SMALL-SIDED GAMES IN TEAM SPORTS TRAINING: A BRIEF REVIEW

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ABSTRACT

Halouani, J, Chtourou, H, Gabbett, T, Chaouachi, A, and Chamari, K. Small-sided games in team sports training: A brief review. *J Strength Cond Res* 28(12): 3594–3618, 2014—Small-sided games (SSGs) incorporating skills, sport-specific movements, at intensities sufficient to promote aerobic adaptations, are being increasingly implemented in professional team sport environments. Small-sided games are often employed by coaches based on the premise that the greatest training benefits occur when training simulates the specific movement patterns and physiological demands of the sport. At present, there is relatively little information regarding how SSG can best be used to improve physical capacities and technical and tactical skills in team sports. It is possible that with some modifications (e.g., number of players, pitch size, coach encouragement, and wrestling), such games may be physiologically beneficial for athletes with relatively high initial aerobic fitness levels. For instance, it has been shown that 3-a-side soccer SSG resulted in higher intensity (i.e., greater overall distance, less jogging and walking, higher heart rate, and more tackling, dribbling, goal attempts, and passes) than 5-a-side SSG. Likewise, when player numbers were kept constant, a larger playing area increased the intensity of the SSG with a smaller playing area having the opposite effect. It has also been demonstrated that energy expenditure was similar between badminton and volleyball courts, but lower than that obtained in a basketball court. Moreover, it has been demonstrated in rugby that wrestling can increase the physical demands of SSG. Consistent coach encouragement can also increase training intensity, although most rule changes have trivial or no effect on exercise intensity. Further research is required to examine the optimal periodization strategies of SSG training for the long-term development of physiological capacity, technical skill, and tactical proficiency, while also minimizing the associated risk of injuries.

KEY WORDS SSG, physiological responses, variables, exercise

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INTRODUCTION

Small-sided games (SSGs) are one of the most common drills used by coaches for soccer training. Although in the past SSGs were mainly used to improve the interaction among players and to develop technical and tactical abilities, they are now employed by many amateur and professional teams as an effective tool for aerobic training (6). Small-sided games are often used by adults as part of their regular training programs in various forms, depending on the aim and the philosophy of the coach. Small-sided games allow more time spent managing the ball under game-like conditions compared with generic training. Thus, most exercise sessions in team sports have SSG played with a reduced number of players on a smaller area than the regular official game pitch size (50). In recent years, the physiological stress generated in soccer SSG has been examined with respect to its potential to improve aerobic fitness (30). The advantages of SSG or training with the ball are commonly considered with respect to the attainment of an exercise intensity of 90–95% of maximum heart rate (HRmax), which has been proposed to enhance soccer-specific endurance capacity, develop game-specific muscle-groups, improve technical and tactical abilities in game-specific conditions, and assume an effective transfer to match play (12,26,31). Impellizzeri et al. (32) have shown that SSGs are equally effective at improving aerobic fitness as common fitness training activities such as interval running with an intensity of 90–95% of HRmax. Dellal et al. (14) also showed that some SSG formats resulted in heart rate (HR) responses comparable with short-duration intermittent running. Therefore, SSGs seem to be effective in combining motor learning, team cohesion components, and aerobic fitness training.

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Hill-Haas et al. (28) and Aguiar et al. (3) have recently summarized the literature relating to SSG in football. However, to date, the literature concerning the effect of SSG on physical and physiological responses and tactical and technical abilities during different team sports has not been summarized. All factors affecting the SSG in the different team sports are analyzed separately to understand their importance in the response of players to training. Therefore, a review summarizing the technical, tactical, and physiological responses of athletes to SSG would provide a more complete understanding of the potential benefits of this training modality.

This article is designed to summarize the current "state of play" in SSG research by reviewing the scientific literature concerning the technical, tactical, and physiological benefits associated with SSG training. A deeper understanding of the influence of manipulating variables to alter the players' responses to SSG will assist coaches to have better control over training, and thus create a more efficient training process. Given the increasing amount of research conducted on SSG in team sports and the fact that some variables are specific to only 1 sport (e.g., wrestling in rugby), an updated review on SSG is justified. This review represents a useful synthesis of all research on SSG in team sports and helps to identify areas for future research, including the investigation of the technical load and tactical transfer of SSG to match performance and the injury rates relative to such a specific training stimulus. Finally, this review serves to further establish SSG training as an alternative conditioning method for team sport players.

This article is presented in 4 sections. The first examines the variables affecting SSG training intensity. The second describes different types of comparisons in SSG. The third examines studies comparing SSG training with interval training (i.e., acute physiological comparisons). The final section concludes the review and provides suggestions for further research.

Search Strategy

This review incorporated studies that examined SSG-based training methods in team sports. A literature search was performed independently by the authors using MEDLINE, ScienceDirect, Web of Science, and Google Scholar databases. The databases were selected as they contain extensive relevant literature in the areas of sports science. The publications' search period ranged from 1984 to 2014. The electronic databases were searched using a number of key terms as selected by the authors: "small-sided games," "physiological responses," "team sports," "variables," and "training." These keywords were used individually and/or combined. A search for relevant articles was also performed from the reference lists of the identified publications.

Variables Affecting Small-Sided Games Intensity

Pitch Area. Pitch area is among the factors thought to influence the physiological stress in SSG and hence, impact upon their ability to be useful tools for physical training sessions. Table 1 summarizes studies that have examined the influence of pitch area on SSG intensity in team sports. Most studies have found an increase in HR, lactate concentration [La−], and rating of perceived exertion (RPE) with an increased size of the pitch area (5,38,50). In this context, Rampinini et al. (50) found an increase in HRmax, [La−], and RPE with an increase of the pitch area: for HRmax (i.e., 89.5 vs. 90.5 vs. 90.9% during 20 × 12 m, 25 × 15 m, and 30 × 18 m, respectively), [La−] (i.e., 6.0 vs. 6.3 vs. 6.5 $mmol \cdot L^{-1}$, respectively), and RPE (8.1 vs. 8.4 vs. 8.5, respectively). Similarly, Atli et al. (5) examined the effect of 2 pitch sizes on HR in basketball players and found 9.3% higher HR values on the large pitch size (28 × 15 m) compared with the small pitch size (14 × 15 m). In terms of technical actions, there were significant differences between half-court and full-court 3-a-side games in the number of shots, rebounds, and passes. Also, during the full-court games, there were fewer assists (1.4 ± 1.4 vs. 2.7 ± 1.9), steals (1.3 ± 1.7 vs. 2.3 ± 1.6), and turnovers (1.7 ± 1.3 vs. 2.8 ± 2.0) when compared with the half-court games.

In rugby, Kennett et al. (38) investigated the effect of 2 pitch sizes (32 × 24 m vs. 64 × 48 m) on physiological responses (i.e., HR, La) and perceived exertion (RPE). There was an increase in the percentage of HRmax (86.7 vs. 89.4%), [La−] (5.7 vs. 8.2 $mmol \cdot L^{-1}$), and RPE (13.7 vs. 15.8, respectively) with an increase of the pitch area. The higher physiological strain with larger pitch sizes is because of the greater area per player, with players having more space to move (i.e., during both the offensive and the defensive phases). This allows the players in possession of the ball to find more space to escape from the nonpossessing players, resulting in the nonpossessing players having more runs and displacements to try to intercept the ball. However, although greater pitch area may increase the intensity of SSG, coaches should be cautious when selecting the pitch area. Indeed, they should select this variable as a function of the genuine pitch area of the competition for the practiced sport. In contrast to the above-mentioned data, Kelly and Drust (37) found a decrease in HR (91 vs. 90 vs. 89%) with an increase of the pitch area in soccer SSG (i.e., 30 × 20 m, 40 × 30 m, and 50 × 40 m, respectively) while the number of players involved in the games were held constant (5 vs. 5). Moreover, the technical actions that changed as a result of changes in pitch size were the number of tackles (SSG1, 45 ± 10; SSG2, 15 ± 4; SSG3: 31 ± 7) and shots (SSG1, 85 ± 15; SSG 2, 60 ± 18; SSG3, 44 ± 9).

Although previous studies reported a significant effect of the pitch area on physiological responses, the results of the literature suggest that pitch dimensions may also affect the physiological responses to SSG when combined with other important factors such as player numbers. This variable could be used to modify the training stimulus according to the aim of each training phase during the season and according to the actual pitch area used in competition for

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TABLE 1. Summary of studies examining the effects of pitch dimensions on small-sided game intensity in team sports.*

Field	Study	Sample size	Age, y	Game design	Duration	Pitch, m	%HRmax	La	RPE
Football	Aroso et al. (4)	14		4 vs. 4	3 × 6 min/90-s rest	30 × 20	70.0 ± 9.0	2.6 ± 1.7	13.3 ± 0.9
						50 × 30			
	Owen et al. (47)	13	17.46 ± 1.05	1 vs. 1	3 × 3 min/ 12-min rest	10 × 5	86.0		
				2 vs. 2		15 × 10	88.0		
						20 × 15	89.0		
						15 × 10	84.2		
						20 × 15	87.4		
						25 × 20	88.1		
				3 vs. 3		20 × 15	81.7		
						25 × 20	81.8		
						30 × 25	84.8		
				4 vs. 4		25 × 20	72.0		
						30 × 25	78.5		
						30 × 25	75.7		
				5 vs. 5		35 × 30	79.5		
						40 × 35	80.2		
	Williams and Owen (60)	9	17 ± 1.0	3 vs. 3		20 × 15	Mean HR: 164 ± 12		
						25 × 20	Mean HR: 166 ± 9		
						30 × 25	Mean HR: 171 ± 11		
	Rampinini et al. (50)	20	24.5 ± 4.1	3 vs. 3 (CE)	3 × 4 min/ 3-min rest	20 × 12	89.5 ± 2.9	6.0 ± 1.8	8.1 ± 0.6 (CR10)
						25 × 15	90.5 ± 2.3	6.3 ± 1.5	8.4 ± 0.4 (CR10)
						30 × 18	90.9 ± 2.0	6.5 ± 1.5	8.5 ± 0.4 (CR10)
				4 vs. 4 (CE)		24 × 16	88.7 ± 2.0	5.3 ± 1.9	7.6 ± 0.5 (CR10)
						30 × 20	89.4 ± 1.8	5.5 ± 1.8	7.9 ± 0.5 (CR10)
						36 × 24	89.7 ± 1.8	6.0 ± 1.6	8.1 ± 0.5 (CR10)
						28 × 20	87.8 ± 3.6	5.2 ± 1.4	7.2 ± 0.9 (CR10)
				5 vs. 5 (CE)		35 × 25	88.8 ± 3.1	5.0 ± 1.7	7.6 ± 0.6 (CR10)
						42 × 30	88.8 ± 2.3	5.8 ± 1.6	7.5 ± 0.6 (CR10)
						32 × 24	86.4 ± 2.0	4.5 ± 1.5	6.8 ± 0.6 (CR10)
				6 vs. 6 (CE)		40 × 30	87.0 ± 2.4	5.0 ± 1.6	7.3 ± 0.7 (CR10)
						48 × 36	86.9 ± 2.4	4.8 ± 1.5	7.2 ± 0.8 (CR10)
	Kelly and Drust (37)	8	18 ± 1	5 vs. 5 (CE)	4 × 4 min/ 2-min rest	30 × 20	91.0 ± 4.0		
						40 × 30	90.0 ± 4.0		
						50 × 40	89.0 ± 2.0		

