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ORIGINAL RESEARCH

Comparison of physical demands between positional games and matches in elite soccer players

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Abstract

Background: In elite soccer, many teams routinely use positional games (PGs) in their practice sessions, striving to simulate competition situations, although some debate exists about the application's usefulness. **Objective:** The main aim of this descriptive study was to compare the physical demands among three different formats of PGs within the competitive profile. **Methods:** A descriptive study was conducted with 19 Argentinian professional soccer players (age 23.7 ± 4.7 years, body mass 73.6 ± 7.0 kg, height 177.2 ± 5.6 cm). External load was monitored by GPS (Catapult™) during typical practice sessions with PGs designs (7 vs. 7 + 1 Floater [F], 9 vs. 9 + 2F + 2 goalkeepers [GK], 10 vs. 10 + 1F + 2GK) and during 10 official matches. Data on total distance (TD), player-load (PL), HILR (distance covered at speed > 14.9 km/h per minute), HSSL (distance covered at speed > 19.9 km/h per minute), number of runs during HILR and HSSL, very high-intensity accelerations (> 3.5 m/s^2; VHIA) and decelerations (< –3.5 m/s^2; VHID) and maximal speed (MS) were measured. In addition, rates of perceived exertion (RPE) were also monitored. **Results:** The mean values of TD and PL were similar to those of match status in every format. With respect to HILR and HSSL, the average values were significantly lower than those obtained in matches for 7 vs. 7 + 1F and 9 vs. 9 + 2F + 2GK formats ($p < .001$). The MS was the other variable in the study that differed notably from the values obtained during matches in each format ($p < .001$). The VHIA values were significantly higher than matches in 7 vs. 7 + 1F, while VHID presented statistical differences in both formats, 7 vs. 7 + 1F and 10 vs. 10 + 1F + 2GK. Regarding RPE, 10 vs. 10 + 1F + 2GK was the only format without statistical difference in comparison with matches ($p < .001$). **Conclusions:** The findings suggest that smaller-sized PGs could be used to stimulate intensity in terms of acceleration/deceleration demands, whereas larger-sized PGs are the optimum format to reach a similar performance in a competitive situation.

Keywords: professional soccer, specific games, match performance, physical demands analysis, high-intensity activity, internal load response

Introduction

Small-sided games (SSGs), also known in the literature as *game-based training* (Gabbett et al., 2009), are play-sport situations interacting together in a flexible manner (Parlebas, 2001). The use of these games in elite soccer is based on the premise that greater performance improvements are achieved when the specific demands of the sport are transferred to competitive situations (Dellal et al., 2011, 2012; Little, 2009). In such manner, several studies have shown that the physiological and physical responses of several approaches can be modified by manipulating variables such as technical and tactical constraints: the number of players per team (Brandes et al., 2012; Hill-Haas et al., 2009), modification of certain rules (Hill-Haas et al., 2009), relative playing area per player (Casamichana & Castellano, 2010; Dellal et al., 2011; Porres et al., 2010), comparison with competition, (Asian-Clemente et al., 2021; Casamichana et al., 2015; Vilamitjana et al., 2020), floaters (Casamichana et al., 2018), among others. All these authors concluded that these different designs enable players to get as close as possible to real competitive situations, in which the physical, physiological, technical, and tactical demands of a match are able to be replicated.

In professional soccer many teams apply these types of activities in their daily training sessions, striving to simulate competition situations and facilitate the development of a core tactical concept with an appropriate game context (Hill-Haas et al., 2011), although there is somewhat of an ongoing debate whether their application is useful or not (Dellal et al., 2012; Lacome et al., 2018).

Furthermore, the emphasis has been practiced on a countless number of drills proposed, with different game instructions and different designs in the shape of the pitch to be used (Casamichana et al., 2015; Vilamitjana et al., 2020). Recently, for instance, some authors compared different approaches with *possession games*, concluding that these kinds of drills simulate the official match situation more accurately than *traditional small-sided games* (Beato et

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al., 2023; Clemente et al., 2019; Vilamitjana, Heinze, et al. 2022). In the former, the players who maintain possession of the ball are "positioned in such a way that the interrelation among them and the space is as efficient as possible, stimulating the development of individual and collective concepts for the understanding of the game" (Vilamitjana, Calleja-Gonzalez, & Marqués-Jiménez, 2022, p. 5).

