, there were no significant differences between SSG^I and SSG^C in the BLa response (Hill-Haas et al., 2009). Köklü (2012) found that the 3-a-side SSG^I and SSG^C measurements were higher than the 2-a-side and 4-a-side games in terms of HR and %HRmax, whereas the 2-a-side SSG^I and SSG^C obtained higher BLa compared to other SSG types.

Concerning the conditions of game a study by Casamichana et al. (2015) reported a physiological impact when man-marking was used, as %HRmean was significantly higher. These results are supported by the study of Aasgaard and Kilding (2018). Likewise, in the study of Castellano et al. (2013) it was concluded that HR responses were higher in SSGs involving possession play than in SSGs with goalkeepers and SSGs with small goals (3 vs. 3, 5 vs. 5, and 7 vs. 7). When the resting regimes were evaluated, it was found that all SSGs

with passive recovery elicited higher physiological responses in terms of the RPE and BLa compared to SSGs with active recovery (Arslan et al., 2017). Furthermore, the type of feedback provided during SSG does not impact the physiological response (HR and BLa) but this does affect RPE (negatively when a strongly pushed feedback are provided) (Brandes & Elvers, 2017).

3.1.2 External load

When comparing SSG^C and SSG^I we found that Casamichana et al. (2012) and **Dellal et al. (2012)** obtained that the high-intensity profile during friendly matches was higher than in SSGs, nevertheless, the global indicators of workload (work-rest ratio, player workload, and exertion index) were higher for SSGs than for friendly matches, as was the distance covered per minute.

Regarding to game formats, Aguiar et al. (2013) found that the distance covered in the smallest format (2 vs. 2) was lower than in all other formats (3-,4- and 5-a-side), moreover, this format presented the lowest number of sprints. Casamichana et al. (2015), Cihan (2015) and Aasgaard and Kilding (2018) investigated the effects of defensive strategies on the external load and demonstrated that adopting tactical rules such as man-marking and double-man pressure in SSG protocols significantly increases total distance and distance covered in the high-intensity running zone by the players. Moreover, Castellano et al. (2013) found that 3 indicators of external load (total distance covered, player load, and the work-rest ratio) decreased when goals/goalkeepers were included, but the number of accelerations was higher in games involving goals/goalkeepers. Arslan et al. (2017) found that the distance covered at the high-intensity running was higher in SSGs with active rest compared to the same SSGs with passive rest. Furthermore, when the type of feedback coach was compared no differences were found for the time-motion characteristics (Brandes & Elvers, 2017). On the other hand, Giménez et al. (2018) analysed the number of ball contacts and observed that during SSGs played with one touch the players performed their highest intensity of exercise (acceleration of >4 m/s^2) and time walking.

3.1.3 Technical-tactical parameters

It is well known that SSGs played on small pitches produce greater technical demands on players (passes, shots and tackles) compared to medium and large pitches (Hodgson et al., 2014; Kelly & Drust, 2009). **Dellal et al. (2012)** compared the technical-tactical demands of SSGs and friendly matches and observed that total numbers of duels and lost ball possession were higher in SSGs for all playing positions than match play, but percentage of successful passes and number of ball possessions were lower in SSGs (particularly with one touch and two touches) compared to match play.

When the number of ball contacts is modified, the percentage of successful passes and number of duels are altered, being fewer in SSGs played with one touch (Dellal et al., 2011).

Bach Padilha et al. (2017) examined players' tactical behaviours during SSGs with and without wildcard players and observed that players showed different tactical behaviours depending on the SSGs format and playing phase. Moreover, when comparing SSGs without wildcard players (4-a-side) and SSGs with internal and external wildcard players (4-a-side +2 internal +2 external), a greater number of dribbling situations were observed during SSGs without wildcard players (Sanchez-Sanchez et al., 2017). Regarding the type of feedback provided by the coach, Brandes and Elvers (2017) found that a strongly pushed feedback provided a decrease in game performance (i.e. volume of play).

3.2 Intervention studies

PEDro score for the 9 selected articles ranged from 6 to 7 out of a maximum of 11 (Table 4). No articles were excluded because of the score obtained. Concealment of allocation is not entirely relevant in studies of this nature; given the nature of football training and the sample selection methods used, it is difficult for researchers to keep themselves and participants unaware of the treatment and groups involved. Blinding of subjects and therapists (i.e. trainers) was also not applicable in this case.

From the 9 articles included in Table 2, 5 studies included a SSG-based intervention group (Bujalance-Moreno et al., 2017; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Owen et al., 2012; Rodríguez-Fernández

Table 4. Physiotherapy evidence database scale (PEDro).