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	Owen et al. (48)	15	26.3 ± 4.85	3 vs. 3	3 × 5 min/4-min rest	30 × 25	94 ± 2.7		
				9 vs. 9		60 × 50	89 ± 4.8		
	Casamichana and Castellano (9)	10	15.5 ± 0.5	5 vs. 5	3 × 8 min/5-min rest	62 × 44	94.6 ± 4.3		6.7 ± 0.8
						50 × 35	94.6 ± 3.4		6.7 ± 0.8
						32 × 23	93.0 ± 5.7		5.7 ± 1.0
Rugby	Foster et al. (21)	8	12–13	4 vs. 4	2 × 4 min/3-min rest	15 × 25	87.9		
						20 × 30	88.1		
						25 × 35	88.4		
						15 × 25	88.5		
						20 × 30	89.3		
				6 vs. 6		25 × 35	90.3		
		14	15–16	4 vs. 4		15 × 25	89.8		
						20 × 30	90.6		
						25 × 35	91.5		
				6 vs. 6		15 × 25	85.0		
						20 × 30	87.0		
						25 × 35	86.5		
	Kenett et al. (38)	20	21.3 ± 1.2	4 vs. 4	2 × 9 min/2-min rest	32 × 24	86.7 ± 6.0	5.7 ± 3.3	13.7 ± 2.7
				6 vs. 6		64 × 48	89.4 ± 4.8	8.2 ± 3.4	15.8 ± 2.2
				8 vs. 8					
Basketball	Atli et al. (5)	12	15.5 ± 0.5	3 vs. 3	4 × 4 min/2-min rest	14 × 15	76.3 ± 2.5		
				3 vs. 3		28 × 15	85.6 ± 3.1		
	Klusemann et al. (40)	16	15–19	2 vs. 2	4 × 2.5 min/1-min rest	15 × 14	84 ± 5		6 ± 2
				4 vs. 4	2 × 5 min/30-s rest	30 × 28	85 ± 4		7 ± 2

*CR10 = category ratio 10 scale; HR = heart rate; %HRmax = percentage of maximum heart rate; La = lactate concentration (mmol. L^{-1}); RPE = rating of perceived exertion.

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each sport. Indeed, coaches could use small pitch areas during the first training phase (i.e., general preparation) and to gradually increase the pitch area to achieve the required intensity during the competitive phase. Moreover, according to the literature, coaches must be careful in the inclusion of this variable in SSG. It is suggested that a larger pitch dimension is used in training to maintain high intensity throughout exercise.

Player Numbers. The number of players involved in the task is another variable that may influence the training intensity of SSG. A summary of studies concerning player numbers is presented in Table 2. Most studies have shown that a smaller number of players results in greater HR, [La−], and RPE responses. In soccer, Dellal et al. (17) investigated the effect of changing player numbers on HR responses in 3 different conditions (i.e., 2 vs. 2, 3 vs. 3, and 4 vs. 4). Smaller player numbers resulted in a greater HR reserve (i.e., 80.1 vs. 81.5 vs. 70.6% for 2 vs. 2, 3 vs. 3, and 4 vs. 4, respectively). Rampinini et al. (50) investigated the effect of 4 different player numbers (3 vs. 3, 4 vs. 4, 5 vs. 5, and 6 vs. 6) on HRmax, [La−], and RPE in 20 amateur soccer players. Higher exercise intensity was observed in the condition with smaller player numbers (3 vs. 3): for HRmax (i.e., 89.5 vs. 88.7 vs. 87.8 vs. 86.4% during 3 vs. 3, 4 vs. 4, 5 vs. 5, and 6 vs. 6, respectively), [La−] (i.e., 6.0 vs. 5.3 vs. 5.2 vs. 4.5 $mmol \cdot L^{-1}$ during 3 vs. 3, 4 vs. 4, 5 vs. 5, and 6 vs. 6, respectively), and RPE (8.1 vs. 7.6 vs. 7.2 vs. 6.8 during 3 vs. 3, 4 vs. 4, 5 vs. 5, and 6 vs. 6, respectively).

In rugby, Foster et al. (22) found that an increase in player numbers (i.e., 4 vs. 4 and 6 vs. 6) resulted in a decrease in the percentage of HRmax (i.e., 90.6 vs. 86.2%, respectively). However, most of the previous studies have only examined equal numbers of players (e.g., 2 vs. 2, 3 vs. 3, etc.) on SSG intensity. Unequal number of players was implemented by Hill-Haas et al. (29) with temporary "overload" and "underload" situations between opposing teams, through the use of a "floating" player (3 vs. 3 + 1 floater). Table 2 summarizes the results of the studies that investigated the effect of player number variations on physiological responses, with an equal or unequal number of players. In his study, Hill-Hass et al. (29) reported no significant differences between the constant (i.e., 4 vs. 3 or 6 vs. 5) and variable (i.e., 3 vs. 3 + 1 floater or 5 vs. 5 + 1 floater) form of unequal number of players. However, compared with the other players, they showed that the floating player traveled a significantly greater total distance (2,668 ± 220 m vs. 2,408 ± 231 m) compared with 4-player teams and performed a greater number of sprints (>18.0 $km \cdot h^{-1}$ vs. 15 ± 3, 9 ± 5, and 8 ± 4) compared with 5-player and 6-player teams. The authors concluded that the use of a floating player may provide a training stimulus that is more conducive to aerobic fitness adaptations.

A reduction of player numbers may increase the exercise intensity during SSG in team sports. Moreover, when using an unequal number of players, the intensity of the SSG is significantly higher for the floater than the other players. Therefore, when using unequal player numbers and depending on the goal of the training session, coaches should alternate floating players during the SSG. Moreover, the data showed a causal link between both variables (i.e., pitch area and player numbers) for achieving a specific goal with training (Figure 1). The results of the studies investigating this combination are detailed in the following section.

Concurrent Manipulation of Pitch Area and Player Numbers. Some studies have found that SSG exercise intensity can be manipulated by concurrently modifying the playing area size and the player numbers. The results of these studies are summarized in Table 3. This table shows that there are subtle differences in the training prescriptions, age and ability of players, intensity measures, and sizes of pitch area among the studies that may affect the exercise intensity in SSG. Hill-Hass et al. (30) examined the effect of 3 forms of player numbers (i.e., 2 vs. 2, 4 vs. 4, and 6 vs. 6) with a constant ratio of player number: pitch size (1:150 m^2) on physiological and perceptual responses (i.e., HR, [La−], and RPE) in soccer players. As the number of players in the SSG teams decreased, the overall physiological and perceptual responses increased. Little and Williams (45) investigated the effect of 6 forms of player numbers and pitch area in soccer (2 vs. 2 on 27 × 18 m, 3 vs. 3 on 32 × 23 m, 4 vs. 4 on 37 × 27 m, 5 vs. 5 on 41 × 27 m, 6 vs. 6 on 46 × 27 m, and 8 vs. 8 on 73 × 41 m) on HR, [La−], and RPE. The results showed a decrease in the percentage of HR (88.9 vs. 91 vs. 90.1 vs. 89.3 vs. 87.5 vs. 87.9%, respectively), [La−] (9.6 vs. 8.5 vs. 9.5 vs. 7.9 vs. 5.6 vs. 5.8 $mmol \cdot L^{-1}$, respectively), and RPE (16.3 vs. 15.7 vs. 15.3 vs. 14.3 vs. 13.6 vs. 14.1, respectively) when the number of players and pitch area increased. Rampinini et al. (50) investigated a variety of pitch areas with constant number of players and clearly showed that for a particular number of players (i.e., from 3 vs. 3 to 6 vs. 6), the increase in pitch size led to higher physiological strain (HR, [La−], and RPE).

More recently, Foster et al. (22) compared 2 forms of player numbers (i.e., 4 vs. 4 and 6 vs. 6) and 3 pitch area sizes (i.e., 15 × 25 m, 20 × 30 m, and 25 × 30 m) on HR responses in rugby league players. Smaller player numbers (i.e., 4 vs. 4) and larger playing areas (25 × 30 m) elicited a higher HR response than the 6 vs. 6 and small pitch area (i.e., percentage of HRmax: 91.5 vs. 86.5%, respectively). These results demonstrate that (a) decreasing player numbers with constant pitch area per player (b) and smaller player numbers with larger pitch area are both suitable approaches to increase the intensity of SSG. Therefore, coaches should carefully handle these 2 important variables. Concerning the choice of players' number, during the competitive phase, we recommend that SSGs are based on a small number, in which case they may alternate between equal or unequal form. At the same time, pitch dimension should be larger to maintain high-intensity exercise. These

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TABLE 2. Summary of studies examining the effects of player numbers on small-sided game intensity in team sports.*