Another approach are the *positional games* (PGs): the players have priority action areas based on their *positional roles during matches*, where game space is adapted to the player's usual context in competition (Casamichana et al., 2018). In this way, a more specific tactical conception is generated which would have a greater transfer capacity towards specific match situations (Vilamitjana, Calleja-Gonzalez, & Marqués-Jiménez, 2022). Ball possession takes on a more tactical sense in the PGs: "They attract the opponent to press in such a way that they must press on the offensive, demonstrating at some point a certain vulnerability on the defensive side" (Vilamitjana, Calleja-Gonzalez, & Marqués-Jiménez, 2022, p. 10). Apart from that, the implementation of floaters during PGs facilitates ball possession and consequently generates numerical superiority for the team retaining the ball (Hill-Haas et al., 2011). As such, the kinematic demands imposed on floaters and regular players, in addition to comparing the demand imposed on wildcards in different PGs formats, have been studied in detail by Casamichana et al. (2018). However, to the best of the author's knowledge, no previous evidence has been published in order to describe physical and physiological patterns during this type of specific game. In this context, the main aim of this descriptive study was to compare the physical demands between three formats of PGs within the competitive profile since the PGs try to reproduce basic principles of play which will subsequently be applied during competition.

Methods

Participants

Nineteen professional soccer players (age 23.7 ± 4.7 years, body mass 73.6 ± 7 kg, height 177.2 ± 5.6 cm; sum of ten skinfold sites 61 ± 9.2 mm, body fat 5.7 ± 1.2%, professional soccer playing experience 5.5 ± 4.4 years) participated in this study; all of them were playing for an elite Argentinian team (elite level, according to the classification by McKay et al., 2022) competing in the First Professional League (LPF) during 2018–2019 season. The sample was composed of 2 central defenders, 4 wide defenders, 5 midfielders, 4 wingers, and 4 forwards. Goalkeepers (GK) were excluded from the study, as they did not participate in the same physical training program as the rest of the squad (Clemente et al., 2013).

Before starting the season, the players were evaluated using FIFA's medical protocol. None of them presented any ailments, pathologies, or injuries, and no medical prescriptions were issued. All the participants were informed about the objectives of this research and volunteered to participate in the study, while written consent was obtained prior to participation. The study protocol was approved by the institutional human research ethics committee and drafted in accordance with the Declaration of Helsinki 2008, updated in Fortaleza, October 2013.

General procedure

During the season, each player's GPS was monitored 10 times during training sessions and 10 times during official games. The tactical formations used by the coach were played implementing the 1-3-4-3 formation (GK; 3 central defenders; 2 wide defenders, 2 midfielders; 2 wingers; 1 forward) and the 1-4-2-1-3 formation (GK; 2 central defenders, 2 wide defenders; 3 midfielders; 2 wingers; 1 forward). The only players who were taken into consideration were those who had completed the first half of each game under normal conditions and with the same role on the pitch, in order to rule out any possible effects of underperformance due to mental fatigue or incidents related to match strategies (Lacome et al., 2018; Paul et al., 2015). All official matches were played on natural grass soccer pitches with official dimensions.

Every week, players performed 5 training sessions (one day of possession or positional games, three days of tactical training, and two days of complementary "set pieces"), each of which lasted, on average, 30 min net. There were one to two weekly strength and conditioning sessions plus the official match (the average total distance covered for all activities per micro-cycle was 28 km). No differences were observed in the weekly methodological structure when the team played with a variety of tactical systems.

Instruments and measurements

The totality of physical parameters was assessed using portable 10-Hz GPS devices (Catapult GPS Optimeye S5, Prahran, Australia), previously validated by Johnston et al. (2014) and Nicolella et al. (2018) and analyzed using an Openfield system (Catapult, Prahran, Australia). To limit inter-unit error, each player wore the same personal device with their own number throughout the course of the season. The GPS devices were activated 15 min prior to the start of the match, in accordance with the manufacturer's instructions (GPS accuracy: <1m circular error probability [50 %] without selective availability [horizontal] and typical differential GPS [Wide Area Augmentation System, Euro Geostationary Navigation Overlay Service, Satellite Augmentation System]: 2.5).

The following speed intensities were used to categorize motion: moderate-intensity running (14.9–19.8 km/h), high-speed running (19.9–25.2 km/h), and sprint running (above 25.2 km/h). The number of runs and the distance covered at each speed intensity were measured. The peak speed was also recorded and the speed thresholds were equal to those reported previously by Di Salvo et al. (2009, 2013). The acceleration and deceleration thresholds (> 3.5 m/s^2 and < –3.5 m/s^2, respectively) and definitions had been used previously by Harper et al. (2019). Load rates profile was determined as HSSL (distance covered at speed > 14.9 km/h per min) and HILR (distance covered at speed > 19.9 km/h per min). Nine study variables were obtained from these parameters and they had been previously reported by

Vilamitjana et al. (2020, 2021, 2022), see Table 1. Rates of perceived exertion (RPE) were monitored (Borg, 1998), and the values from the competition were obtained immediately at the end of the game.

