TECHNICAL REPORT

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The Reproducibility of Physiological Responses and Performance Profiles of Youth Soccer Players in Small-Sided Games

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Small-sided games (SSGs) are frequently used as an alternative to interval training to provide an aerobic training stimulus.[1] Although the variability of the physical, perceptual, and physiological responses during SSGs training has been previously established,[2,3] an understanding of the reproducibility of the acute physiological responses and movement demands of these games, when completed within the same session and between different training sessions, is also important. This information may allow coaches to better control the SSG training process with soccer players. Consequently, the aim of this study was to determine the within- and between-training session reproducibility of two SSG formats (2 versus 2 and 4 versus 4 players) and two regimes (intermittent and continuous).

Methods

Sixteen amateur male soccer players from the same club (mean ± SD age: 16.3 ± 0.6 years) playing in the top-level domestic U19 age-group competition, participated in the study. All players were notified of the research procedures, requirements, benefits, and risks before giving informed consent.

The SSGs were played over a 9-week in-season period in random order at the same time of day. To match the SSG opposing teams, players were divided into matched pairs according to skill ability and shuttle test performance, before being allocated to SSG teams. All SSGs (with consistent coach encouragement) were played at the start of each training session, with two sessions per week and at least 48 hours separating each session. The preseason training period (12 weeks) was used to familiarize the players with all SSG formats and regimes. The duration of the continuous regimen (SSG^C) was 24 minutes, while the intermittent regimen (SSG^I) involved 4 × 6-minute interval bouts with 1.5 minutes of passive rest

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between bouts. The pitch sizes (length × width) used for 2 versus 2 and 4 versus 4 games were 28 m × 21 m and 40 m × 30 m, respectively.

Reproducibility of each SSG was determined through comparison of different players' physiological and perceptual responses to the same SSG format and regimen (either across three concurrent 2 versus 2^I or 2 versus 2^C games, or two concurrent 4 versus 4^I or 4 versus 4^C games) completed within the same training session. Between-session reproducibility was determined when the same SSGs were played several weeks apart.

Heart rate (HR) was measured (5-s recording intervals) via short-range radiotelemetry (Polar Team Sport System; Polar Electro, Kempele, Finland) and expressed as a percentage of maximum heart rate (%HRmax). Maximum HR was determined from a maximal 20-m shuttle test to fatigue. Global ratings of perceived exertion (RPE) were recorded immediately after the SSGs using the Borg scale (6–20 scale). Capillary blood samples were drawn from an earlobe at rest and within 1.5 minutes of the cessation of each SSG. Time–motion characteristics were measured using portable global positioning system (GPS) units (SPI 10; GPSports, Canberra, Australia).Total distance, distance traveled at 0 to 6.9 km/h, and distance traveled at >18 km/h were the time motion variables assessed. The reproducibility of each dependent measure was calculated using the typical error of measurement (TE).[4] The TE was also expressed as a percentage of the mean (TE%). Effect size (ES) was calculated using Cohen's *d* statistic. Values of 0.2, 0.5, and >0.8 were considered small, medium, and large, respectively.

Results

Table 1 summarizes the within and between SSG reproducibility for the 4 versus 4 games. The TE% scores for total distance, distance traveled at 0 to 6.9 km/h, percentage HR max, and RPE ranged between 2% and 10% both within and between sessions, for both 4 versus 4^C and 4 versus 4^I (Table 1). The TE% scores for distance traveled at >18 km/h and blood lactate, ranged between 2% and 51% (Table 1). The within-session TE% scores for total distance, distance traveled at 0 to 6.9 km/h, %HR max, and RPE ranged between 2% and 6% and 3% and 15% for 2 versus 2^I and 2 versus 2^C, respectively (data not shown). The within-session TE% scores for distance traveled at >18 km/h and blood lactate ranged between 10% and 52% for both 2 versus 2^C and 2 versus 2^I (data not shown). The between-session TE% scores for total distance, distance traveled at 0 to 6.9 km/h, %HR max, and RPE ranged between 0% and 7% and 2% and 9% for 2 versus 2^I and 2 versus 2^C, respectively (data not shown). The between-session TE% scores for distance traveled at >18 km/h and blood lactate ranged between 16% and 53% for both 2 versus 2^C and 2 versus 2^I (data not shown).The within-session ES's were generally small to medium for both 4 versus 4^C and 4 versus 4^I (Table 1). In contrast, the between-session ES's were medium to large for both 4 versus 4^C and 4 versus 4^I (Table 1).