Field	Study	Sample size	Age, y	Game design	Duration	Pitch, m	%HRmax	La, mmol·L^{-1}	RPE
Football	Aroso et al. (4)	14		4 vs. 4	3 × 6 min/90-s rest	30 × 20	70.0 ± 9.0	2.6 ± 1.7	13.3 ± 0.9
						50 × 30			
	Owen et al. (47)	13	17.46 ± 1.05	1 vs. 1	1 × 3 min/12-min rest	10 × 5	86.0		
						15 × 10	88.0		
						20 × 15	89.0		
				2 vs. 2		15 × 10	84.2		
						20 × 15	87.4		
				3 vs. 3		25 × 20	88.1		
						20 × 15	81.7		
						25 × 20	81.8		
				4 vs. 4		30 × 25	84.8		
						25 × 20	72.0		
						30 × 25	78.5		
				5 vs. 5		30 × 25	75.7		
						35 × 30	79.5		
						40 × 35	80.2		
	Williams and Owen (60)	9	17 ± 1.0	3 vs. 3		20 × 15	Mean HR: 164 ± 12		
						25 × 20	Mean HR: 166 ± 9		
						30 × 25	Mean HR: 171 ± 11		
	Katis and Kellis (36)	34	13 ± 0.9	3 vs. 3	10 × 4 min/3-min rest		87.6 ± 4.77		
				6 vs. 6			82.8 ± 3.22		
	Hill-Hass et al. (29)	12	15.6 ± 0.8	3 players	24 s	37 × 28	82.3 ± 3.5	2.5 ± 0.7	16.3 ± 1.6
							2,543 ± 187 (TD, m)	553 ± 187 (D, m)	10 ± 6 (SP, m)
		16		4 players	24 s	37 × 28	83.1 ± 4.0	2.5 ± 0.9	14.6 ± 1.9
							2,408 ± 231 (TD, m)	482 ± 187 (D, m)	8 ± 4 (SP, m)
		8		Floater	24 s	37 × 28	82.7 ± 3.0	2.3 ± 0.8	16.3 ± 1.5
							2,668 ± 220 (TD, m)	628 ± 132 (D, m)	9 ± 6 (SP, m)
		20		5 players	24 s	47 × 35	82.5 ± 5	2.5 ± 1.0	15.2 ± 1
							2,526 ± 302 (TD, m)	649 ± 190 (D, m)	9 ± 5 (SP, m)
		24		6 players	24 s	47 × 35	81.4 ± 5.1	2.6 ± 1.1	14.9 ± 0.9
							2,524 ± 247 (TD, m)	589 ± 177 (D, m)	8 ± 4 (SP, m)
		4		Floater	24 s	47 × 35	82.5 ± 5.6	2.8 ± 0.2	16.3 ± 1.7
							2,610 ± 201 (TD, m)	673 ± 194 (D, m)	15 ± 3 (SP, m)
		Matched PN (a)		3 vs. 3 and 5 vs. 5			82.5 ± 4.6	2.6 ± 1.1	15.2 ± 1.4
							2,585 ± 204 (TD, m)	582 ± 190 (D, m)	

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	Overload PN		6-player and 4-player teams			82.3 ± 4.5	2.6 ± 1.0	14.7 ± 1.5
						2,458 ± 243 (TD, m)	528 ± 184 (D, m)	
	Underload PN		5 player and 3 player teams			82.3 ± 4	2.6 ± 1	15.8 ± 1.5
						2,535 ± 247 (TD, m)	598 ± 192 (D, m)	
Owen et al. (48)	15	26.3 ± 4.85	3 vs. 3	3 × 5 min/4-min rest	30 × 25	94 ± 2.7		
			9 vs. 9		60 × 50	89 ± 4.8		
Da Silva et al. (13)	16	13.5 ± 0.7	3 vs. 3	3 × 4 min/3-min rest	30 × 30	89.8 ± 2		
			4 vs. 4			89.8 ± 2		
			5 vs. 5			86.9 ± 3		
Brandes et al. (7)	17	14.9 ± 0.7	2 vs. 2	3 × 4	28 × 21	93.3 ± 4.2	4.6 ± 1.8	
			3 vs. 3	3 × 5	34 × 26	91.5 ± 3.3	3.4 ± 1.3	
			4 vs. 4	3 × 6	40 × 30	89.7 ± 3.4	4.2 ± 1.8	
Köklü et al. (41)	16	15.7 ± 0.4	1 vs. 1	1 × 6	6 × 18	86.1 ± 4.2	9.4 ± 2.9	
			2 vs. 2	2 × 6	12 × 24	88.0 ± 4.9	8.0 ± 2.8	
			3 vs. 3	3 × 6	18 × 30	92.8 ± 4.1	7.5 ± 2.5	
			4 vs. 4	4 × 6 min/2-min rest	24 × 36	91.5 ± 3.6	7.2 ± 2.7	
Dellal et al. (15)	27	16.5 ± 0.5	2 vs. 2	8 × 2 min/1-min rest	20 × 25	80.1 ± 3.6		
			3 vs. 3	6 × 30 s/90-s rest	25 × 30	81.5 ± 4.3		
			4 vs. 4	4 × 4 min/2-min rest	28 × 35	70.6 ± 5.9		
Dellal et al. (16)	20	27 ± 2	2 vs. 2	2 × 4 min	20 × 15	90.7	3.5	7.6
			3 vs. 3	3 × 4 min	25 × 18	89.3	3.3	7.7
			4 vs. 4	4 × 4 min	30 × 20	85.5	2.8	7.9
Castellano et al. (11)	14	21.3 ± 2.3	3 vs. 3	3 × 3 min/5-min rest	43 × 30	93.8 ± 3.4		
			5 vs. 5	3 × 5 min/5-min rest	55 × 38	92.7 ± 4.0		
			7 vs. 7	3 × 7 min/5-min rest	64 × 46	94.3 ± 5.3		
Aguiar et al. (2)	10	18.0 ± 0.67	2 vs. 2	3 × 6 min/1-min rest	150 m^2 per player	87.46 ± 7.46		17.01 ± 2.88
			3 vs. 3			89.56 ± 3.15		17.01 ± 2.88
			4 vs. 4			85.91 ± 5.98		15.00 ± 2.25
			5 vs. 5			84.56 ± 7.56		13.48 ± 2.67
Abrantes et al. (1)	16	15.75 ± 0.45	3 vs. 3	4 × 4 min/2-min rest	20 × 30 m	HR zone 1 (<75%); 0.7 ± 0.1		16.6 ± 0.3

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							HR zone 2 (75–85%); 1.4 ± 0.2 HR zone 3 (85–90%); 0.7 ± 0.1 HR zone 4 (≥90%); 1.1 ± 0.2		
				4 vs. 4	20 × 40 m		HR zone 1 (<75%); 1.1 ± 0.2 HR zone 2 (75–85%); 1.6 ± 0.1 HR zone 3 (85–90%); 0.8 ± 0.1 HR zone 4 (≥90%); 0.6 ± 0.2		16.0 ± 0.5
Rugby	Foster et al. (22)	8	12–13	4 vs. 4	2 × 4 min/3-min rest	15 × 25	87.9		
						20 × 30	88.1		
						25 × 35	88.4		
				6 vs. 6		15 × 25	88.5		
						20 × 30	89.3		
						25 × 35	90.3		
		14	15–16	4 vs. 4		15 × 25	89.8		
						20 × 30	90.6		
						25 × 35	91.5		
				6 vs. 6		15 × 25	85.0		
						20 × 30	87.0		
						25 × 35	86.5		
	Kenett et al. (38)	20	21.3 ± 1.2	4 vs. 4	2 × 9 min/2-min rest	32 × 24	88.8 ± 5.9	8.9 ± 3.2	17.4 ± 1.5
				6 vs. 6		64 × 48	88.4 ± 5.7	6.5 ± 3.0	15.0 ± 1.8
				8 vs. 8			87.1 ± 5.1	6.0 ± 3.7	12.7 ± 2.5
Basketball	Sampaio et al. (53)	8	15.5 ± 0.6	3 vs. 3	4 × 4 min/3-min rest		87.1		3.0
				4 vs. 4			82.7		4.1
	Klusemann et al. (40)	16	15–19	2 vs. 2	4 × 2.5 min/1-min rest	15 × 14	86 ± 4		8 ± 2
				4 vs. 4	2 × 5 min/30-s rest	30 × 28	83 ± 5		6 ± 2

*HR = heart rate; HRmax = percentage of maximum HR; La = lactate concentration; RPE = rating of perceived exertion; TD = total distance (m); *D* = distance (m): >13.0 km·h^{-1}; SP = number of sprints >18.0 km·h^{-1}; PN = player number; (a) = matched team excluding floater.

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recommendations are also applicable during the competitive phase. However, intense training sessions should not be more than one session per week when players have a match during each week.

Rule Modifications. Some studies have investigated the effect of rules changes on SSG intensity and technical and tactical skills. Table 4 shows different types of rules changes such as the number of ball touches, man marking, and presence of goalkeepers on physiological, technical, and tactical responses. In football, Dellal et al. (16,18) examined the influence of the number of ball touches and free play on the physical demands, technical performances, and physiological responses in soccer players. The authors reported that the free play rule presented the greater number of duels, decreased the number of sprint and high-intensity runs performed, and preserved the effectiveness of the technical actions (i.e., successful passes and number of balls lost) in comparison with 1 touch and 2 touches SSG. Recently, Abrantes et al. (1) investigated the effects of 3 forms of SSG on technical and physiological parameters (i.e., HR and RPE) in soccer SSG: 3 vs. 3 and 4 vs. 4 for the number of players and exclusively offensive, exclusively defensive, and both situations (offensive and defensive style) for playing form. The authors showed that the 3 vs. 3 SSG elicited the higher HR and RPE responses. Moreover, they reported that the most intense and the higher technical actions (i.e., passes, dribbles, tackles, and shots) situation was the mixed offensive and defensive situation when compared with the exclusively offensive or defensive situations. Jake et al. (34) examined the effect of manipulating the defensive phase rules: with and without man marking on exercise intensity in 3 vs. 3 on soccer SSG. The authors reported that there was a ~4.5% increase in HR during the man-marking soccer SSG situation in comparison with nonmarking. Collectively, these findings demonstrate that modifying the games' rules significantly affect the intensity of SSG. However, to date, this variable has received little attention by coaches and researchers. Therefore, further research should investigate the effect of rule changes on exercise intensity in SSG. Moreover, SSGs should include some modifications to preserve intensity and to maintain relevance to real situations in the game. To do this, coaches are encouraged to apply 1 touch ball, alternating between offensive and defensive style, challenging players to practice pressure form at specific times during play, and include small goals to motivate the players. Coaches may include 2 or 3 variables at the same time during the exercise but must be careful to ensure homogeneity of the training stimulus.