The positional games: Design

PGs are performed with the objective of the team ball possession where the players have priority action areas based on their position during competition, and where game space is adapted to the players' usual context in matches, albeit without restricting the players' space exploration during the tasks (Casamichana et al., 2018). These PGs require selected roles to position themselves intelligently, so the team works dynamically and collectively in accordance (Vilamitjana, Calleja-Gonzalez, & Marqués-Jiménez, 2022). Therefore, an important concept is considered in PGs: positional superiority involves setting players into positions between or behind the opposition lines, where they are more likely to have time and space on the ball and are thus more likely to affect the game (Vilamitjana, Calleja-Gonzalez, & Marqués-Jiménez, 2022).

Both 7 vs. 7 +1F and 9 vs. 9 + 2F + 2GK were deployed conserving the same design but holding a different relative playing area per player (77 and 86 m^2, respectively), see Figure 1. The dimensions of each design were selected based on the observations described in the article by Fradua et al. (2013): The relative playing area per player which was between 65–110 m^2, and according to Casamichana et al. (2015), between 50–100 m^2 (Figure 1). The 10 vs. 10 + 1F + 2G format was designed to reach approximately 50% of the official field dimensions (164 m^2 per player) and horizontal lines were drawn in the pitch to delimit positional roles and tasks (Figure 1).

The same monitoring procedure was performed for each PG design and official matches. Altogether, three training sessions were recorded for analysis (in different weeks during the competitive season). All these sessions started with a similar 23-min standardized warm-up (identical to the one implemented by Vilamitjana, Calleja-Gonzalez, & Marqués-Jiménez, 2022) and were performed on a natural pitch, at the same time in the morning (10:00–12:00 am).

The PGs were achieved using an intermittent format of 2 repetitions × 6 min. In between these sets, 2 min of passive recovery was carried out, to promote a more optimal recovery (identical work-to-rest ratio time implemented by Vilamitjana, Heinze, et al., 2022). During rest periods, ad libitum, water was provided for players. In addition, there were two assistant coaches outside the playing area to ensure the continuity of the game. The latter were also assigned as other tasks, such as timers and referees (i.e., to enforce the rules, to survey each ball involvement, etc.).

Statistical analysis

Descriptive statistical measures such as mean and standard deviation were calculated for each condition and player. To determine the effects of the condition, a linear mixed effects model was used for every response variable, where the condition was considered as the fixed effect and the player was considered as a random effect. In this way, we accounted for the autocorrelation of observations within the same player. The matches were used as the reference group. We compared: (a) matches and 10 vs. 10 + 1F + 2GK, (b) matches and. 7 vs. 7 + 1F, and (c) matches and 9 vs. 9 + 2F + 2GK. The model was fitted using the maximum likelihood method. The results include the table with the estimation of the model parameters, their standard errors, and *p*-values. Significant statistical differences were declared at the 5% level. The Cohen effect size *d* was presented (performed by calculating the differences between the means of the groups divided by the common standard deviation) and the commonly used interpretation is to refer to effect sizes as small (d = 0.2), medium (d = 0.5), large (d = 0.8), very large (d = 1.2) and huge (d = 2.0), based on benchmarks suggested by Cohen (1988) and expanded by Sawilowsky (2009). Statistical calculations were performed with R statistical software version (Version 4.2.0; R Foundation for Statistical Computing, Vienna, Austria). The statistical report was prepared with the KNITR statistical R package (Version 1.30; https://yihui.org/knitr/).

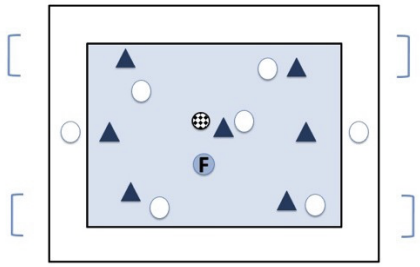
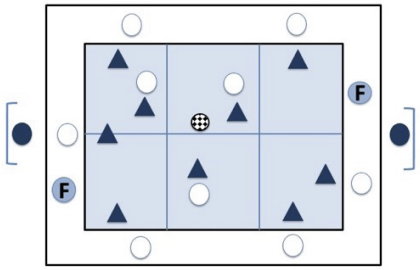
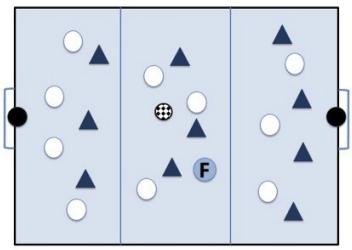
Results

The means and *SD*s of the metrics for the different PGs and matches are shown in Table 2. The mean values of TD and PL resembled those of match status (Table 2). With respect to the load rates (HILR and HSSL), the average values were significantly lower than those obtained in matches for 7 vs.