Study	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Total score (out of 11)
Bujalance-Moreno et al. (2017)	0	1	0	1	0	0	0	1	1	1	1	**6**
Dellal et al. (2008)	1	0	0	1	0	0	0	1	1	1	1	**6**
Dellal et al. (2012)	0	1	0	1	0	0	0	1	1	1	1	**6**
Faude et al. (2014)	1	0	0	1	0	0	0	1	1	1	1	**6**
Impellizzeri et al. (2006)	1	0	0	1	0	0	0	1	1	1	1	**6**
Mohr and Krustrup (2016)	1	1	0	1	0	0	0	1	1	1	1	**7**
Owen et al. (2012)	1	0	0	1	0	0	0	1	1	1	1	**6**
Paul et al. (2018)	1	1	0	1	0	0	0	1	1	1	1	**7**
Rodríguez-Fernández et al. (2017)	1	0	0	1	0	0	0	1	1	1	1	**6**

Notes: 0 = item was not satisfied; 1 = item was satisfied. Item 1: eligibility criteria were specified; Item 2: subjects were randomly allocated to groups; Item 3: allocation was concealed; Item 4: the groups were similar at baseline regarding the most important prognostic indicators; Item 5: there was blinding of all subjects; Item 6: there was blinding of all therapists who administered the therapy; Item 7: there was blinding of all assessors who measured at least one key outcome; Item 8: measurements of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; Item 9: all subjects for whom outcome measuments were available received the treatment or control condition as allocated, or where this was not the case, data for at least one key outcome were analyzed by "intention to treat"; Item 10: the results of between groups statistical comparisons are reported for at least one key outcome; Item 11: the study prevides bothpoint measurements and measurements of variability for at least one key outcome.

et al., 2017) with one of them (Bujalance-Moreno et al., 2017) including a control group (whereas intervention group performed SSGs, control group kept performing traditional physical training as programmed by coaches). The comparison between SSG^{I} and SSG^{C} in the long-term was not taken into account in any of the studies analysed. All these studies lasted a minimum of 4 weeks, with 18 weeks being the longest intervention period (Impellizzeri et al., 2006) and included up to 1 (Dellal et al., 2008; Dellal et al., 2012; Paul et al., 2018), 2 (Bujalance-Moreno et al., 2017; Dellal et al., 2012; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Faude, Steffen, Kellmann & Meyer., 2014; Owen et al., 2012) or 4 (Paul et al., 2018; Rodríguez-Fernández et al., 2017) SSG sessions per week. Only 3 of these studies (Bujalance-Moreno et al., 2017; Owen et al., 2012; Rodríguez-Fernández et al., 2017) solely performed SSG sessions for intervention groups, with most of these studies performing SSG and HIIT (based on running exercises) sessions (Dellal et al., 2008; Dellal et al., 2012; Faude et al., 2014; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Paul et al., 2018) (all the studies, at least 1 sessions per week). To check the effectiveness of training programmes, all these studies included different tests to assess the effects of the intervention, such as: repeated sprint ability (RSA) test (Bujalance-Moreno et al., 2017; Mohr & Krustrup, 2016; Owen et al., 2012; Rodríguez-Fernández et al., 2017) (neuromuscular adaptation); recovery-stress questionnaire for athletes (Faude et al., 2014) (physiology adaptation); sit-and-reach test (Rodríguez-Fernández et al., 2017) (neuromuscular adaptation); jump test (Faude et al., 2014; Paul et al., 2018; Rodríguez-Fernández et al., 2017) (neuromuscular adaptation); continuous aerobic running test (Vameval) (Dellal et al., 2008; Dellal et al., 2012) (physiological adaptation); 30–15 intermittent fitness test ($30–15_{IFT}$) (Dellal et al., 2012; Paul et al., 2018) (physiological adaptation); submaximal treadmill test (Impellizzeri et al., 2006; Owen et al., 2012) (physiological adaptation); anthropometrical assessment (Owen et al., 2012) (physiological adaptation); sprint test (Bujalance-Moreno et al., 2017; Faude et al., 2014) (neuromuscular adaptation); endurance test (Faude et al., 2014) (physiological adaptation); Yo-Yo intermittent recovery level 2 test (Mohr & Krustrup, 2016) (physiological adaptation); football specific endurance (Impellizzeri et al., 2006) (neuromuscular adaptation); and change of direction (COD) ability test (Bujalance-Moreno et al., 2017; Faude et al., 2014; Paul et al., 2018) (neuromuscular adaptation). Additionally, HR, RPE and BLa were used to determine acute responses to training programmes in several studies (Dellal et al., 2008; Dellal et al., 2012; Faude et al., 2014; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Owen et al., 2012; Paul et al., 2018). Moreover, most of the studies (Bujalance-Moreno et al., 2017; Dellal et al., 2012; Faude et al., 2014; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Owen et al., 2012; Paul et al., 2018; Rodríguez-Fernández et al., 2017) focused on assessment the athletic performance of participants.

3.2.1 Neuromuscular adaptations

When comparing HIIT (based on running exercises) and SSG, both training methods improved the performance in football players. SSG increased performance more than HIIT (Dellal et al., 2012). In a study by Owen et al. (2012) 4 weeks SSG training intervention induced significant improvements in RSA parameters. Likewise, Rodríguez-Fernández et al. (2017) showed that SSGs improved RSA and flexibility performance after 5 weeks of training intervention. In a longer intervention (6 weeks), Bujalance-Moreno et al. (2017) found SSG training increased the performance in COD, acceleration and RSA. On the other hand, Faude et al. (2014) showed that additional endurance training (twice a week) conducted either as running intervals or as SSGs led to a decrease in countermovement jump (CMJ) height (−2.3%). Mohr and Krustrup (2016) found that anaerobic speed endurance production (individual drills with balls) induced a greater effect on Yo-Yo intermittent recovery level 2 test, RSA and peak sprinting performance in moderately trained football players, compared to anaerobic speed endurance maintenance training (SSGs). Furthermore, Paul et al. (2018) demonstrated that an increase in the frequency of SSG training per week resulted in an improvement in the 30–15 intermittent fitness test but not in the CMJ and COD.

