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Influence of the number of players and the relative pitch area per player on heart rate and physical performance in youth soccer

Brief running head: Influence of different large-side games on young soccer players' demands

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Brief running head: Influence of different large-sided games on young soccer players' demands

Abstract

The aim of the present study was to analyze the influence of different large-sided games on the physical and physiological variables in under-13s soccer players. The effects on heart rate (HR) and physical demands of different number of players (7, 9, and 11) together with the relative pitch area (100, 200, and 300 m^2) during two 12 min repetitions were analyzed in this study. The variables analyzed were: mean, maximum and different intensity zones of HR; total distance (TD); work:rest ratio (W:R); player-load (PL); five absolute and three relative speed categories. The results support the theory that a change in pitch dimensions affects locomotor activity more than the number of players does, but also refutes the hypothesis that the change in the number of players has a greater effect on HR. To be more specific, an increase in the relative pitch area per player (300/200/100 m^2) was associated with higher values of the following variables: TD (2250-2314/2003-2148/1766-1845 m), W:R (0.5-0.6/0.4-0.5/0.3 AU), PL (271-306/246-285/229-267 UA), $\%HR_{mean}$ (85-88/85-89/81-83 %), $\%HR_{max}$ (95-100/97-100/95-98 %), and affected the percentage of time spent in both absolute (above 8 $km \cdot h^{-1}$) and relative speed (above 40% of V_{max}) categories ($p<0.05$, effect size: 0.31-0.85). These results may help youth soccer coaches to plan the progressive introduction of large-sided games so that task demands are adapted to the physiological and physical development of participants.

Keywords: youth soccer, team sport, game format, physical and physiological performance

INTRODUCTION

In junior or youth soccer the competitive format needs to be adapted to the characteristics of those involved, and consequently the rules are often modified to suit the physical development of children and youngsters (1). These adaptations make it easier for them to take part (2) by increasing their experience in the game. In this context, some studies have examined how the structure of training can be adapted by changing the pitch size, the number of players, the duration of the match, or the relative pitch area per player (3,4). This is important as there is a need for scientific evidence regarding the effects that different competitive formats have on young players, not least so that training can be adapted to the needs of participants(5). It is not always easy to carry out research on matches played within a competitive format as, due to them being official matches modification of variables is not an option. Therefore, studies using large-sided games during the training process could be an alternative (13). However there is little evidence relating to how large-sided formats affect the demands on young players, as most research to date has been carried out on small-sided games.

The number of players is a variable that is often modified not only in competitive settings but also during training drills, where it affects the task intensity (6), which increases when player number per team is reduced. Various studies have explored the influence of this variable while keeping other factors constant, such as relative pitch area per player (7). Indeed, research of this kind has examined a range of scenarios from 1 vs. 1 (8) up to 8 vs. 8 (8,9), as well as various intermediate combinations (10,11,7), and it has generally been found that a smaller number of players leads to an increase in heart rate (HR), blood lactate concentration, and the rating of perceived exertion (RPE). It is suggested that these changes are largely the result of the increased frequency of ball contacts (9,12,13). Conversely, a larger number of players appears to lead to greater demands in terms of high-intensity

running and sprints (11,7). Although HR and technical information exists on player demands in 9-a-side game (13) there are no studies that compare 9-a-side to 11-a-side games with the same players.

The majority of previous studies concerning small-sided matches have focused on how changes to pitch size may affect the demands on players(14,15,16,17), as these changes are possible in both absolute and relative terms (6). Although the results have not been entirely consistent, the literature generally supports the idea that a larger playing area leads to increased physiological and physical demands (14,18,16). A possible explanation for this is related to the effective playing time, which is increased due to there being fewer interruptions to play on a larger pitch (14). The pitch size also seems to influence the motor behavior of players, with smaller playing areas being associated with a greater frequency of actions such as control and dribble and control and shoot, and also a greater number of ball interceptions and clearances (14). Pitch dimensions have also been shown to have an effect on the interactive behavior of teams (19), but it is not known if pitch dimensions have the same effect when these are big.