Goalkeepers Presence. The presence of goalkeepers is another variable that may influence SSG intensity. Table 5 summarizes the SSG studies that investigated the effects of goalkeepers' presence on SSG intensity. Sassi et al. (55) investigated the effect of soccer goalkeepers on physiological responses to a 4 vs. 4 SSG. The authors showed a significant decrease in HR (i.e., percentage of HRmax: 91.0 vs. 88.8%) during SSG with goalkeepers compared with no-goalkeeper situations; however, the decrease in [La−] (i.e., 16.4 vs. 16.2 $mmol \cdot L^{-1}$) was not significant. Likewise, Mallo and Navarro (46) examined the effect of the presence of soccer goalkeepers on HR during 3 vs. 3 (and 3 vs. 3 plus a goalkeeper) SSG and reported a significant decrease in HR (173 vs. 166 $b \cdot min^{-1}$) when goalkeepers were included in the SSG. Recently, Köklü et al. (42) investigated the effects of SSG with and without goalkeepers on 3 physiological parameters (HRmax, [La−], and RPE) in 3 different forms of SSG (2 vs. 2, 3 vs. 3, and 4 vs. 4). The authors found a decrease in %HRmax (2 vs. 2 [86.0 vs. 88.0%], 3 vs. 3 [86.9 vs. 89.1%], and 4 vs.4 [88.7 vs. 90.1%]), [La−] (2 vs. 2 [7.4 vs. 8.4 $mmol \cdot L^{-1}$], 3 vs. 3 [6.5 vs. 7.3 $mmol \cdot L^{-1}$], and 4 vs.4 [6.1 vs. 6.9 $mmol \cdot L^{-1}$]), and RPE (2 vs. 2 [6.0 vs. 7.3], 3 vs. 3 [4.6 vs. 6.5], and 4 vs.4 [5.1 vs. 5.7]) when goalkeepers were present. However, these results were not confirmed by Dellal et al. (14) who found an increase of 10.7% in percentage HR reserve in the 8 vs. 8 games when goalkeepers were included. This contradiction may be because of the inclusion of a goalkeeper that probably changed the physiological and tactical behavior of the outfield players (57) because it is possible that some players were more motivated than others by their presence (14). In fact, the aims of scoring and simultaneously protecting their own goalkeepers may have imposed a greater activity on the soccer players in the latter study reporting higher physiological strain (14,56,57). In the other studies, the decrease in the SSG intensity could be because of the good defensive organization that contributes to a decrease in physiological responses (44,46,55). Therefore, given the equivocal findings, future studies should carefully examine the influence of goalkeepers' presence on SSG intensity. It is worthy to note that in their study, Dellal et al. (14) have showed that SSGs were accompanied by a higher interindividual HR coefficient of variation with respect to in-line interval training runs. Thus, 1 disadvantage of SSG is that not all the players exercise at similar intensities, with relatively large discrepancies of physiological strain. In addition, according to the literature, coaches should avoid including goalkeepers during SSG and use only small goals to preserve motivation of the players and training intensity.

Coach Encouragement. Direct supervision and coaching of exercise sessions during SSG have been shown to improve adherence to an exercise program, increase training intensity, and increase performance measures in a variety of training modes. In football, active and consistent coach encouragement has also been suggested to have an influence on training intensity (6,50). Rampinini et al. (50) investigated the effect of coaches' encouragement in 20 amateur football players on HR, [La−], and RPE responses during different forms of SSG: 3 vs. 3, 4 vs. 4, 5 vs. 5, and 6 vs. 6 players on small, medium, and large pitches area. The authors

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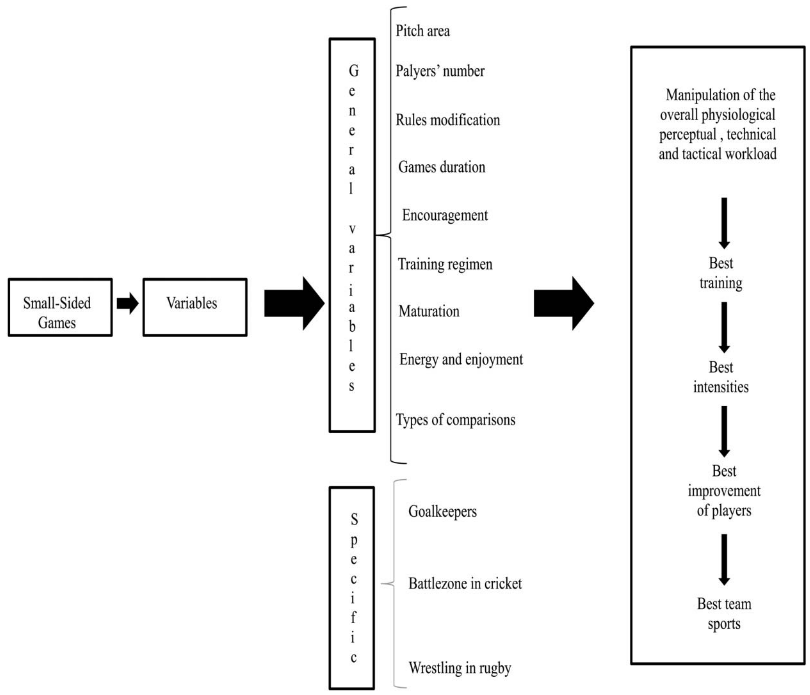

Figure 1. Model for the analysis of small-sided game variables.

demonstrated that the physiological responses to SSG were significantly higher during situations with coaches' encouragement in comparison with no encouragement during all SSG formats: HR (i.e., mean percentage of HRmax: 88.7 vs. 86.5%, respectively), [La−] (i.e., 5.5 vs. 4.2 $mmol \cdot L^{-1}$, respectively), and RPE (i.e., 7.7 vs. 6.3, respectively). Similarly, Sampaio et al. (54) reported a significant increase in RPE for 2 vs. 2 (i.e., 14.1 vs. 15.5) and 3 vs. 3 (14.4 vs. 15.8) soccer SSG with verbal encouragement; but no significant change in the percentage of HRmax both in 2 vs. 2 (81.2 vs. 83.7%) and 3 vs. 3 (79.8 vs. 80.8%, respectively). Collectively, these studies support the importance of coach encouragement during SSG when the aim is to achieve high exercise intensity. To date, only Rampinini et al. (50) have addressed these effects and found higher HR, [La−], and RPE when the coaches provided encouragement during the SSG. Thus, further studies should explore this variable and its effects on physiological responses. During training sessions, coaches should support rule modifications during SSG by providing verbal encouragement and motivation. This verbal encouragement positively influences the physiological responses to SSG.

Training Regimen: Intermittent vs. Continuous. Whether the training program is continuous or intermittent can affect exercise intensity in SSG. In this regard, most studies have used traditional interval training. The results of these studies are summarized in Table 6. The prescription of interval training is based on 5 variables: work intensity and duration, recovery type (passive/active) and duration, and total work duration (work interval number × work duration). Small-sided games using intermittent training regimens consist of consecutive bouts of SSG play interspersed with active or passive rest periods compared with continuous SSG formats that use long duration (i.e., 10–30 minutes). To date, only 2 studies have compared the 2 forms of training in SSG (30,41). However, other studies have used only 1 form of SSG training (Table 6). In football, Hill-Hass et al. (30) have compared 2 forms of SSG training, that is, interval (4 × 6 minutes with 1.5-minute rest) and continuous (1 × 24 minutes), with 3 forms of player numbers, i.e., 2 vs. 2, 4 vs. 4, and 6 vs. 6. The authors reported that global RPE and HRmax were significantly higher in continuous SSG than in interval SSG (i.e., 87 vs. 84% for HR and 12.3 vs. 11.6 for RPE, respectively). Therefore, both intermittent and continuous SSG training regimes could be used during the season for match-specific aerobic conditioning but with some differences in the players' physiological responses. Likewise, Köklü (41) investigated 2 forms of SSG training, i.e., interval (3 × 2, 3 × 3, and 3 × 4 minutes) and continuous (1 × 6, 1 × 9, and 1 × 12 minutes, respectively) with 3 forms of player numbers (i.e., 2 vs. 2, 3 vs. 3, and 4 vs.4) in basketball SSG. The results demonstrated that 3-a-side

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Table 3. Summary of studies examining the effects of concurrent manipulation of player numbers and pitch dimensions on small-sided game intensity in team sports.*

Field	Study	Sample size	Age, y	Game design	Duration	Pitch, m	%HRmax	La, mmol·L^{-1}	RPE
Football	Platt et al. (49)	2	10–12	3 vs. 3	1 × 15 min	27 × 18	88.0		
				5 vs. 5	1 × 15 min	37 × 27	82.0		
	Little and Willams (45)	28	22.8 ± 4.5	2 vs. 2	4 × 2 min/2-min rest	27 × 18	88.9 ± 1.2	9.6 ± 1.0	16.3 ± 0.9
				3 vs. 3	4 × 210 s/90-s rest	32 × 23	91.0 ± 1.2	8.5 ± 0.8	15.7 ± 1.1
				4 vs. 4	4 × 4 min/2-min rest	37 × 27	90.1 ± 1.5	9.5 ± 1.1	15.3 ± 0.7
				5 vs. 5	4 × 6 min/90-s rest	41 × 27	89.3 ± 2.5	7.9 ± 1.7	14.3 ± 1.5
				6 vs. 6	3 × 8 min/90-s rest	46 × 27	87.5 ± 2.0	5.6 ± 1.9	13.6 ± 1.0
				8 vs. 8	4 × 8 min/90-s rest	73 × 41	87.9 ± 1.9	5.8 ± 2.1	14.1 ± 1.8
	Jones and Drust (35)	8	7 ± 1	4 vs. 4	1 × 10 min	30 × 25	83.0		
				8 vs. 8	1 × 10 min	60 × 40	79.0		
	Rampinini et al. (50)	20	24.5 ± 4.1	3 vs. 3 (CE)	3 × 4 min/3-min rest	30 × 18	90.9 ± 2.0	6.5 ± 1.5	8.5 ± 0.4
				4 vs. 4 (CE)		36 × 24	89.7 ± 1.8	6.0 ± 1.6	8.1 ± 0.5
				5 vs. 5 (CE)		42 × 30	88.8 ± 2.3	5.8 ± 1.6	7.5 ± 0.6
				6 vs. 6 (CE)		48 × 36	86.9 ± 2.4	4.8 ± 1.5	7.2 ± 0.8
	Dellal et al. (14)	10	26 ± 2.9	1 vs. 1	4 × 90 s/90-s rest	10 × 10	77.6 ± 8.6		
				2 vs. 2	6 × 150 s/150-s rest	20 × 20	80.1 ± 8.7		
				4 vs. 4 with GK	2 × 4 min/3-min rest	30 × 25	77.1 ± 10.7		
				8 vs. 8 with GK	2 × 10 min/5-min rest	60 × 45	80.3 ± 12.5		
				8 vs. 8	4 × 4 min/3-min rest	60 × 45	71.7 ± 6.3		
				10 vs. 10 with GK	3 × 20 min/5-min rest	90 × 45	75.7 ± 7.9		
	Hill-Hass et al. (27)	16	16–18	2 vs. 2	1 × 24 min	28 × 21	89.0 ± 4.0 2,574 ± 16 (TD, m)	6.7 ± 2.6 1,176 ± 8 (D, m)	13.1 ± 1.5 44 ± 24 (SP, m)
				4 vs. 4		40 × 30	85.0 ± 4.0 2,650 ± 18 (TD, m)	4.7 ± 1.6 1,128 ± 10 (D, m)	12.2 ± 1.8 65 ± 36 (SP, m)