3.2.2 Physiological parameters

A different training response, in terms of % reserve heart rate (%HRres) was found after an intervention period, with an increase of %HRres in the short-duration intermittent running with active recovery compared with the short-duration intermittent running with passive recovery and all SSG formats. The %HRres was lower homogeneous (the physical effect was variable according to the game; a sided game change in characteristics implies a change in physiological impact) in SSGs than in short-duration intermittent running (Dellal et al., 2008). Owen et al. (2012) showed that a SSG intervention period (4 weeks) improved running economy (RE), which translates into a reduction of oxygen uptake (VO_2) and HR at running speeds of 9, 11, and 14 km/h. In a study by Faude et al. (2014) running intervals or SSGs slightly increased individual anaerobic threshold velocity (+1.3%), moreover the peak heart rate decreased during the training periods (−1.8%), and an increase was found for urea concentration (+9.2%). Impellizzeri et al. (2006) showed that football-specific aerobic training using SSGs or interval running was just as effective in enhancing both aerobic power and capacity after the pre-season training period. During the competitive season, additional aerobic training only resulted in a moderate increase in running velocity at lactate threshold (~5%). Finally, Paul et al. (2018) showed that a concentrated period of SSG and HIIT is an effective training method to improve average %HRmax in youth football players.

3.2.3 External load

In the study of Impellizzeri et al. (2006) variables related of match performance improved after the pre-season period using generic and specific aerobic training (running interval training and SSGs). The time spent during low- and high-intensity activities increased by 14 and 18%, while walking time decreased by 10%. Furthermore, the total distance covered during match play increased by 6%. Mohr and Krustrup (2016) reported that speed endurance production training

organized as individual football drills produced markedly higher peak and average running speed than speed endurance maintenance training conducted as 2 vs. 2 SSGs, while there was no difference in distance covered between the two training regimes.

4. Discussion

The purpose to this systematic review was to critically analyse the literature to determine how SSGs affect football players from a multidisciplinary perspective (physiological, external load, technical/tactical and neuromuscular) in the short- and long-term. The main findings from the cross-sectional studies included in this review are: (1) at a physiological level, the main difference was that players obtained higher %HR, BLa and RPE when played in a smaller format compared to other higher format SSGs; (2) at external load level, physical demands were higher (distance covered, acceleration, deceleration, sprints) in SSGs played on medium and large pitches than on small pitches, for both amateur and professional level players; and (3) at a technical level, 2 vs. 2 format obtained higher technical/tactical indexes (passes, shots, etc.) compared with other formats, and besides, amateur players present lower percentage of successful technical action compared with professional players. On the other hand, the major outcomes from intervention studies included in this review are: (1) SSG-based training programmes are effective in improving specific performance in amateur or professional football players; (2) it is possible to use some SSG-based programmes for physically integrated training, since these obtain similar values (relative to the intensity) to those found in the players during short-duration intermittent running training; and (3) SSG could be an effective method to improve the performance in football specific actions as RSA, sprint and COD for amateur and elite football players. However, caution should be exercised when interpreting these findings, owing to the heterogeneity that exists among study protocols. In the next section, acute responses to SSGs (including cross-sectional studies) and long-term adaptations to SSG interventions (including SSG-based training programmes) are discussed separately.

4.1 Acute responses to ssg-based protocols

Understanding the effect of varying external factors on both exercise intensity and technical scores would allow a better integration of SSGs within the whole football training process that includes both physical and technical training. These factors include pitch area, player number, coach encouragement, training regimen (continuous or interval, including work-rest manipulations), rule modifications, and the use of goals and/or goalkeepers, among others (Jeffreys & Nitka, 2004; Little, 2009). The large number of variables that can be manipulated to prescribe different SSG sessions and influence game intensity contributes to the fact that only accurate game monitoring can guarantee the effective improvement of player physical fitness. When more than one variable is manipulated simultaneously, responses are more difficult to predict because of the different nature and inter-relation of the stimulus. In this way, the key is the knowledge of each of the effects caused by the different training stimulus by the trainer.

4.1.1 Acute effect of ssg-based protocols on physiological parameters

In the comparison between SSG^I and SSG^C (this aspect was not considered in the intervention studies), there are some doubts about the effect that these training regimes produce at a physiological level (Hill-Haas et al., 2009; Köklü, 2012). In previous studies equivocal findings regarding acute responses (RPE and %HRmax) between SSG^C and SSG^I have been reported (Hill-Haas et al., 2009). A possible explanation for this is that the additional rest period between the work bouts during SSG^I enables the players to start subsequent work bouts with a lower %HRmax, resulting in an overall lower %HRmax for SSG^I. In a study by Köklü (2012) when comparing the two training regimes, it was observed that SSG^I and SSG^C were similar in terms of physiological responses. On the other hand, a study of **Dellal et al. (2012)** that compared the results of three different 4 vs. 4 SSGs (SSG^I) and two 11-a-side friendly matches (SSG^C) found that the BLa recorded in all the three SSGs were significantly lower in comparison to friendly matches; the RPE results presented similar values between match play and SSGs; and, in general, the HR responses were greater during all the SSGs in comparison to those found during friendly matches.