What is not clear, however, is whether changes to the number of players and the pitch size have the same effect at competitive levels other than those studied to date, when they are applied in large-sided games (when there are more than 9 players on the team). However, in daily practice, the coach may set many training tasks that involve modifying both the number of participating players and the dimensions of each participant's space, without taking into account the demands of such tasks on the players. Consequently, the aim of this study was to examine the influence of different large-sided games on HR and physical performance in under-13 soccer players. Specifically, we studied training matches involving 7, 9, and 11 players per side, and relative pitch areas per player of 100 m^2, 200 m^2, and 300 m^2. The basis of our hypothesis is that changes in the number of players where the relative dimensions of

each participant remain constant will lead to a greater change in HR, whilst changing the dimensions for each participant will have a major effect on the locomotor activity of each player. The results of the study will contribute to a better understanding of how the demands on players are influenced by different large-sided games at junior level.

METHODS

Experimental Approach to the Problem

The study was conducted over a five-week period (October-November) during the competitive season. In the weeks prior to this the players were familiarized with both the type of large-sided game and the material to be used. During the week immediately before the study began, each participant performed the Yo-Yo Intermittent Recovery Test-level 1 (YYIRT1) (20) in order to determine the individual maximum HR (HR_{max}). As in other studies, (21) the maximal sprinting speed was also determined, which was assessed over 30 m, using photocells (Kit Racetime2 SF, Microgate, Italy). All procedures were carried out on the same day on an outdoor artificial pitch with the players wearing football boots.

Nine training sessions were held (two per week, except for week 5) on an outdoor artificial grass pitch and at similar times of day. Each session began with a 15-min standard warm-up, followed by one of the large-sided games played over two 12-min halves, with a 5-min passive rest period at half-time. The order in which the nine possible large-sided games (3 levels for the number of players x 3 levels for the relative pitch area per player) were played and recorded was established randomly (see Table 1).

**********PLEASE, INSERT TABLE 1 HERE**********

During all the training sessions, coaches were present in order to offer encouragement to the players (18). In addition, eight footballs were distributed around the edge of the pitch in order to maximize the effective playing time (14). All the matches were played at the same time of day in order to avoid the effects of circadian rhythms on the results (22). All participants were advised to follow a normal diet and to eat at more or less the same time of day (14:30 hours), with special emphasis being placed on a high intake of water and carbohydrates.

Participants

Twenty four players from the youth academy of an elite team from the Spanish first division (average age 13.3 ± 0.5 years; height 152.9 ± 5.7 cm; weight 42.2 ± 5.2 kg) participated in the study. At the time of the study the players were playing at under-13 level, which implies a normal size pitch (60m x 100m) and the usual rules of 11-a-side soccer. On average the participants had been playing federation school soccer for three years, and their standard training involved four sessions per week (each lasting around 90 minutes), in addition to a competitive match. All the players and their parents or legal guardians were notified of the research design and its requirements, as well as the potential benefits and risks, and each participant gave written informed consent prior to the start. The Ethics Committee of the University of the Basque Country (CEISH) also gave its institutional approval of the study.

In order to avoid potential imbalances between the two teams, players were classified according to the coach's subjective appraisal of their ability, and were then assigned to a given team as appropriate. The 7-a-side matches used a 1-3-2-1 formation. The extra two players in the 9-a-side matches took up a midfield and forward role respectively (i.e. the formation was 1-3-3-2), while the 11-a-side matches used a 1-4-3-3 formation. In terms of

data recording, in order to maintain de player between-variability, the same five individual players were observed in each of the different large-sided games.

Independent variables: relative pitch area per player and number of players per team

The independent variables were as follows: 1) the relative pitch area (RPA) per player: 100 m^2, 200 m^2, or 300 m^2 (RPA100, RPA200, and RPA300, respectively); and 2) the number of players (NP) per team: 7, 9, or 11 (NP7, NP9, and NP11, respectively). Although the overall pitch size was varied, the *length:width* ratio was held constant. The standard rules of 11-a-side soccer were followed in all large-sided games.

Heart rate (HR)

The physiological profile was assessed on the basis of HR (23), which was recorded every 5 seconds using a telemetric device (Polar Team Sport System, Polar Electro Oy, Finland). As previously mentioned, the HR_{max} of each player was determined by means of the YYIRT1 (24,25) enabling four intensity zones to be established (7,10): <75%HR_{max}, 75-84%HR_{max}, 84-90%HR_{max}, and >90%HR_{max}. For the purposes of analysis the variables used were: percentage of time spent in each intensity zone during each large-sided game, and the relative values in relation to the mean and maximum HR obtained in the YYIRT1 (i.e. $\%HR_{mean}$ and $\%HR_{max}$).