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				6 vs. 6		49 × 37	83.0 ± 4.0 2,590 ± 33 (TD, m)	4.1 ± 2.0 1,142 ± 16 (D, m)	10.5 ± 1.5 71 ± 36 (SP, m)
	Katis and Kellis (36)	34	13 ± 0.9	3 vs. 3	10 × 4 min/3-min rest	25 × 15	87.6 ± 4.77		
				6 vs. 6		40 × 30	82.8 ± 3.22		
	Owen et al. (48)	15	26.3 ± 4.85	3 vs. 3	3 × 5 min/4-min rest	30 × 25	94 ± 2.7		
				9 vs. 9		60 × 50	89 ± 4.8		
Rugby	Foster et al. (22)	8	12–13	4 vs. 4	2 × 4 min/3-min rest	15 × 25	87.9		
						20 × 30	88.1		
						25 × 35	88.4		
				6 vs. 6		15 × 25	88.5		
						20 × 30	89.3		
						25 × 35	90.3		
		14	15–16	4 vs. 4		15 × 25	89.8		
						20 × 30	90.6		
						25 × 35	91.5		
				6 vs. 6		15 × 25	85.0		
						20 × 30	87.0		
						25 × 35	86.5		
	Kenett et al. (38)	20	21.3 ± 1.2	4 vs. 4	2 × 9 min/2-min rest	32 × 24	88.8 ± 5.9	8.9 ± 3.2	17.4 ± 1.5
	Kenett et al. (38)	20	21.3 ± 1.2	6 vs. 6	2 × 9 min/2-min rest	64 × 48	88.4 ± 5.7	6.5 ± 3.0	15.0 ± 1.8
				8 vs. 8			87.1 ± 5.1	6.0 ± 3.7	12.7 ± 2.5

*%HRmax = percentage of maximum heart rate; La = lactate concentration; RPE = rating of perceived exertion; CE = coach encouragement; TD = total distance; SP = number of sprints >18.0 $km \cdot h^{-1}$.

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TABLE 4. Summary of studies examining the effects of rules modifications on small-sided game intensity in team sports.*

Field	Study	Sample size	Age, y	Game design	Duration	Pitch, m	Rules	%HRmax	La, mmol·L^{-1}	RPE
Football	Aroso et al. (4)	14		2 vs. 2	3 × 1.5/90-s rest	30 × 20	Player to player marking		8.1 ± 2.7	
				3 vs. 3	3 × 4 min/90-s rest		Maximum of 3 consecutive touches		4.9 ± 2.0	
	Sassi et al. (55)	9		8 vs. 8 with GK	4 × 4 min/2-min rest	50 × 30	Free touch	82.0	3.3 ± 1.2	
				8 vs. 8 with GK			Free touch with pressure	91.0		
	Sampaio et al. (54)	8	15 ± 0	2 vs. 2	2 × 90 s/90-s rest	30 × 20	Player to player marking			17.1 ± 0.5
							Maximum of 2 consecutive touches			16.8 ± 0.5
				3 vs. 3	2 × 3 min/90-s rest		Player to player marking			16.5 ± 0.5
							Maximum of 2 consecutive touches			16.5 ± 0.5
	Little and Williams (45)	23	22.8 ± 4.5	5 vs. 5	5 × 2 min/2-min rest	55 × 32	Pressure half-switch	89.9		
				6 vs. 6	5 × 2 min/2-min rest	59 × 27	Pressure half-switch	90.5		
	Mallo and Navarro (46)	10		3 vs. 3	1 × 5/10-min rest	33 × 20	Possession	91.0		
							Possession with 2 outside neutral players	91.0		
							Normal rules with GK	88.0		
	Hill-Hass et al. (29)	24	15.6 ± 0.8	3 vs. 4 and 3 vs. 3 with 1 floater	24 min continuous	37 × 28	Condition a† + b‡	83.3 ± 3.8	2.8 ± 1.0	15.8 ± 1.6
		23					Condition a + b + c§	84.8 ± 3.8	2.4 ± 0.8	15.6 ± 2.3
		23					Condition a + b + c + d‖	80.3 ± 4.8	2.3 ± 1.1	14.8 ± 1.2

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	26					Condition a + b + c + d + e + f¶	83.7 ± 4.0	2.8 ± 1.1	15.1 ± 1.6
	21		5 vs. 6 and 6 vs. 5 with 1 floater	24 min continuous	47 × 35	Condition a‡ + b§	81 ± 4	2.2 ± 1.0	15.3 ± 1.1
	22					Condition a + b + c‖	83 ± 5	3.2 ± 1.2	14.9 ± 1.4
	20					Condition a + b + c + d¶	83 ± 5	2.3 ± 1.1	14.6 ± 0.9
	21					Condition a + b + c + d + e[f]	80 ± 3	2.4 ± 0.9	14.9 ± 1.1
Dellal et al. (18)	40	25.3 ± 2.4	4 vs. 4	4 × 4 min/3-min rest	30 × 20 m	1 ball touch	87.6 ± 2.5	3.0 ± 0.3	8.0 ± 0.7
						2 ball touch	85.6 ± 3.0	2.9 ± 0.1	7.9 ± 0.8
						Free ball touch	84.7 ± 2.7	2.8 ± 0.2	7.3 ± 0.6
Dellal et al. (16)	20	27.4 ± 1.5	4 vs. 4	4 × 4 min/3-min rest	30 × 20	1 ball touch	B1: 85.0 ± 2.3	2.5 ± 0.2	6.8 ± 0.8
							B2: 86.7 ± 2.4	2.8 ± 0.3	7.8 ± 0.8
							B3: 88.2 ± 2.6	3.1 ± 0.4	7.9 ± 0.8
							B4: 90.4 ± 2.7	3.5 ± 0.5	8.9 ± 0.8
						2 ball touch	B1: 83.4 ± 2.8	2.5 ± 0.1	6.9 ± 0.8
							B2: 84.7 ± 2.9	2.7 ± 0.2	7.7 ± 1.0
							B3: 86.1 ± 3.1	3.0 ± 0.2	8.1 ± 0.7
							B4: 89.7 ± 3.2	3.2 ± 0.3	8.9 ± 0.5
						Free ball touch	B1: 82.7 ± 2.6	2.4 ± 0.3	6.3 ± 0.5
							B2: 84.1 ± 2.6	3.1 ± 0.2	7.1 ± 0.5
							B3: 85.1 ± 2.7	3.3 ± 0.2	7.3 ± 0.7
							B4: 86.8 ± 2.9	4.5 ± 0.3	8.2 ± 0.9
Abrantes et al. (1)	16	15.75 ± 0.45	3 vs.3	4 × 4 min/2-min rest		Only defense	Zone 1 (<75%); 1.3 ± 0.2 (+) Zone 2 (75–85%); 2.0 ± 0.1 Zone 3 (85–90%); 0.6 ± 0.2 (+) Zone 4 (≥90%); 0.2 ± 0.1 (+)		16.0 ± 0.3
						Only offense	Zone 1 (<75%); 0.7 ± 0.2 (+) Zone 2 (75–85%); 1.4 ± 0.2 (+) Zone 3 (85–90%); 0.8 ± 0.2 (+) Zone 4 (≥90%); 1.1 ± 0.3 (+)		15.9 ± 0.5
						Both types	Zone 1 (<75%); 0.7 ± 0.3 (+)		16.0 ± 0.3

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							Zone 2 (75–85%); 1.2 ± 0.1 (+) Zone 3 (85–90%); 0.9 ± 0.1 (+) Zone 4 (≥90%); 1.3 ± 0.2 (+)	
Jake et al. (34)	12	16.2 ± 0.7	3 vs. 3	3 × 4 min/4-min rest	18 × 25 m	Man marking and goals	80.5 ± 5.8	7.1 ± 0.7
						Man marking without goals	80.5 ± 4.1	7.4 ± 0.8
						Goals without man marking	75.7 ± 4.7	6.9 ± 0.9
						Without goals and without man marking	76.1 ± 4.2	6.9 ± 0.8
Castellano et al. (11)	14	21.3 ± 2.3	3 vs. 3	3 × 3 min/5-min rest	43 × 30	SSG-P	94.6 ± 3.0	
						SSG-G	94.8 ± 3.7	
						SSG-g	91.8 ± 2.8	
			5 vs. 5	3 × 5 min/5-min rest	55 × 38	SSG-P	94.6 ± 4.1	
						SSG-G	92.1 ± 4.0	
						SSG-g	91.5 ± 3.5	
			7 vs. 7	3 × 7 min/5-min rest	64 × 46	SSG-P	94.9 ± 5.4	
						SSG-G	93.2 ± 4.4	
						SSG-g	94.7 ± 5.9	

#a : Data for Sassi et al.(60), Little et Williams, (50) and Mallo et Navarro, (51) are presented as mean values.
†condition a: offside rule in effects (from one-third zone of the pitch).
‡condition b: kick in only (ball cannot be thrown in if it leaves the pitch).
§condition c: all attacking team players must be in front two zones for a goal to count.
||condition d: before scoring the attacking team must pass the ball to one of two neutral players who can move up and down outside the pitch. A maximum of one touch on the ball is allowed.
¶condition e: one player from each team complete 4 repetitions of "sprints the width/jog the lengths" on a 90s interval (3 *vs.* 4 and 3 *vs.* 3 +1 games) or three repetition each 80-s (5 *vs.* 5 and 5 *vs.* 5 +1 games). TD travelled per player, regardless of game format, would be approximately 440m.

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TABLE 5. Summary of studies examining the effects of GK on small-sided game intensity in team sports.*

Field	Study	Sample size	Age, y	Game design	Pitch, m	Duration	Rules	HR	La, $mmol\cdot L^{-1}$	RPE
Football	Sassi et al. (55)	9		4 vs. 4	30 × 30	4 × 4 min/150-s rest	Possession	%HRmax: 91.0	6.4 ± 2.7	
				4 vs. 4 with GK	33 × 33			%HRmax: ↓ 88.8	6.2 ± 1.4	
	Mallo and Navarro (46)	10		3 vs. 3	33 × 20	1 × 5 min/10-min rest	Normal rules	Mean HR: 173 $b\cdot min^{-1}$		
				3 vs. 3 with GK				Mean HR: 166 $b\cdot min^{-1}$		
	Dellal et al. (14)	20	26 ± 2.9	8 vs. 8	60 × 45	4 × 4 min/3-min rest		%HRres: 71.7		
				8 vs. 8 with GK	60 × 45	2 × 10 min/5-min rest		%HRres: ↑ 80.3		
	Köklü et al. (34)	16	16.5 ± 1.5	2 vs. 2	15 × 27	2 × 4 min/2-min rest	Collective possession	%HRmax: 86	7.4	6
				2 vs. 2 with GK				%HRmax: 88	8.4	7.3
				3 vs. 3	20 × 30	3 × 4 min/2-min rest		%HRmax: 86.9	6.5	4.6
				3 vs. 3 with GK				%HRmax: 89.1	5.3	6.5
				4 vs. 4	25 × 32	4 × 4 min/2-min rest		%HRmax: 88.7	6.1	5.1
				4 vs. 4 with GK				%HRmax: 90.1	6.9	5.7

*HR = heart rate; La = lactate concentration; RPE = rating of perceived exertion; %HRmax = percentage of maximum heart rate; GK = goalkeepers; %HRres = percentage of heart rate reserve; ↑ = increase to; ↓ = decrease to.