Another aspect that should be analysed is the different bout duration. First, it has been demonstrated that SSG formats with short bout duration elicited lower %HRmax compared to those with long and continuous bout duration. Second, SSG formats with long bout duration produced lower BLa and RPE than SSG formats with short and continuous bout duration (Köklü et al., 2017). Taken together, both the SSG^I and SSG^C training regimes could be used during the season to provide a conditioning stimulus similar to match intensity, moreover SSG^I also seems to elicit more activation of anaerobic lactic metabolism, which may be useful for developing fitness requiring repeated sprint efforts with short recovery.

Differences in physiological responses to SSG^C and SSG^I might be expected, but what about between different SSG formats? Some studies found differences in the physiological response to the compared protocols (Aguiar et al., 2013; Arslan et al., 2017; Brandes & Elvers, 2017; Casamichana et al., 2015; Castellano et al., 2013; Clemente et al., 2014; Dellal et al., 2012; Dellal et al., 2011; Dellal et al., 2011; Hill-Haas et al., 2009; Köklü et al., 2015; Rampinini et al., 2007). The validity of comparing different formats of SSGs is an arduous and difficult task, since it depends on multiple factors such as number of touches, goals, types of marking, among others (Casamichana et al., 2015; Clemente et al., 2014; Dellal et al., 2011; Dellal et al., 2011; Dellal et al., 2011). So, we must be careful to draw definitive conclusions and make an overall assessment.

It seems clear that when changing the game formats (maintaining duration of work and rest periods, pitch size and conditions and rules of game), the formats with fewer players elicit greater %HR, RPE and BLa than in all other formats (2 vs.

2 and 3 vs. 3) (Aguiar et al., 2013; Hill-Haas et al., 2009). Likewise, SSGs played on a larger pitch were more intense than the same drills played on smaller pitches (Rampinini et al., 2007). But what happens when changing the conditions or rules of game? The results showed that the type of marking influenced the physiological demands of players (Aasgaard & Kilding, 2018; Casamichana et al., 2015). In the same way, when possession play was used in SSGs, the intensity was greater than in SSGs with goalkeepers or small goals (Castellano et al., 2013). These findings are similar to those found in the study of Köklü et al. (2015) that reported an increased in %HR, BLa and RPE during SSGs without goalkeepers compared with the SSGs with goalkeepers. Regarding a study that examined the effect of formats and scoring methods on football players' HR responses, it was reported that the 3 vs. 3 format induced higher HR responses and that the use of one central goal increased this too, above the other formats and scoring methods (Clemente et al., 2014). In a study by Dellal et al. (2011) it was observed that the SSGs played with one touch induced increase in BLa and RPE compared with two touches or free play (HR responses were unchanged by the modification of the rules (except for 4 vs. 4)). As for the incorporation of wildcard players during SSGs, it has been reported that the inclusion of internal and external wildcard players reduces HR and RPE values compared with the control condition (Sanchez-Sanchez et al., 2017). In conclusion, these results demonstrate that exercise intensity in SSGs can be manipulated through modifying multiple variables, so it is vital for coaches to improve their knowledge about the effect of variables manipulations on the athletic performance.

4.1.2 Acute effect of ssg-based protocols on external load

The available evidence about external load within SSG-based programmes is large. However, in the current review, only 4 of the reviewed manuscripts (Casamichana et al., 2012; **Dellal et al., 2012**; Hill-Haas et al., 2009; Köklü et al., 2017) examined the external load in the comparison between SSG^C and SSG^I in football players. Casamichana et al. (2012) and **Dellal et al. (2012)** examined the impact of developing SSG training sessions compared to conducting friendly matches, and the results would seem to indicate that SSGs are played at a higher intensity than are friendly matches. About that, Hill-Haas et al. (2009) compared two SSG training regimes (SSG^I and SSG^C) and observed that the players covered a greater distance at 13.0–17.9 km/h, a greater total distance at higher running speed, and a greater total number of sprints with SSG^I compared with SSG^C, moreover, no significant differences between SSG^C and SSG^I for total distance covered or for distance travelled while walking, jogging, or running at moderate speed. On the other hand, Köklü et al. (2017) analysed different bout duration (interval and continuous durations) during different SSGs (2-, 3- and 4-a-side) and reported that the short bout duration format showed significantly shorter distances covered in walking and greater distances covered in moderate-intensity running, as well as, significantly greater total distance covered compared to long bout duration and continuous duration in all formats. The greater frequency of sprint activity during SSG^I might be due to the additional passive rest period between each interval bout, which may have allowed for greater physiological recovery.

On the other hand, there are a lot of studies in the current review that examined the effect of game formats and other variables on the external load. In general, modification of the number of players and the balance of the opposition has been shown to alter the total distance covered (Aasgaard & Kilding, 2018; Aguiar et al., 2013; Casamichana et al., 2015; Cihan, 2015), as well as high-intensity running and sprinting performances (Hill-Haas et al., 2010, 2009; Jastrzębski & Radzimiński, 2015). The number of ball contacts per possession is a variable that also induced differences in external load demands. In this sense, Dellal et al. (2011), Dellal et al. (2011) and Giménez et al. (2018) found that SSGs played with one touch increased total distance covered by sprinting and high-intensity runs, in addition to performing more high intensity exercise (acceleration of >4 m/s^2) and walking. Moreover, a study by Dellal et al. (2011) examined the relationship between the playing level in football and external load demands observing that amateur players covered less total distance with respect to sprinting and high-intensity running than professional players. The ability to complete repeated sprints may represent the best physical factor differentiating the playing level (Rampinini et al., 2009).