Table 1 Definition of study variables

Variable	Definition
Total distance (TD)	The total distance covered for the time determined for each activity in meters per minute.
Player-load (PL)	The sum of the accelerations across all axes of the internal tri-axial accelerometer during movement. It considers instantaneous rate of change of acceleration and divides it by a scaling factor (in units per minute).
High-intensity load rate (HILR)	Quotient between distances covered at moderate intensity, high-speed running, and sprint by the amount of time of each activity in meters per minute.
High speed running-sprints load rate (HSSL)	Quotient between distances covered at high-speed running and sprint by the amount of time of each activity in meters per minute.
Runs in HILR (#HILR)	The number of runs performed at moderate intensity, high-speed running, and sprint, in number per minute.
Runs in HSSL (#HSSL)	The number of runs performed at high-speed running and sprinting, in number per minute.
Very high-intensity accelerations (VHIA)	The number of accelerations performed above 3.5 m/s^2, in number per minute.
Very high-intensity decelerations (VHID)	The number of decelerations performed below –3.5 m/s^2, in number per minute.
Maximal speed (MS)	The absolute maximal speed reached, in km/h.
Rate of perceived exertion (RPE)	Borg rating of perceived scale (0–10).

Figure 1 Positional games designs and diagrams

	Design and Objectives	***Diagram***
7 vs. 7 + 1F	*Setting Up:* Rectangle shape, 32 meters width and a length of 36 meters, with a 5-metres strip around the pitch; 2 mini-goals placed five meters from each goal line. *Objective:* For a player to be eligible to shoot in any of the opposite team's mini-goals 5 passes must be made, followed by a pass between the lines to set up a player on the same team (from inside the rectangle pitch to the 5-metres strip area). The defenders must press, intercept the ball, and then try to score in any of two opposite mini goals. One floater (F) facilitates the playing from the team retaining the ball.	
9 vs. 9 + 2F + 2GK	*Setting Up:* Rectangle shape, 24 meters width and a length of 38 meters, with two 5-metres strips around the pitch; 2 official goals placed five meters from each goal line. *Objective:* Blue team plays inside; white team plays outside with three players inside. Outsider team has to pass the ball from defenders to attackers, doing at least 5 passes to shoot. The inner team has to recover the ball and progress in the field to shoot by attackers' players. Two floaters (F) facilitate the playing from the team retaining the ball (outsider team). Every field position has to respect its own game space.	
10 vs. 10 + 1F + 2GK	*Setting Up:* Rectangle shape, 50 meters width and a length of 69 meters (divided in three areas); an official goal located in the end line, with one goalkeeper in each one. *Objective:* Possession of the ball from lower to higher zone (making no more than 3 touches of ball per player). Only one player can descend to a lower zone to assist the defence. One floater (F) facilitates the playing from the team retaining the ball.	

Note. F = floater player; GK = goalkeeper.

Table 2 Means, *SD*s, and effect sizes from positional games compared with matches

Variable	7 vs. 7 + 1F		9 vs. 9 + 2F + 2GK		10 vs. 10 + 1F + 2GK		Match
	M ± *SD*	Cohen's *d*	*M* ± *SD*	Cohen's *d*	*M* ± *SD*	Cohen's *d*	*M* ± *SD*
TD (m/min)	110.7 ± 11.6	0.2	109.7 ± 14.9	0.2	110.9 ± 15.7	0.1	112.5 ± 8.4
PL (*n*/min)	11.6 ± 1.8	0.1	11.2 ± 2.3	0.1	10.8 ± 2.2	0.3	11.4 ± 1.4
HILR (m/min)	14.4 ± 4.2***	2.2	17.6 ± 6.3***	1.3	25.0 ± 8.2	0.1	24.7 ± 4.7
HSSL (m/min)	1.5 ± 1.3***	3.6	2.7 ± 1.8***	2.5	6.5 ± 4.2	0.4	7.9 ± 2.2
#HILR (runs)	1.5 ± 0.5**	0.8	1.7 ± 0.7	0.2	1.9 ± 0.6*	0.8	1.8 ± 0.3
#HSSL (runs)	0.1 ± 0.1***	2.7	0.2 ± 0.2***	2.0	0.4 ± 0.3	0.4	0.5 ± 0.1
VHIA (*n*/min)	1.1 ± 0.5***	0.8	0.6 ± 0.3**	0.9	0.7 ± 0.3	0.5	0.8 ± 0.2
VHID (*n*/min)	2.4 ± 0.7***	2.7	1.3 ± 0.6	0.6	1.5 ± 0.5**	1.1	1.1 ± 0.2
MS (km/h)	21.3 ± 2***	4.9	22.5 ± 1.5***	4.9	24.0 ± 2.3***	3.0	29.5 ± 1.3
RPE	7.3 ± 2***	3.7	7.5 ± 0.6***	3.6	9.0 ± 1.1	0.3	9.2 ± 0.3

Note. F = floater player; GK = goalkeeper; TD = total distance covered; PL = player-load; HILR = high-intensity load rate; HSSL = high-speed running-sprints load rate; #HILR = number of runs performed in HILR; #HSSL = number of runs performed in HSSL; VHIA = very high-intensity accelerations; VHID = very high-intensity decelerations; MS = maximal speed; RPE: rate of perceived exertion. *p < .05 from the match; **p < .01 from the match; ***p < .001 from the match.