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interval SSG and the continuous SSG were significantly more intense than the 2-a-side and 4-a-side games in terms of HRmax (i.e., for 3-a-side: 92.0 vs. 91.2% during interval and continuous SSG, respectively, and for 2-a-side: 88.6 vs. 88.8% during interval and continuous SSG, respectively). Whereas, the 2-a-side interval SSG and continuous SSG resulted in higher [La−] concentrations compared with other SSG types (i.e., for 2-a-side: 7.8 vs. 8.1 during interval and continuous SSG, respectively, and for 3-a-side 6.8 vs. 7.2 $mmol \cdot L^{-1}$ during interval and continuous SSG, respectively). Thus, this study demonstrated that interval SSG and continuous SSG are similar in terms of physiological responses except for 2-a-side [La−] responses, suggesting that both interval and continuous SSG can be used effectively for the physiological adaptations of soccer-specific endurance. In that event, coaches can alternate between intermittent and continuous regimen during SSG training. However, coaches should take into account other variables (i.e., player numbers, pitch area, and period of the season) that may influence the intensity of exercise, to maintain the effectiveness of these 2 regimens on physiological and perceptual responses.

Game Duration. To date, only 1 study has explored the influence of the game duration on physiological responses in soccer SSG (21). In this study, Fanchini et al. (21) investigated the effect of SSG duration with 2-, 4-, and 6-minute interval format, on exercise intensity (i.e., HR and [La−]) and technical actions during 3 vs. 3 SSG. There was a significant increase in HR responses (expressed in percentage HRmax) between the 2- and 4-minute game durations (82.4 vs. 85.9%, respectively) and a decrease between the 4- and 6-minute game durations (85.9 vs. 85.6%, respectively). However, no significant differences were found in RPE responses between the 3 different bouts (2, 4, and 6 minutes: 6.7 vs. 6.8 vs. 6.8, respectively). Moreover, no effect of duration was found in any of the technical actions (i.e., passes, dribbles, tackles, and shots). The authors concluded that the 4-minute bouts seem to provide the optimal physical training stimulus during the interval SSG training format.

In conclusion, to date, only 1 study has examined the effect of SSG duration on physiological responses in soccer players. Therefore, we are unable to provide firm practical recommendations on the optimum duration of SSG for training adaptations. Further studies investigating the effect of different SSG durations on physiological responses and technical and tactical skills in different team sports are warranted. In this context, it would be worthy to conduct longitudinal studies to not only determine the technical and physiological responses to SSG but also the long-term effects of different SSG training protocols of differing bout durations. From a practical perspective, 4-minute durations seem to provide higher exercise intensities during SSG interval during. Therefore, we would recommend that coaches use the 4 × 4-minute format during SSG.

Energy Expenditure and Enjoyment. Despite their importance during aerobic training, to the best of the authors' knowledge, there is only 1 study that has explored the energy expenditure and enjoyment during SSG in overweight boys (58). In this study, the authors examined whether energy expenditure and enjoyment during SSG training on a badminton court (6.1 × 13.4 m) were comparable to larger court dimensions (volleyball and basketball courts: 9 × 18 m and 14.2 × 26.5 m, respectively). In this study, 12 overweight boys played 30-minute 3-a-side SSG on each court in a counterbalanced design. During SSG, energy expenditure was estimated through accelerometry, HR, and RPE. Energy expenditure was similar between badminton and volleyball courts, but lower than the energy expenditure obtained during a basketball court. Mean percentage of HRmax was significantly lower on the badminton court than the volleyball and the basketball courts. However, there was no effect of court size on RPE or enjoyment. These results suggest that it may be preferable to play SSG on a larger court when space is available. However, the selection of this variable during SSG training depends on the official court area of the practiced sports. Alternatively, when space is limited, the difference in energy expenditure between court sizes is equivalent to an additional 2–3 minutes of play on a badminton court.

Player Maturation. Player maturation is another important factor that has been neglected by most studies in SSG and seems to have an influence on physiological responses during games. Indeed, Da Silva et al. (13) examined the influence of players' maturation on exercise intensity and involvements with the ball. Sixteen male soccer players completed 2 bouts of 3 vs. 3 (SSG3), 4 vs. 4 (SSG4), and 5 vs. 5 (SSG5) SSG training. Intensity was measured using HR and expressed as a percentage of HRmax, and the maturation stage was determined using the Tanner stage scale. Intensity in SSG3 (89.8 ± 2.0% HRmax) was higher than that in SSG5 (86.9 ± 3.0% HRmax), and there were no differences between SSG3 and SSG4 or SSG4 and SSG5. Moreover, no effects of number of players were found in involvements with the ball, passes, target passes, tackles, and headers. Significantly more crosses, dribbling, and shots on goal were observed during SSG3 compared with SSG4 or SSG5. However, the authors showed that the level of maturation was not associated with either exercise intensity or involvements with the ball. These results extend previous findings with adult players (32,45,50) suggesting that SSGs can provide an adequate training stimulus for young players and are feasible for groups with heterogeneous maturation levels. Therefore, coaches could use SSG training effectively with different age groups and categories.

Wrestling in Rugby. In collision sports such as rugby league and rugby union, players are required to perform multiple tackles per game, with static lifting, scrums, and mauls placing considerable demands on players (24).

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TABLE 6. Summary of studies examining the effects of training regimen on small-sided game intensity in team sports.*

Study	Sample size	Age, y	Design	Duration	Regimen	%HRmax
Owen et al. (47)	13	17.46 ± 1.05	1 vs. 1 to 5 vs. 5	3 × 3 min/12-min rest	Interval	1 vs. 1:86.0
						2 vs. 2:88.0
						3 vs. 3:81.7
						4 vs. 4:72.0
						5 vs. 5:79.5
Aroso et al. (4)	14		4 vs. 4	3 × 6 min/90-s rest	Interval	70.0 ± 9.0
Jones and Drust (35)		7 ± 1	4 vs. 4	1 × 10 min	Continuous	Mean HR: 175 ± 10 $b \cdot min^{-1}$
			8 vs. 8			Mean HR: 168 ± 6 $b \cdot min^{-1}$
Rampinini et al. (50)	20	24.5 ± 4.1	3 vs. 3	3 × 4 min/3-min rest	Interval	89.5 ± 2.9
			5 vs. 5			88.8 ± 3.1
Kelly and Drust (37)	8	18 ± 1	5 vs. 5	4 × 4 min/2-min rest	Interval	91.0 ± 4.0
Little and Williams (45)	28	22.8 ± 4.5	2 vs. 2	4 × 2 min/2-min rest	Interval	90.8
			3 vs. 3	4 × 210 s/90-s rest	Interval	90.6
			4 vs. 4	4 × 4 min/2-min rest	Interval	90.2
			5 vs. 5	4 × 6 min/90-s rest	Interval	89.3
			6 vs. 6	3 × 8 min/90-s rest	Interval	87.5
			8 vs. 8	4 × 8 min/90-s rest	Interval	87.6
Dellal et al. (14)	10	26 ± 2.9	1 vs. 1	4 × 90 s/90-s rest	Interval	77.6
			2 vs. 2	6 × 150 s/150-s rest	Interval	80.1
			4 vs. 4 with or without GK	2 × 4 min/3-min rest	Interval	77.1
			8 vs. 8 with or without GK	2 × 10 min/5-min rest	Interval	80.3
			8 vs. 8	4 × 4 min/3-min rest	Interval	71.7
			10 vs. 10 with GK	3 × 20 min/5-min rest	Interval	75.7
Hill-Hass et al. (30)	16	16.2 ± 0.2	2 vs. 2; 4 vs. 4; 6 vs. 6	4 × 6 min/90-s rest	Interval	84 ± 1
			2 vs. 2; 4 vs. 4; 6 vs. 6	1 × 24 min	Continuous	87 ± 1
Owen et al. (48)	15	26.3 ± 4.85	3 vs. 3	3 × 5 min/4-min rest	Interval	94 ± 2.7
			9 vs. 9			89 ± 4.8
Katis and Kellis (36)	34	13 ± 0.9	3 vs. 3	10 × 4 min/3-min rest	Interval	87.6 ± 4.77
			6 vs. 6			82.8 ± 3.22
Dellal et al. (16)	20	27 ± 2	2 vs. 2	2 × 4 min/3-min rest	Interval	%HRres: 80.1 ± 3.6
			3 vs. 3	3 × 4 min/3-min rest	Interval	%HRres: 81.5 ± 4.3
			4 vs. 4	4 × 4 min/3-min rest	Interval	%HRres: 70.6 ± 5.9
Da silva et al. (13)	16	13.5 ± 0.7	3 vs. 3	3 × 4/3-min rest	Interval	89.8 ± 2
			4 vs. 4			89.8 ± 2
			5 vs. 5			86.9 ± 3
Brandes et al. (7)	17	14.9 ± 0.7	2 vs. 2	3 × 4/1.5-min rest	Interval	93.3 ± 4.2
			3 vs. 3	3 × 5/1.5-min rest	Interval	91.5 ± 3.3
			4 vs. 4	3 × 6/1.5-min rest	Interval	89.7 ± 3.4
Köklü et al. (42)	16	15.7 ± 0.4	1 vs. 1	1 × 6 min/2-min rest	Interval	86.1 ± 4.2
			2 vs. 2	2 × 6 min/2-min rest	Interval	88.0 ± 4.9
			3 vs. 3	3 × 6 min/2-min rest	Interval	92.8 ± 4.1
			4 vs. 4	4 × 6 min/2-min rest	Interval	91.5 ± 3.6

(continued on next page)