Table 1 Within and Between-Session Reliability of 4 Versus 4 Small-Sided Soccer Games Training

4 Versus 4 Continuous	Training Session 1 game 1 versus game 2			Training Session 2 game 3 versus game 4		
Variable	**TE**	**TE%**	**Mean difference (ES)**	**TE**	**TE%**	**Mean difference (ES)**
Total Distance (m)	58	2	(0.5)	102	4	(0.2)
Distance (0–6.9 km/h) (m)	64	6	(0.7)	48	4	(1.0)
Distance (>18 km/h) (m)	20	51	(0.4)	16	26	(0.5)
$\%HR_{max}$	2	2	(0.4)	3	4	(0.3)
RPE (AU)	1	10	(0.6)	1	10	(0.5)
Blood [La^-] ($mmol \cdot L^{-1}$)	1	16	(0.6)	1	35	(0.3)
4 Versus 4 Intermittent						
Total Distance (m)	116	4	(0.1)	98	4	(0.7)
Distance (0–6.9 km/h) (m)	59	5	(0.1)	39	3	(0.1)
Distance (>18 km/h) (m)	20	35	(0.1)	27	28	(0.3)
$\%HR_{max}$	3	3	(0.5)	2	2	(0.3)
RPE (AU)	1	12	(0.3)	1	9	(0.8)
Blood [La^-] ($mmol \cdot L^{-1}$)	1	21	(0.8)	1	24	(0.1)
4 Versus 4 Continuous (Between-Session Reproducibility)						
	game 1 versus game 3			**game 2 versus game 4**		
Total Distance (m)	123	5	(1.7)	78	3	(1.4)
Distance (0–6.9 km/h) (m)	42	4	(0.4)	69	7	(1.1)
Distance (>18 km/h) (m)	22	34	(0.5)	17	43	(1.6)
$\%HR_{max}$	4	4	(1.8)	3	3	(0.4)
RPE (AU)	1	10	(1.7)	1	8	(0.1)
Blood [La^-] ($mmol \cdot L^{-1}$)	1	30	(3.8)	1	20	(1.2)
4 Versus 4 Intermittent (Between-Session Reproducibility)						
Total Distance (m)	89	3	(0.5)	102	4	(0.8)
Distance (0-6.9 km/h) (m)	40	3	(0.7)	60	5	(0.3)
Distance (>18 km/h) (m)	25	38	(1.1)	23	35	(1.3)
$\%HR_{max}$	2	3	(0.1)	2	2	(0.4)
RPE (AU)	1	10	(0.2)	1	9	(1.1)
Blood [La^-] ($mmol \cdot L^{-1}$)	1	19	(3.4)	0	2	(0.1)

Discussion

The 4 versus 4 SSG formats and regimes (SSG^I and SSG^C) used in this study displayed similar physical, physiological, and perceptual responses when played concurrently within the same training session or in a duplicate training session completed several weeks later. Similarly, the 2 versus 2 formats and regimes also displayed moderate reproducibility, both within and between training sessions. The reproducibility of distance traveled at >18 km/h and blood lactate was poor. The former may be due to low sampling rate (1 Hz) of the GPS device and the brief duration of the high-intensity efforts during the SSGs. The latter may be due to differences in exercise intensity before blood sampling. The range of TE% scores for 2 versus 2^I tended to be narrower compared with the 4 versus 4 games. These findings agree with previous research, which demonstrated better reproducibility for smaller format games, and overall moderate reliability of physiological and perceptual responses to various SSGs.[3] These results also show that SSGs can be played in either continuous (SSG^C) or interval-based bouts (SSG^I) to apply a consistent aerobic training stimulus. Soccer coaches can therefore be confident in using small-format soccer-specific SSGs to apply a consistent training stimulus to players, if the SSG design is kept consistent.

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