7 + 1F and 9 vs. 9 + 2F + 2GK formats (p < .001), differing notably from the levels held by competition (58.3–19.0% for 7 vs. 7 + 1F and 71.3–34.2% for 9 vs. 9 + 2F + 2GK, respectively; Table 2). The effect sizes of these mean differences were d = 2.2–3.6 for 7 vs. 7 + 1F and d = 1.3–2.5 for 9 vs. 9 + 2F + 2GK, respectively (Table 2). Otherwise, no statistical differences were observed during 10 vs. 10 + 1F + 2GK in comparison with matches in mentioned variables.

Concerning #HILR, the differences obtained were less for the 7 vs. 7 + 1F (83.3%, p = .009) and significantly higher during 10 vs. 10 + 1F + 2GK format compared with competition (105.6%, p = .049; Table 2). The effect size of mean differences was 0.8 for both formats (Table 2). No statistical difference was obtained for 9 vs. 9 + 2F + 2GK. Regarding #HSSL, the difference was significantly lower than matches for 7 vs. 7 + 1F and 9 vs. 9 + 2F + 2GK formats (20 and 40%, respectively; p < .001). The effect size of mean differences was 2.7 and 2.0, respectively (Table 2). No statistical difference was found for 10 vs. 10 + 1 + 2GK (Table 2).

During VHIA and VHID variables, the average was higher for 7 vs. 7 +1F (p < .001), with percentages relevant to those which were determined in matches (137.5 and 118.5%, respectively; the effect size of mean differences was 0.8–2.7), see Table 2. The same occurs in VHID for 10 vs. 10 + 1F + 2GK format (136%, p = .008; the effect size of mean differences was 1.1), see Table 2. No statistical difference was found in VHIA for 10 vs. 10 + 1F + 2GK and VHID for 9 vs. 9 + 2F + 2GK (Table 2).

Maximal speed was the other variable of study that differed markedly from the values obtained during matches in each format (72.2, 76.3, and 81.4%, for 7 vs. 7 + 1F, 9 vs. 9 + 2F + 2GK and 10 vs. 10 + 1F + 2GK respectively; p < .001). The effect size of mean differences was 4.9, 4.9, and 3.0, respectively (Table 2). Finally, with regard to RPE, 10 vs. 10 + 1F + 2GK was the only format without statistical difference in comparison with matches (p < .045), see Table 2.

Discussion

The main aim of this study was to compare the physical and physiological demands between different formats of PGs and competition. To the best of our knowledge, this is the first study that comprehensively analyzes the mechanical demands of different specific PGs in professional players.

On the one hand, the analysis of the PGs data describes competition-like performance in TD and PL in every format studied. Concretely, Owen et al. (2014) found no significant differences in variables such as TD and high-intensity efforts when they compared medium (6 vs. 6 + 2GK and 7 vs. 7 + 2GK) and large-sided games (8 vs. 8 + 2GK and 9 vs. 9 + 2GK) with 11 vs. 11 formats (10 vs. 10 + 2GK, pitch size 100×74 m, 336 m^2 per player). Meanwhile, another study by Gaudino et al. (2014) was performed comparing small-sided games with possession games in three different formats (5 vs. 5, 7 vs. 7, and 10 vs. 10; 73–135 m^2 per player) and reached the same conclusion as Owen et al. (2014), while further arguing that this effect was due to a larger pitch area and less pressure being sustained from opponents, with an increased number of options for making passes among players (Owen et al., 2014). With respect to the load rates (HILR and HSSL), the average values were significantly lower than those obtained in matches for 7 vs. 7 + 1F and 9 vs. 9 + 2F + 2GK formats, showing lower percentage values obtained in matches. A similar conclusion was reached in studies using possession games with 7 vs. 7 and 8 vs. 8 formats and similar relative playing area per player designs (~88–99 m^2 per player; Vilamitjana et al., 2020).

On the other hand, 10 vs. 10 + 1F + 2GK was the only format with mean values similar to matches for most variables of the study (except in MS). Other studies have found that larger pitch sizes caused an increase in TD and mechanical work, but with more relative playing area per player designs (10 vs. 10 + 2GK; 291 m^2 per player; Caldeira et al., 2022). In another comparison among different large-sided game formats (8 vs. 8 and 10 vs. 10, among others) with matches, only 10 vs. 10 (342 m^2 per player) allowed players to reach similar running intensities to those of competition (TD and high-intensity running at speed > 14.4 km/h) (Lacome et al., 2018). Beato et al. (2023) concluded that large-sided game 10 vs. 10 (9 vs. 9 + 2GK, with regular goals, 184 m^2 per player) was the most suitable format to achieve high-speed running (at speed > 19.9 km/h) and sprinting distance (at speed > 25.2 km/h), although the intensities recorded were lower than those observed during regular matches. Other authors concluded that 10 vs. 10 (9 vs. 9 + 2GK, with small goals) simulates the official match situation more accurately than other large-sided or conditioned games in sprinting and loading demands (Clemente et al., 2019). In the present study, with a similar format (9 vs. 9 + 2F + 2GK), the variables with no significant difference were TD, PL, #HILR, and VHID, when compared to the competition.