Regarding changes in the game format (possession play vs. regulation goals and goalkeepers vs. small goals only), it is known that indicators of external load decrease when SSGs are played with goals/goalkeepers (Castellano et al., 2013). This is in line with the findings reported by Mallo and Navarro (2008) and Köklü et al. (2015) Conversely, Gaudino et al. (2014) discovered that total distance, very high (19.8–25.2 km/h) and maximal (>25.2 km/h) speed distances, absolute maximal velocity and maximum acceleration and deceleration were higher in SSGs played with regular goals and goalkeepers than in possession play. Finally, whereas Hodgson et al. (2014) reported that SSGs (5 vs. 5 including goalkeepers) played on medium and large pitches had a greater external load than on small pitches, Hulka et al. (2016) obtained a greater distance covered by players during 5 vs. 5 SSGs with goalkeepers than without them played on the small pitch. These results indicate that the pitch size is a very important variable that influences the player's work load and that the inclusion of the goalkeeper decreases the work load of the player on a small pitch, but not on a medium or large pitch.

Additionally, further information is needed about two relevant points in the design of SSGs: resting regimes and the order of presentation of SSGs within the session. Regarding the resting regimes, Arslan et al. (2017) indicated that 2-a-side SSG with passive rest induced lower total distance covered than 2-a-side SSG with active rest (running at certain intensity), moreover the distance covered at high-intensity running was higher in 4-a-side SSG with active rest than 4-a-side SSG with passive rest. This might be due to active rest periods in SSGs allow to remove a part of BLa produced and phosphocreatine resynthesis, contributing to anaerobic system engagement during the following effort (Dupont, Moalla, Guinhouya, Ahmaidi, & Berthoin, 2004). Finally, Sanchez-Sanchez et al. (2018) reported that the moment of SSG application is important, since greater physical demands (i.e. high-intensity distance, total distance)

were observed during SSG played at the beginning of training sessions (especially when a fixed recovery period was used) compared to SSG played at the end of training sessions.

4.1.3 Acute effect of ssg-based protocols on technical-tactical parameters

The effect of SSGs on technical-tactical performance has been widely studied (Brandes & Elvers, 2017; Clemente et al., 2014; Dellal et al., 2012; Dellal et al., 2011; **Dellal et al., 2012**; Dellal et al., 2011; Dellal et al., 2011; Edis et al., 2016; Fanchini et al., 2011; Hodgson et al., 2014; Kelly & Drust, 2009; Mallo & Navarro, 2008; Sampaio et al., 2014). When generalising the results of studies we must be cautious and take into account other variables that may affect the technical-tactical parameters.

In turn, the influence of modifying the number of ball contacts allowed per individual possession is an important variable because modern elite football is characterised by the capacity of players to play with fewer ball contacts per possession (Dellal et al., 2008). In this sense, Dellal et al. (2011) found that percentage of successful passes and number of duels was fewer in SSGs played with one touch. In a later study, the free-play rule showed a greater number of duels and resulted in less technical actions (successful passes and number of ball losses) as compared with the SSG played in one touch and two touch format (Dellal et al., 2011). Another important aspect is comparing the difference of the level of play that exists during SSGs and if the modification of this rule induces the same technical load between amateurs and professionals during SSGs. In their study, Dellal et al. (2011) reported that amateurs had a lower percentage of successful passes and lost a greater amount of ball possessions per possession than their professional counterparts. Therefore, the technical pattern is also considered as one of the key factors that differentiate amateur and professional playing levels.

In addition to the aforementioned results, Clemente et al. (2014) examined the effects of the number of players and scoring method on technical performance, observing a higher number of individual indicators in smaller formats, and efficiency index, performance score, and attacks with the ball higher in opponent's endline (scoring method). The ability of the players to successfully complete technical actions decreases from the first period to the last period of SSGs, and this difference is also influenced by the numbers of players and the game formats (Dellal et al., 2012). Thus, the examination of the effect of bout duration on technical actions is important too. In the study by Fanchini et al. (2011) technical actions were not influenced by duration, and only a few technical abilities tended to decrease across bouts (passes, successful passes, and interceptions).

The incorporation of wildcard players also influences the technical-tactical parameters. In a study by Sanchez-Sanchez et al. (2017), was observed that the incorporation of internal and external wildcard players during SSGs reduced the number of dribbling actions. Regarding tactical behaviour, Bach Padilha et al. (2017) observed that in SSG without wildcard, players more frequently performed the tactical principles of concentration during defensive phase and penetration for the offensive phase (1 vs. 1 situation); and in SSG with wildcard, players made more effective use of playing space during the offensive phase and limited the space for the opponent by compacting the defence (defensive unity).

At last, postural adaptation and balance are important features for football players to set their body positions quickly, maintain them completely and perform perfectly their technical skills under challenging conditions such as sudden directional changes of the ball and distractions (slippery field, wind, etc.) (Evangelos et al., 2012). For that, the purpose of the study by Edis et al. (2016) was to determine the relationship between postural control variables and football-specific technical variables, reporting that greater postural control levels are among the important variables that affect success in the performance of technical skills under rival pressure and suddenly changing conditions.