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Dellal et al. (18)	27	16.5 ± 0.5	2 vs. 2	8 × 2 min/1-min rest	Interval	80.1 ± 3.6
			3 vs. 3	6 × 30 s/90-s rest	Interval	81.5 ± 4.3
			4 vs. 4	4 × 4/2-min rest	Interval	70.6 ± 5.9
Casamichana and Castellano (9)	10	15.5 ± 0.5	5 vs. 5	3 × 8 min/5-min rest	Interval	94.6 ± 4.3
						94.6 ± 3.4
						93.0 ± 5.7
Dellal et al. (19)	40	25.3 ± 2.4	4 vs. 4	4 × 4 min/3-min rest	Interval	87.6 ± 2.5
Köklü (43)	20	16.6 ± 0.5	2 vs. 2	3 × 2 min/2-min rest	Interval	88.6 ± 3.8
			3 vs. 3	3 × 3 min/2-min rest		92.0 ± 2.0
			4 vs. 4	3 × 4 min/2-min rest		90.1 ± 2.5
			2 vs. 2	1 × 6 min	Continuous	88.8 ± 3.2
			3 vs. 3	1 × 9 min		91.2 ± 2.6
			4 vs. 4	1 × 12 min		89.3 ± 2.7
Kenett et al. (38)	20	21.3 ± 1.2	4 vs. 4	2 × 9 min/2-min rest	Interval	88.8 ± 5.9
			6 vs. 6			88.4 ± 5.7
			8 vs. 8			87.1 ± 5.1
Foster et al. (22)	8	12–13	4 vs. 4	2 × 4 min/3-min rest	Interval	87.9
						88.1
						88.4
			6 vs. 6			88.5
						89.3
						90.3
	14	15–16	4 vs. 4			89.8
						90.6
						91.5
			6 vs. 6			85.0
						87.0
						86.5

*%HRmax = percentage of maximum heart rate; GK = goalkeepers; %HRres = percentage of heart rate reserve.

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Consequently, the physiological demands of the rugby codes are significantly increased through the large amounts of tackling, wrestling, grappling, and physical collisions that occur during match play (23). One method of simulating the most demanding passages of play during a rugby match is to intermittently integrate wrestling periods throughout the SSG. Gabbett et al. (24) investigated the influence of wrestling on the physiological demands of SSG in rugby league. In this study, 28 elite rugby league players completed 2 training sessions performed 5 days apart. Two SSGs, with or without intermittent wrestling, were played in each session. The players were divided into 4 teams of 7 players. On day 1, 2 teams played 2 $\times$ 8-minute SSG with a recovery period of 90 seconds, whereas the remaining 2 teams played the SSG with intermittent wrestling. The wrestling periods employed grappling, pushing, and pulling tasks that were similar in nature to the demands of rugby. At random periods throughout the game, the players were required to wrestle a partner for approximately 5 seconds. A total of 8 wrestling periods were performed throughout each 8-minute game, for a total of 16 wrestling periods. On day 2, the groups were crossed over. The results of this study demonstrated that the games without wrestling resulted in a greater total distance covered (2,475 $\pm$ 31 vs. 1,964 $\pm$ 27 m) and greater distance covered in low (930 $\pm$ 19 vs. 842 $\pm$ 19 m), moderate (1,120 $\pm$ 28 vs. 752 $\pm$ 26 m), high (332 $\pm$ 16 vs. 240 $\pm$ 12 m), and very high (24 $\pm$ 4 vs. 15 $\pm$ 3 m) speeds. Conversely, the games with wrestling resulted in a significantly greater distance covered in mild, moderate, and maximal accelerations and a greater number of repeated high-intensity effort bouts (2.1 $\pm$ 0.2 vs. 0.2 $\pm$ 0.1 bouts). No significant differences were detected between games with and without wrestling for the total number of skill involvements, including receives, passes, effective passes, ineffective passes, and disposal efficiency. From a practical perspective, these results suggest that intermittent wrestling may be a useful supplement to rugby SSG to concurrently train repeated-effort ability and skills under game-specific fatigue. Therefore, coaches should incorporate intermittent wrestling during rugby SSG training to replicate the repeated high-intensity effort demands of match play.

Battlezone in Cricket. Vickery et al. (59) were the first to explore SSG in cricket. The authors have investigated the movement demands and physiological responses of cricket SSG termed: Battlezone. Thirteen amateur male cricket players completed 2 sessions of a generic cricket SSG (Battlezone) consisting of 6 $\times$ 8 minutes separated by 5 minutes of passive rest. Heart rate and movement demands were continuously recorded, whereas [La−] and RPE were recorded after each respective bout. The results showed that batsmen covered the greatest distance (1,147 $\pm$ 175 m) and demonstrated the greatest mean movement speed (63 $\pm$ 9 $m \cdot min^{-1}$) during each bout. The majority of time (i.e., 65–86%) was spent with a HR ranging between 51 and 85% of HRmax, [La−] ranging between 1.1 and 2.0 $mmol \cdot L^{-1}$, and an RPE ranging between 4.2 and 6.0. Movement demands and physiological responses did not differ between standardized sessions within respective playing positions. These results suggest that the physiological responses and movement characteristics of cricket SSG are consistent between sessions within respective playing positions.

Types of Comparisons in Small-Sided Games

Several studies have compared the intensity of SSG with that experienced during competitive match play in soccer (19). This comparison was performed with different team formation methods (43), SSG and friendly matches (FM) (10), amateur vs. professional players (16), and between movement patterns in matches of different playing standards (25). The findings of these studies can also be used to determine if the most intense periods of matches are comparable to the intensity of SSG exercises. Dellal et al. (19) compared the effects of common rule changes on technical and physical demands for elite soccer players in 5 playing positions during various 4-minute SSG in comparison to 11-a-side match. Compared with match play, total distance covered per minute of play and high-intensity running activities (i.e., sprinting and high-intensity runs) were significantly higher during SSG than during the football match for all playing positions. Indeed, the authors showed that % HRmax, [La−], and RPE were higher in SSG compared with match play (i.e., 87.6 vs. 83.2%, 4.8 vs. 3.0 $mmol \cdot L^{-1}$, and 8.0 vs. 7.4 for %HRmax, [La−], and RPE, respectively). Also, a greater number of duels and lost balls, and a lower percentage of successful passes and total number of ball possessions were found during the different SSGs for all playing positions in comparison to match play.

For comparison between team formations methods, Köklü et al. (43) examined the influence of different team formations on the physiological responses of 4 vs. 4 SSG (SSG4) in young soccer players. SSG4 team formations were created according to 4 different methods: according to the coaches' subjective evaluation, technical scores, $\dot{V}O_2max$, and $\dot{V}O_2max$ multiplied by technical scores. The 4 teams played 4 $\times$ 4 minutes with 2 minutes of passive rest at 2-day intervals. The authors showed that %HRmax, [La−], and RPE responses during SSG4 were significantly higher for teams chosen according to $\dot{V}O_2max$ and $\dot{V}O_2max$ multiplied by technical scores compared with coaches' subjective evaluation and technical scores. In addition, teams chosen by $\dot{V}O_2max$ and $\dot{V}O_2max$ multiplied by technical scores spent significantly more time in a high-intensity zone (i.e., above 90% HRmax) and covered a greater distance in the high-intensity running zone (i.e., above 18 $km \cdot h^{-1}$) than teams formed according to technical scores. In conclusion, to spend more time in the high-intensity HR and running zones, the teams in SSG4 should be formed according to the players' $\dot{V}O_2max$ or the values calculated using both the $\dot{V}O_2max$ and technical scores.

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Casamichana et al. (10) compared the physical demands of FM and SSG. Twenty-seven semiprofessional soccer players were monitored during 7 FM and 9 sessions involving different SSGs. The authors showed significant differences between SSG and FM for the following variables: (a) overall workload (SSG > FM), (b) the distribution of the distance covered in the speed zones 7.0–12.9 $km \cdot h^{-1}$ (SSG > FM) and >21 $km \cdot h^{-1}$ (FM > SSG), and (c) the distribution of time spent in certain speed zones (FM > SSG: 0.0–6.9 and >21 $km \cdot h^{-1}$; FM > SSG: 7.0–12.9 $km \cdot h^{-1}$). The results show that coaches and strength and conditioning professionals should consider FM during their training routine to foster specific adaptations in the domain of high-intensity effort.

For the comparison between amateur and professional soccer players during various SSG exercises (i.e., 2 vs. 2, 3 vs. 3, and 4 vs. 4), Dellal et al. (16) found that, in 2 vs. 2 SSG, both RPE and [La−] were higher in amateurs with respect to professionals (i.e., 8.5 vs. 7.9 and 4.6 vs. 3.6 $mmol \cdot L^{-1}$, respectively). However, HR responses were similar (91.8 vs. 90.2%, respectively) between amateurs and professionals. Moreover, the authors found that physiological responses for amateurs during 4 vs. 4 SSG were similar to those recorded for 3 vs. 3 SSGs. More specifically, there was no significant difference in the HR response between amateur and professional players during 4 vs. 4 SSG (i.e., 86.4 vs. 86.0% of HRmax, respectively). Across all SSGs, amateurs completed a lower proportion of successful passes and lost a greater number of possessions compared with the professional players. These results demonstrate that playing level influences the physiological responses obtained during SSG. Consequently, this study has shown that the main differences between elite and amateur players within SSG concern the capacity of players to perform high-intensity actions (e.g., high-intensity running and sprints, etc.).

Gabbett and Mulvey (25) compared the movement patterns of SSG (3 vs. 3 and 5 vs. 5) vs. domestic matches against male youth teams, national-league matches, and international standard competition in elite women soccer players. The authors found that the overall exercise to rest ratios were similar among SSG (1:13), domestic competition against male youth teams (1:15), national-league matches (1:16), and international competition (1:12). Greater total distance was covered during the international matches 9,968 ± 1,143 than in SSG (4.48 ± 1,304 m), competition against male youth teams (9,324 ± 804 m), and national-league matches (9,706 ± 484 m). Although few repeated-sprint bouts were performed in the lower levels of SSG and match play, repeated-sprint bouts occurred commonly in international competition (4.8 ± 2.8 bouts). The results show that SSG may simulate the overall movement patterns of women's soccer competition but offer an insufficient training stimulus to simulate the high-intensity repeated-sprint demands of international competition.

Studies Comparing Small-Sided Games Training with Interval Training

Although there has been an increase in the use of sport-specific conditioning approaches for team sports, several researchers have questioned its effectiveness when compared with traditional methods of conditioning (8,12,20,33,51). The results of these studies are summarized in Table 7.