With regard to high-intensity accelerations and decelerations, the VHIA values were significantly higher than matches in 7 vs. 7 + 1F, while in VHID statistical differences have been found in both formats, 7 vs. 7 + 1F and 10 vs. 10 + 1F + 2GK. Recently, Beato et al. (2023) have found that possession games 6 vs. 4 formats (180 m^2 per player) displayed a higher frequency of acceleration and deceleration actions per minute (> 3.0 / < –3.0 m/s^2). Other authors have ratified the fact that when soccer is played in smaller relative playing areas per player than those used for official games, the number of accelerations and decelerations increases significantly (Asian-Clemente et al., 2021).

An additional study parameter that differed notably from the values obtained during matches in each format was MS (72, 76 and 81.4%, respectively). This variable seems to reach closer to those of competition values as the relative playing area per player increases (77, 86, and 164 m^2 per player, respectively). Gaudino et al. (2014) concluded that MS increased with big pitch dimensions during possession and small-sided games (10 vs. 10 > 7 vs. 7 > 5 vs. 5, 135, 98 and 73 m^2 per player, respectively). Further evidence showed that an increased pitch size led to getting greater inter-player and inter-team distances, which translated into

more space available to get to run close to the MS (Clemente et al., 2021; Lacome et al., 2018; Riboli et al., 2020).

The RPE is not a common variable considered when specific games are compared in elite soccer. In the present study, 10 vs. 10 + 1F + 2GK was the only format with comparable values of RPE to those obtained in matches. Similar mean values of HILR, #HILR, and VHIA were obtained during this format in correlation with RPE. It seems that in some combination, high-speed running distance (> 14.4 km/h) and number of accelerations (> 3 m/s^2) during training sessions are likely to be strong predictors of RPE (Gaudino et al., 2015). However, a lower relative playing area per player would demand lower RPE values in comparison with matches. Other studies have shown the highest scores of RPE (7.5–8.0) during possession games (6 vs. 4, 184 m^2 per player) and large-sided games (10 vs. 10, 184 m^2 per player), while 8 vs. 8 + 2F reached the lowest score value (4.0; Beato et al., 2023). In this sense, future studies should evaluate internal load patterns among different PG formats in comparison with the match's profile.

This study presents practical implications. On the one hand, larger PG formats such as 10 vs. 10 + 1F + 2GK can reach competition-like performance in several physical metrics and perceived effort. On the other hand, smaller PG formats as 7 vs. 7 + 1F can stimulate high-intensity accelerations and decelerations. Coaches and trainers could implement this information to adapt the different PGs to fit the main physical goal of any training session previous to matches during a competitive period.

The main limitation of this study lies in the sample size. Apart from this fact, we must consider that all the players belonged to the same team. It has not been determined whether these results would be generalizable to other teams and competitive levels. Additionally, a study involving a larger number of players would be essential to evaluate performance by positional roles. However, the fact that it is linked to elite players on-site provides it with added value for practitioners given its ecological validity.

Conclusions

The results indicate that the level of TD and PL performance obtained in all the formats studied was close to that of the matches. The high-intensity acceleration values were significantly higher than matches in 7 vs. 7 + 1F, while high-intensity decelerations presented statistical differences in both formats, 7 vs. 7 + 1F and 10 vs. 10 + 1F + 2GK. Furthermore, 10 vs. 10 + 1F + 2GK was the only format with mean values similar or higher to matches for most variables of the study. This suggests that smaller-sized PGs could be used to stimulate intensity in terms of acceleration/deceleration demands, whereas larger-sized PGs are the optimum format to reach a similar performance level to that in competition. Coaches and practitioners may use such information to implement PGs to fit the main physical goal of any training session previous to matches during a competitive period.

Conflict of interest

The authors report no conflict of interest.

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References

Asian-Clemente, J., Rábano-Muñoz, A., Muñoz, B., Franco, J., & Suarez-Arrones, L. (2021). Can small-side games provide adequate high-speed training in professional soccer? *International Journal of Sports Medicine, 42*(6), 523–528. https://doi.org/10.1055/a-1293-8471

Beato, M., de Keijzer, K., & Costin, A. (2023). External and internal training load comparison between sided-game drills in professional soccer. *Frontiers in Sports and Active Living, 5,* Article 1150461. https://doi.org/10.3389/fspor.2023.1150461

Borg, G. (1998). *Borg's perceived exertion and pain scales*. Human Kinetics.