These results demonstrate that modifying the number of ball contacts allowed per individual possession, number of players (wildcard) and length of pitch can influence technical-tactical demands on players and exercise intensity in SSGs, being greater when lower numbers of ball contacts are allowed, SSGs are played on small pitches and without wildcard players. However, the frequency of technical actions (passes/shots/dribbles) is not the only indicative measure of technical efficiency and benefit but some technical actions defined by distance, pace and techniques adopted in elite 11 vs. 11 competitions are in fact absent from SSGs (clipping, crossing, heading). Therefore, further research is needed to clarify the complex nature of technical-tactical specificity.

4.2 Long-term adaptations to ssg-based football programmes

4.2.1 Neuromuscular adaptations

Despite differences in training programmes conducted by the selected studies (Bujalance-Moreno et al., 2017; Dellal et al., 2008; Dellal et al., 2012; Faude et al., 2014; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Owen et al., 2012; Paul et al., 2018; Rodríguez-Fernández et al., 2017), all agree that athletic performance improve after SSG intervention. Dellal et al. (2012) performed one of the longest interventions included in this review (10 weeks) by combining usual football training (technical and tactical) with HIIT (30 s runs at 95%V30-15$_{IFT}$, 15 s runs at 100%V30-15$_{IFT}$ and 10 s runs at 95%V30-15$_{IFT}$) or SSG (2 vs. 2 and 1 vs. 1) for 2 sessions/week maximum. This work concluded that performance in Vameval (continuous aerobic running test) increased by 5.1% and 6.6% (HIIT and SSG groups, respectively) and the 30-15$_{IFT}$ with CODs increased by 5.1% and 5.8% (HIIT and SSG groups, respectively). For its part, Jastrzebski et al. (2014) found that HIIT (based on running exercises) and SSGs have limited effects on running speed in young football players. Similarly, Hill-Haas et al. (2009) performed studies regarding the effectiveness of generic training (running exercises) and SSG training, and observed that the time measured during the 5 m and 20 m runs did not change significantly. On the other hand, Mohr and Krustrup (2016) observed that individual drills with balls obtained a greater effect on RSA and peak sprinting performance in football players, compared to SSGs training.

In contrast, Chaouachi, Chtara, Hammami, and Chtara (2014) examined the effects of a multidirectional sprint (COD training) and SSG training on performance in elite-level young male football players. The SSG group showed improvements in sprint (+1.5%) and COD (+5.1%) but this was lower than those in the COD group (4 and 6.7%, respectively). The SSG group had a superior effect on agility performance (+6.2%) compared with COD group (+4.2%), considered as the ability to provide a proper COD according to an unpredicted external stimulus (Sheppard & Young, 2006). Furthermore, Paul et al. (2018) analysed the effects of combining SSG and HIIT sessions in a higher frequency of training per week (4 SSG sessions and 1 HIIT) versus a regular training organisation (1 SSG and HIIT sessions as well as training of strength/power and speed and agility, respectively) after 4 weeks of intervention in professional players. The results showed an improvement in the 30-15 intermittent fitness test for the groups with higher SSG training frequency (from 17.0 ± 1.1 to 18.4 ± 0.8 km/h) with no difference for the control group (17.9 ± 1.3 to 18.2 ± 1.6 km/h). The CMJ and COD performance were unchanged in both groups.

From the selected studies, five compared HIIT sessions (based on running exercises) with SSG-based workouts, but other authors went further and prescribed football plans exclusively using SSGs. Rodríguez-Fernández et al. (2017) replaced the regular endurance training programme (HIIT with short-duration intermittent running) with a SSG-based plan (different formats) 4 times per week and observed significant improvements in flexibility and RSA performance ($P < 0.05$), after 5 weeks of intervention. On the other hand, Bujalance-Moreno et al. (2017) reported improvements in acceleration, RSA, and COD ability test after 6 weeks of SSG training programme (2 sessions/week) during the season. Even during a shorter intervention (Owen et al., 2012), the use of SSG sessions (2 per week) over 4 weeks has shown improvements in RSA. Based on these results, the presence of at least 2 sessions of SSG workouts in a football plan allows amateur football players to improve their athletic performance.

In spite of the results obtained in the different studies, coaches should take into consideration that SSGs need to have specific conditions to improve positively the players' physical fitness (Rampinini et al., 2007). It has been reported that football players with worst initial RSA performance improved more significantly their fastest sprint (~2.5%) and the total time (~3.0%) during the RSA than players with best initial RSA performance, after a SSG-based training programme (Rodríguez-Fernández et al., 2017). In line with the previous results, Faude et al. (2014) demonstrated that players with low baseline values achieved relevant adaptations in endurance capacity, independent of the training method (running interval training or SSGs). Perhaps, the exercise intensity performed during SSGs were different according to the level of the players, and this could affect the results obtained. It seems clear that the same training performed did not cause the same effect for all players.

One of the best physical factors differentiating the playing level may be the ability to complete repeated sprints (or what is the same RSA) (Rampinini et al., 2009). Therefore, the players with best level need to increase their work with other types of training (i.e. interval training, weight training) or to find other more suitable combinations of the different variables that characterize SSGs (i.e. pitch dimension, number of players, rules, work-rest ratio, goals).