Reilly and White (51) compared the intensity of SSG and aerobic interval training. They trained 18 professional soccer players (i.e., divided into 2 groups of 9 players) twice per week over 6 weeks during sport-specific conditioning involving SSG of 5 vs. 5 over 6 × 4 minutes interspersed with 3 minutes of active recovery (i.e., jogging at 50–60% of HRmax). In aerobic interval training, the subjects performed 6 × 4-minute periods of running at 85–90% of HRmax interspersed with 3 minutes of active recovery (i.e., jogging at 50–60% of HRmax). After the training intervention, $\dot{V}O_2max$ increased by only 0.2% for the SSG group and by 0.3% for the aerobic interval group with no statistical significant differences within or between groups.

Chamari et al. (12) investigated the effect of 8 weeks of training (twice per week) involving 15 young male soccer players on physiological responses to SSG. Once per week, players performed 4 × 4-minute bouts on the Hoff track at 90–95% HRmax, separated by 3-minute active recovery at 60–70% of HRmax. During the second session on the following day, players participated in 4 vs. 4 SSG on a 20-m square pitch at the same intensity as session 1. The 3-minute active recovery involved 2 players passing and juggling with the ball. This training regime resulted in an increase in $\dot{V}O_2max$ of 7.5% and a decrease in running economy of 14% while running at 7 $km \cdot h^{-1}$. Submaximal HR also decreased by 9 $b \cdot min^{-1}$. Sassi et al. (55) compared the responses of repetitive interval running with SSG (i.e., 4 vs. 4 and 8 vs. 8) training in top European league soccer players. Repetitive running consisted of 4 × 1,000 m runs, separated by 150 seconds of recovery. The authors concluded that SSG with the ball provided physiological training stimuli comparable with interval training without the ball. This was supported by the higher intensity observed, expressed as HR, during SSG (178 ± 7 $b \cdot min^{-1}$) than repetitive running (167 ± 4 $b \cdot min^{-1}$).

In addition to the observed increases in aerobic fitness, Impellizzeri et al. (33) found substantial changes in several measures of match performance albeit derived from 1 (i.e., posttraining) match analysis, for both training groups (i.e., interval training and SSG training). Perhaps, most relevant to soccer performance was the 22.8 and 25.5% increases in the time spent performing high-intensity activities for the interval and SSG training groups, respectively (Table 7).

Recently, Dellal et al. (20) compared the effects of soccer SSG vs. high-intensity intermittent training (HIT) on the performance in a continuous aerobic test (Vameval) and in an intermittent test with changes of direction (30-15

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intermittent fitness test [30-15 IFT]). Twenty-two amateur soccer players were divided into 3 groups (HIT [$n = 8$], SSG [$n = 8$], and a control group [CG; $n = 6$]). The SSG group performed 2 forms of training 2 vs. 2 and 1 vs. 1 on 2 different pitch areas (20 × 20 and 15 × 10 m, respectively), whereas the HIT group performed 3 types of intermittent runs with passive recovery (30 s–30 s, 15 s–15 s, and 10 s–10 s). Both groups conducted 9 sessions of training for 6 weeks. High-intensity intermittent training and SSG groups showed significantly improved Vameval (5.1 and 6.6%, respectively) and 30-15 IFT (5.1 and 5.8%, respectively) performances, whereas no changes were observed for the CG. Also, there were no differences between the 3 groups in the HRmax, HRrest, and RPE before and after training. These results demonstrate that both SSG and HIT training were equally effective in developing the aerobic capacity and the ability to perform intermittent exercises with change of direction in male amateur soccer players.

In handball, Buccheit et al. (8) investigated the effect of HIT vs. specific game–based handball training (HBT). The HIT consisted of 12–24 × 15-second runs at 95% of the speed reached at the end of the 30-15 IFT interspersed with 15-second passive recovery. The HBT consisted of SSG handball performed over a similar time period. The results showed a small difference between the HIT and the HBT groups in $\dot{V}O_2max$ (50.1 vs. 53.3 $ml \cdot min^{-1} \cdot kg^{-1}$, respectively) and in HR (178.6 ± 7.8 vs. 175.4 ± 8.7 $b \cdot min^{-1}$, respectively). The authors concluded that both HIT and HBT were effective training modes for adolescent handball players.

It seems that sport-specific or traditional aerobic conditioning approaches are comparable in terms of developing aerobic fitness and match performance in soccer. As expected, the magnitude of response in most instances is dependent on the intensity, frequency, and duration of training as well as the total duration of the training program and the initial fitness level of the athletes involved. Small-sided games seem slightly more physically strenuous than traditional training approaches as demonstrated by the elevated HR responses (26) that may potentially evoke greater improvements in cardiovascular function and subsequently aerobic fitness adaptations. These higher responses can be attributed to the additional physical demands imposed upon players during SSG and possibly the motivation and enthusiasm of players (52).

Few studies have investigated the effects of SSG training on injury rates in team sports (23,24,39). It is worthy to note that SSG seem to have numerous advantages with respect to running interval training; nevertheless, as SSGs are performed with a lot of player contacts, it is a possibility that contact injuries could be one of the disadvantages of such a form of training. This warrants further investigation. Moreover, from a practical application viewpoint, we suggest that SSGs are an effective form of training to develop aerobic fitness and to prepare players for real situations that occur during match play. Small-sided games can be used to ensure motivation and enthusiasm of players; however, coaches should be aware of the different variables that may influence playing intensity.

Conclusion

Small-sided games are widely used by coaches to develop technical and tactical skills as well as to improve the endurance of team sport players. Several studies have systematically investigated the effects of SSG while manipulating different variables or game rules such as pitch size, the number of players, or the combination of these variables in team sports. Some studies have also included variables such as coach encouragement, rule modifications, and different work regimes. The studies confirm that by altering these factors, it is possible to manipulate the overall physiological and perceptual workload placed on players.

Research has focused on evaluating physiological, tactical, and technical responses of athletes when these factors were modified in SSG. Further studies are required to improve the understanding of the interaction between the technical, tactical, and physical demands of SSG, and how these can be better manipulated to improve the training process for team sport players.

In addition, because of the lack of consistency in SSG design, players' fitness, age, ability, level of coach encouragement, and playing rules among the studies, it is difficult to make firm conclusions on the influence of each of these factors separately. Because of these limitations, SSG management requires further investigations. The use of standardized conditions in SSG studies will allow a better understanding of the role of each factor and may help researchers to develop more reliable recommendations.

Practical Applications

This review provides information that can help coaches and strength conditioning professionals. As the intensity of training varies according to the season phase and aims, SSG training sessions should be used with different formats (i.e., by manipulating the player numbers, the pitch size, etc.) at different phases of the season. Coaches can alter the number of players to vary the exercise intensity during SSG. Indeed, higher exercise intensity is reached with lower player numbers and with larger pitch areas. Also, coach encouragement is effective for increasing exercise intensity. Therefore, continuous coach encouragement is needed during SSG training session to provide some feedback to the players and to attain the required intensity. Concerning goalkeepers, some contradictions are observed on SSG intensity in the presence or absence of these players and the results are currently inconclusive. However, when coaches use large pitch areas with large goals, the presence of goalkeepers could motivate the players to play with higher intensities. Using different bout durations seems to have minimal effect on exercise intensity. Concerning the

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TABLE 7. Studies comparing small-sided games training with interval training.*

Field	Study	Sample size	Age, y	Group	Training intervention	Results
Football	Reilly and White (51)	9	18.2 ± 1.4	SSG	6 wk, 2 sessions per week SSG (5 vs. 5) 4 min, 3 min at 50–60% of HRmax × 6	$\dot{V}O_2max$ ↑↓ La_{max} ↑↓
		9	18.2 ± 1.4	Interval	6 wk, 2 sessions per week, running intervals 4 min at 85–90% of HRmax, 3 min at 50–60% of HRmax × 6	$\dot{V}O_2max$ ↑↓ La_{max} ↑↓
	Sassi et al. (55)	9		SSG	4 vs. 4, 8 vs. 8	91% of HRmax
				Interval	running intervals: 1,000 m, 150-s rest × 4	85% of HRmax
	Impellizzeri et al. (33)	14		SSG	12 wk, 2 sessions per week: 4 min, 3 min at 60–70% of HRmax × 4	$\dot{V}O_2max$: ↑7%
		15		Interval	12 wk, 2 sessions per week running intervals: 4 min at 90–95% of HRmax, 3 min at 60–70% of HRmax × 4	$\dot{V}O_2max$: ↑8%
	Dellal et al. (20)	10	26 ± 2.9	SSG	1 vs. 1, 2 vs. 2, 4 vs. 4, 8 vs. 8 and 10 vs. 10 with and without a goalkeeper (5–7 training sessions per week for 6 mo)	HRres: 77%
		10	26 ± 2.9	Interval	Short-duration intermittent runs: 30–30-s with active recovery, and 30–30-s, 15–15-s, 10–10-s, and 5–20-s with passive recovery (5–7 training sessions per week for 6 mo)	HRres in the 30–30-s intermittent run: 85.7%
Rugby	Gabbett (23)	37	22.1 ± 0.9	SSG	9 wk, 2 sessions per week skill-based conditioning games, 60–100 min	$\dot{V}O_2max$: ↑5%
		32	22.3 ± 0.8	Interval	9 wk, 2 sessions per week, 60–100 min: speed, power, agility, and endurance training	$\dot{V}O_2max$: ↑5%
Handball	Buchheit et al. (8)	15	15.5 ± 0.9	SSG	SSG performed over a similar time period	Mean $\dot{V}O_2$: 53.3 ± 3.3 Mean HR: 175.4 ± 8.7
		17	15.5 ± 0.9	Interval	10 wk, 2 sessions per week 12–24 × 15 s runs at 95% of the speed reached at the end of the 30-15 intermittent fitness test interspersed with 15-s passive recovery	Mean $\dot{V}O_2$: 50.1 ± 7.1 Mean HR: 178.6 ± 7.8

*SSG = small-sided games; HR = heart rate; HRmax = maximal HR; $\dot{V}O_2$ = oxygen uptake; $\dot{V}O_2max$ = maximal oxygen uptake; La_{max} = maximal lactate concentration; HRres = heart rate reserve; ↑ = increase to; ↑↓ = no change.

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duration, the utilization of 4 × 4-minute SSGs seems to offer the most effective format. Moreover, manipulating some rules such as increasing the number of ball touches or introducing man marking can increase the intensity of SSG.

In summary, further studies should explore other factors such as decision making and cognitive load of players during different SSG formats. A careful examination of the influence of goalkeepers on SSG intensity and the effect of different SSG durations on physiological responses and technical and tactical actions is warranted. Moreover, further studies exploring the effect of continuous SSG vs. interval SSG training on physiological responses and technical and tactical skills in different team sports may allow for firm recommendations to be made on the design and implementation of SSG.

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