Brandes, M., Heitmann, A., & Müller, L. (2012). Physical responses of different small-sided game formats in elite youth soccer players. *Journal of Strength and Conditioning Research, 26*(5), 1353–1360. https://doi.org/10.1519/JSC.0b013e318231ab99

Caldeira, R., Gouveia, É., Ihle, A., Marques, A., Clemente, F., López, H., Henriques, R., & Sarmento, H. (2022). The relationship between different large-sided games and official matches on professional football players' locomotor intensity. *International Journal of Environmental Research and Public Health, 19*(7), Article 4214. https://doi.org/10.3390/ijerph19074214

Casamichana, D., & Castellano, J. (2010). Time-motion, heart rate, perceptual and motor behaviour demands in small-sides soccer games: Effects of pitch size. *Journal of Sports Sciences, 28*(14), 1615–1623. https://doi.org/10.1080/02640414.2010.521168

Casamichana, D., Gómez Díaz, A. J., Cos Morera, F., & Martín García, A. (2018). Wildcard players during positional games. *Apunts. Educación Física y Deportes, 133,* 85–97. https://doi.org/10.5672/apunts.2014-0983.es.(2018/3).133.06

Casamichana, D., San Roman J., Calleja J., & Castellano, J. (2015). *Cuantificación de las cargas durante los juegos reducidos. Los juegos reducidos en el entrenamiento del fútbol* [Quantification of loads during small-sided games. Small-sided games in soccer training]. Fútbol de Libro.

Clemente, F., Afonso, J., & Sarmento, H. (2021). Small-sided games: An umbrella review of systematic reviews and meta-analyses. *PLOS ONE, 16*(2), Article e0247067. https://doi.org/10.1371/journal.pone.0247067

Clemente, F., Couceiro, M., Martins, F., Ivanova, M., & Mendes, R. (2013). Activity profiles of soccer players during the 2010 world cup. *Journal of Human Kinetics, 38,* 201–211. https://doi.org/10.2478/hukin-2013-0060

Clemente, F., Praça, G., Bredt, S., van der Linden, C., & Serra-Olivares, J. (2019). External load variations between medium and large-sided soccer games: Ball possession games vs regular games with small goals. *Journal of Human Kinetics, 70,* 191–198. https://doi.org/10.2478/hukin-2019-0031

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203771587

Dellal, A., Chamari, K., Owen, A., Wong, D., Lago-Penas, C., & Hill-Haas, S. (2011). Influence of the technical instructions on the physiological and physical demands within small-sided soccer games. *European Journal of Sport Science, 11*(5), 353–359. https://doi.org/10.1080/17461391.2010.521584

Dellal, A., Owen, A., Wong, D., Krustrup, P., Van Exsel, M., & Mallo, J. (2012). Technical and physical demands of small vs. large-sided games in relation to playing position in elite soccer. *Human Movement Science, 31,* 957–969. https://doi.org/10.1016/j.humov.2011.08.013

Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in Premier League soccer. *International Journal of Sports Medicine, 30*(3), 205–212. https://doi.org/10.1055/s-0028-1105950

Di Salvo, V., Pigozzi, F., González-Haro, C., Laughlin, M. S., & De Witt, J. K. (2013). Match performance comparison in top English soccer leagues. *International Journal of Sports Medicine, 34*(6), 526–532. https://doi.org/10.1055/s-0032-1327660

Fradua, L., Zubillaga, A., Caro, O., Fernández-García, A., Ruiz-Ruiz, C., & Tenga, A. (2013). Designing small-sided games for training tactical aspects in soccer: Extrapolating pitch sizes from full-size professional matches. *Journal of Sports Sciences, 31*(6), 573–581. https://doi.org/10.1080/02640414.2012.746722

Gabbett, T., Jenkins, D., & Abernethy, B. (2009). Game-based training for improving skill and physical fitness in team sport athletes. *International Journal of Sports Science and Coaching, 4*(2), 273–283. https://doi.org/10.1260/174795409788549553

Gaudino, P., Alberti, G., & Iaia, F. (2014). Estimated metabolic and mechanical demands during different small-sided games in elite soccer players. *Human Movement Science, 36,* 123–133. https://10.1016/j.humov.2014.05.006

Gaudino, P., Iaia, M., Strudwick, A., Hawkins, R., Alberti, G., Atkinson, G., & Gregson, W. (2015). Factors influencing perception of effort (session rating of perceived exertion) during elite soccer training. *International Journal of Sports Physiology and Performance, 10*(7), 860–864. https://doi.org/10.1123/ijspp.2014-0518