It is also important to examine the format and the duration of work intervals during SSG. Some of these studies included SSG large formats (6 vs. 6, 8 vs. 8 and 10 vs. 10) with work periods ranging from 4 to 20 min (Dellal et al., 2008; Rodríguez-Fernández et al., 2017), and others (Bujalance-Moreno et al., 2017; Dellal et al., 2008; Dellal et al., 2012; Faude et al., 2014; Impellizzeri et al., 2006; Mohr & Krustrup, 2016; Owen et al., 2012; Paul et al., 2018; Rodríguez-Fernández et al., 2017) SSG small formats (1 vs. 1, 2 vs. 2, 3 vs. 3, 4 vs. 4 and 5 vs. 5) with shorter work intervals (ranging from 45 s to 4 min). Based on these findings, the authors suggest that SSG must be a part of training plans for football players, combining this type of training with interval and weight training, but training periodization should take the progressive overload principle into consideration. For example, during a traditional periodization (increasing intensities and decreasing volumes), SSG should move from large formats to small formats and more intense.

None of the selected studies has directly measured or monitored injury risk factors during SSG intervention. There is a lack of researches that implicate the SSG to the injury risk in football players. Therefore, it seems that consensus exists about the benefits of SSG interventions for football players, although more longitudinal studies covering the effects of SSG-based training programmes on injury risk factors for football players are needed.

4.2.2 Physiological adaptations

Related to maximal oxygen uptake (VO_{2max}) is the concept of running economy, the energetic cost of running at a given speed (Saunders, Pyne, Telford, & Hawley, 2004). Only one of the selected studies (Owen et al. (2012) assessed RE after 4-week SSG training intervention and observed that this training method improved RE and HR (reduced significantly VO_2 and HR at running speed 9, 11, and 14 km/h). Moreover, the results of the studies by Jastrzebski et al. (2014) and Radziminski, Rompa, Barnat, Dargiewicz, and Jastrzebski (2013) recommended the use of SSG, compared with interval running, for improving VO_{2max} after SSG-based training programme (both 8 weeks). The benefits of an improvement of VO_{2max} found in youth football players has shown to culminate in greater involvement with the ball, total distance covered, and a 100% increase in the number os sprints performed during match play (Radziminski et al., 2013). Therefore, RE can be considered a influencing factor on both the anaerobic and aerobic system in football players and that the periodized SSG training intervention could have a positive effect on that.

Concerning the HR responses, a study by Dellal et al. (2008) with a duration of 7 weeks combining short-duration intermittent running and a SSG session (2 sessions per week) reported %HR reserve was higher in the 30–30 (working time-recovery time in seconds) with active recovery than in

30–30 with passive recovery (9.1%), but also higher than in all SSGs. The greater intensity of the 30–30 (active recovery) can be due to the lack of additional passive rest period between each of the intraseries bouts, which could have allowed for greater physiological recovery. Moreover, in that study was found that %HRres was less homogeneous during the different SSGs compared to intermittent running (intersubject coefficient of variation = 11.8% versus 5.9%, respectively); that fact can be explained because the activity of the football players was not totally controlled by the staff because the moves of football players were different depending on their experience, their position during the competition game, the movements of the opponents, and/or their motivation (Spalding, Lyon, Steel, & Hatfield, 2004; Stølen et al., 2005). Finally, in the study of Paul et al. (2018) was observed that the average % HRmax were 83% for the group with higher SSG training frequency versus 73% for the group with smaller frequency (only 1 SSG training session per week).

In the comparison of SSG and generic interval training (running interval training) there is a consensus that both training methods improve the aerobic and recovery capacity of football players. There are a lot of studies (Dellal et al., 2008; Dellal et al., 2012; Hill-Haas et al., 2009; Impellizzeri et al., 2006; Los Arcos et al., 2015; Faude et al., 2014; Radziminski et al., 2013) that have shown that specific and generic interval training are equally effective in development and maintaining physical capacity in amateur or elite football players. Besides that, Hill-Haas et al. (2009) observed that the generic training group was perceived to be more intense than SSG group in elite youth players, during a 7 week of intervention. On the other hand, Jastrzebski et al. (2014) found the performance intensity of young football players during interval training was higher in SSGs than in the running form. This fact can be due to game rivalry, and resulted in a significant VO_{2max} increase in the SSG group after the 8-week regime. Thus, Radziminski et al. (2013) suggests SSGs are more highly recommended training drills than interval running, as the simultaneous development of physical capacity and the technical-tactical skills is important as well as the motivation generated by this type of training. This method of training is very similar to the conditions of a football match, and that is why the authors suggest its use as part of training periodization.

4.2.3 External load

Only 2 of the selected studies analysed variables related to match performance (Impellizzeri et al., 2006; Mohr & Krustrup, 2016). In the study of Impellizzeri et al. (2006) after the preseason training period significant changes were found in the objective measures of match performance such as: time spent during low- and high-intensity activities (increased by 14 and 18%) and total distance covered during match-play (increased by 6%). However, no further changes were found after training during the competitive period. The total distance covered during a match is considered a weak indicator of football performance as it does not reflect how much players tax their maximal aerobic power (Van Gool, Van Gerven, & Boumans, 1988). On the other hand, the high-intensity activity was suggested to be a better measure of physical performance during a football game (Bangsbo, Nørregaard, & Thorsø, 1991; Krustrup et al., 2003; Mohr, Krustrup, & Bangsbo, 2003). Meanwhile, Mohr and Krustrup (2016) demonstrated that the speed endurance production players (individual drills with balls) reached markedly higher peak and average running speeds in comparison to the speed endurance maintenance players (SSGs).