Harper, D., Carling, C., & Kiely, J. (2019). High-intensity acceleration and deceleration demands in elite team sports competitive match play: A systematic review and metaanalysis of observational studies. *Sports Medicine, 49,* 1923–1947. https://doi.org/10.1007/s40279-019-01170-1

Hill-Haas, S., Dawson, B., Coutts, A., & Rowsell, G. (2009). Physiological responses and time-motion characteristics of various small-sided soccer games in youth players. *Journal of Sports Sciences, 27*(1), 1–8. https://doi.org/10.1080/02640410802206857

Hill-Haas, S., Dawson, B., Impellizzeri, F., & Coutts, A. (2011). Physiology of small-sided games training in football. A systematic review. *Sports Medicine*, *41*(3), 199–200. https://doi.org/10.2165/11539740-000000000-00000

Johnston, R., Watsford, M., Kelly, S., Pine, M., & Spurrs, R. (2014). The validity and reliability of 10 Hz and 15 Hz GPS units for assessing athlete movement demands. *Journal of Strength and Conditioning Research, 28*(6), 1649–1655. https://doi.org/10.1519/JSC.0000000000000323

Lacome, M., Simpson, B., Cholley, Y., Lambert, P., & Buchheit, M. (2018). Small-sided games in elite soccer: Does one size fit all? *International Journal of Sports Medicine, 13*(5), 568–576. https://doi.org/10.1123/ijspp.2017-0214

Little, T. (2009). Optimizing the use of soccer drills for physiological development. *Strength and Conditioning Journal, 31*(3), 67–74. https://doi.org/10.1519/SSC.0b013e3181a5910d

McKay, A., Stellingwerff, T., Smith, E., Martin, D., Mujika, I., Goosey-Tolfrey, V., Sheppard, J., & Burke L. (2022). Defining training and performance caliber: A participant classification framework. *International Journal of Sports Physiology Performance, 17*(2), 317–331. https://doi.org/10.1123/ijspp.2021-0451

Nicolella, D., Torres-Ronda, L., Saylor, K., & Schelling, X. (2018). Validity and reliability of an accelerometer-based player tracking device. *PLOS ONE, 13*(2), Article e0191823. https://doi.org/10.1371/journal.pone.0191823

Owen, A., Wong, D., Paul, D., & Dellal, A. (2014). Physical and technical comparisons between various sided games within professional soccer. *International Journal of Sports Medicine, 35*(4), 286–292. https://doi.org/10.1055/s-0033-1351333

Parlebas, P. (2001). *Juegos, deporte y sociedad. Léxico de praxiología motriz* [Games, sport and society. Lexicon of motor praxeology]. Paidotribo.

Paul, D., Bradley, P., & Nassis, G. (2015). Factors affecting match running performance of elite soccer players: Shedding some light on the complexity. *International Journal of Sports Physiology and Performance, 10*(4), 516–519. https://doi.org/10.1123/ijspp.2015-0029

Porres, D., Paz Fernández, J., Fernández Gonzalo, R., Cervera, J., & Yagüe Cabezón, J. (2010). Variabilidad de la carga fisiológica en los pequeños juegos de fútbol en función del espacio. [Variability of physiological load in small-sided football games as a function of space]. *Apunts. Educación Física y Deportes, 102,* 70–77.

Riboli, A., Coratella, G., Rampichini, S., & Esposito, F. (2020). Area per player in small-sided games to replicate the external load and estimated physiological match demands in elite soccer players. *PLOS ONE, 15*(9), Article e0229194. https://doi.org/10.1371/journal.pone.0229194

Sawilowsky, S. (2009). New effect size rules of thumb. *Journal of Modern Applied Statistical Methods, 8*(2), 467–474. https://doi.org/10.22237/jmasm/1257035100

Vilamitjana, J., Calleja-González, J., & Marqués-Jiménez, D. (2022). Methodological approach in the development of specific games in elite soccer. In B. Sobota (Ed.), *Game theory – From idea to practice* (pp. 1–19). Intechopen. https://doi.org/10.5772/intechopen.108399

Vilamitjana, J., Heinze, G., Verde, P., & Calleja-González, J. (2020). Comparison of physical performance between possession games and matches in professional football. *Apunts. Educación Física y Deportes, 141,* 75–86. https://doi.org/10.5672/apunts.2014-0983.es.(2020/3).141.09

Vilamitjana, J., Heinze, G., Verde, P., & Calleja-González, J. (2021). High-intensity activity according to playing position with different team formations in soccer. *Acta Gymnica, 51,* Article e2021.003. https://doi.org/10.5507/ag.2021.003

Vilamitjana, J., Heinze, G., Verde, P., & Calleja-González, J. (2022). Comparison of high-intensity patterns between possession games and small-sided games in professional soccer. *Acta Gymnica, 52,* Article e2022.009. https://doi.org/10.5507/ag.2022.009