There are several studies that have shown the effects of speed endurance production training on fatigue resistance during high-intensity exercise and manifested greater improvement compared with speed training (Mohr et al., 2007), endurance training (Iaia et al., 2008) and short-term tapering (Thomassen, Christensen, Gunnarsson, Nybo, & Bangsbo, 2010). So, a very high and constant exercise intensity during speed endurance production training and concomitant long recovery intervals may be speculated to be a stimuli for a wide range of adaptations in muscular systems that are important for improving fatigue resistance during intense intermittent exercise (Mohr & Krustrup, 2016).

4.3 Amateur and professional players

The differences between amateur and professional football players might limit the adaptations and physical results of SSGs. The RSA, with limited rest, is a major physical determinant of success in modern football, and it may represent the best physical factor differentiating the playing level (Rampinini et al., 2009). A study by Dellal et al. (2011), demonstrated a significant difference between amateur and professional players for the total distance covered in sprinting and high-intensity running, in addition to the relative physiological responses, including BLa concentration and perceptual responses, being higher for amateur perhaps because of their lower fitness level. Additionally, the technical pattern is also considered as one of the key factors that differentiate amateur and professional playing levels. In the aforementioned study, amateur seemed to be less technically proficient than professional as showed by a greater amount of lost balls per possession and a greater number of skill errors, with the greatest difference being most apparent in the small formats (i.e. 2- and 3-a-side) and when the SSG was played using the one touch rule. Therefore, the authors suggest that SSG format must be adapted according to the characteristics of the players, objectives and programmed adaptations.

5. Conclusion

In conclusion, the main goal of this review was to critically analyse the literature to determine how SSGs affect football players from a multidisciplinary perspective (physiological, external load, technical/tactical and neuromuscular) in the short- and long term. Across the presented studies, we concluded that SSG training is effective in improving specific performance in football players. In particular, cross-sectional studies included in this review showed that players obtained higher %HR, BLa, RPE and technical/tactical indexes (passes, shots, etc.) when played in smaller format as well as increased higher external load demands in SSGs played on medium and large pitches. Likewise, both SSG^{I} and SSG^{C} training regimes have the potential to improve the players' endurance

(maximal oxygen consumption and delayed fatigue) in addition to improving technical and tactical skills, so the authors support the idea that both must be part of training programmes for football players to maximise adaptations to training. On the other hand, intervention studies have shown SSG-based programmes are an effective method to improve the performance in football specific actions as RSA, sprint and COD for amateur and elite football players. Therefore, the authors suggest that SSGs are an efficient option for football players to simulate real match play situations and a proper tool in order to improve the physical fitness of players.

6. Practical applications

The main practical relevance of this review is that SSG training improves specific physical capacities on the football players. The design of SSG depends of training objective, moment of the season and the playing level of football players. The knowledge about methodological aspects plays a key role in the design of SSG protocols. From a practical point of view, the authors suggest that the inclusion of 2 to 4 SSG sessions in a football plan, accumulating work periods longer than 12 min and working at lactate threshold or at VO_{2max} per session, lets football players improve their aerobic and anaerobic performance. Regarding the type of SSG, a good practice for football players would include SSG protocols involving 3-a-side or 4-a-side with short work periods (3–6 min) with 4 to 8 repetitions, and with work-rest ratios of approximately 0.5:1 to 1:1, performed at close to all-out intensities.

In summary, the authors present a series of key points that can be very useful for the reader when designing SSG protocols. The main key points of SSGs are: (1) the order of presentation might be at beginning of a training session if the objective is improving the performance of football players (i.e. total distance); (2) SSG training interventions lasting at least 4 weeks improve RE and HR (reduced significantly VO_2); (3) increase the SSG training frequency per week (4 times per week) resulted in improvements of specific endurance in football (%HRmax); (4) progressive overload principle, SSG should move from large formats to small formats and more intense (increasing intensity and decreasing volumes) during a traditional season; (5) players with worst initial RSA (factor differentiating the playing level) performance improve more significantly their fastest sprint and total time during the RSA than players with best initial RSA performance, after a SSG-based training programme; (6) players with the best level of RSA need to increase their work load with other type of training (i.e. plyometric training, weight training) or to find the necessary stimulus within an appropriate SSG in order to improve their performance; (7) SSGs with active rest obtained higher performance in high-intensity actions, moreover a lower load in terms of the RPE and BLa; and (8) strong feedback by the coach can negatively affect the RPE and game performance, so mild feedback is advised since it will improve the tolerance of high training loads and training frequency. However, caution should be exercised when interpreting these key points, since it is necessary to understand how the modification of all the variables affects the responses to the SSG.

Future studies are required to increase the understanding of the interaction between the technical-tactical, external load and physiological demands of SSGs, as well as to investigate how these can be manipulated through modifying or altering factors influencing the game (i.e. player number, ball contact, pitch size, the use of goalkeepers, etc.) to improve the performance of football players. Furthermore, to increase the impact upon the subject area, future research might investigate: (1) positional differences within SSGs; (2) effect upon 11 vs. 11 competition, comparison of internal and external measures; and (3) elite vs. non elite. At the end, the SSG-based protocols will vary according to training periodisation (as in any sport), which must be based on the specificity and progressive overload principle.

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