Physical performance: global indicators, and absolute and relative speed ranges

Physical performance was measured using a portable GPS device operating at a sampling frequency of 10 *Hz* (MinimaxX v.4.0, Catapult Innovations), and the data subsequently downloaded to a PC and analyzed using the software package Logan Plus v.4.5.1 (Catapult Innovations, 2010). This technology has previously been shown to be a

reliable and valid way of monitoring high-intensity running (26) over a distance of 30 m (standard error, SE = 0.2 m; coefficient of variation, CV = 0.7%; bias = 6.5%; and standard error of measurement, SEM = 5.1%).

The global performance indicators were as follows: total distance covered (TD); the work:rest ratio (W:R), defined as the distance covered by the player at a speed ≥4 $km \cdot h^{-1}$ (period of activity or work) divided by the distance covered at a speed <4 $km \cdot h^{-1}$ (period of recovery or rest); and player load (PL), which was determined via accelerometry (27,28,29), specifically by means of a 100 Hz triaxial accelerometer that combined the accelerations produced in three planes of body movement. Player load is an indicator that seems to be highly correlated with the Edwards method and session-RPE (29), and the high reliability of its results, both within and between devices, suggests that accelerometers are able to detect changes or differences in physical activity (30).

Five speed categories were established (all in $km \cdot h^{-1}$): 0-3, 3-8, 8-13, 13-16, and >16 (31,32). Then the distance covered at speeds relative to the maximum individual speed (V_{max}) achieved during the speed test was estimated, (as proposed by Buchheit et al. 2012). On the basis of this, three categories were established (all in $km \cdot h^{-1}$): >40%, 40-60%, and >60% of the V_{max}. The distance covered in metres in each one of these speed categories, both absolute and relative, was tracked.

Statistical analysis

The data is presented as means and standard deviations (means ±SD). The variables did not fulfil the assumption of normality. In the event that a significant difference was observed, a two-way comparison was performed using the Mann-Whitney U test, with post hoc Bonferroni correction. Effect sizes were also calculated (33), and defined as follows: null, <0.3; mild, 0.3-0.5; moderate, 0.5-0.7; strong, 0.7-0.9; and very strong, 0.9-1.0. All the

statistical analyses were performed using SPSS 19.0 for Windows (SPSS Inc., Illinois USA), with significance being set at $p<0.05$.

RESULTS

Global indicators

Table 2 shows the results for the global indicators. When the relative pitch area (RPA) per player was 100 m^2 none of the three indicators changed significantly according to the number of players per team (NP7, NP9, and NP11). However, comparison of RPA200 with RPA100 revealed that values of TD and W:R were both significantly higher when the RPA was 200 m^2, regardless of the number of players involved (i.e. the effect was observed for 7, 9, and 11 players). Comparison of RPA300 with RPA100 showed the same effect, that is, values of both TD and W:R were significantly higher when the RPA was 300 m^2, regardless of the number of players involved. It should be noted, however, that in the latter comparison, player load was also significantly higher for RPA300 when 9 and 11 players were involved. Finally, comparison of RPA300 and RPA200 revealed that values of TD and W:R were both significantly higher when the RPA was 300 m^2 but only for NP7 and NP9.

**********PLEASE, INSERT TABLE 2 HERE**********

Relative HR data and percentage of time spent in different HR intensity zones

Table 3 presents the results in relation to %HR. In the comparison of RPA200 and RPA100 the $\%HR_{mean}$ was significantly higher for NP7 when the RPA was 200 m^2, while both $\%HR_{mean}$ and $\%HR_{max}$ were significantly higher with an RPA of 200 m^2 and 11 players a side (NP11). This pattern of results was repeated when comparing RPA300 with RPA100, with higher values corresponding to the RPA of 300 m^2. The only significant difference

related to the number of players concerned the variable %HR_{max}, which was higher for both NP7 and NP11 compared with NP9.

**********PLEASE, INSERT TABLE 3 HERE**********

Figure 1 shows the percentage time that players spent in different HR intensity zones. When there were seven players per side (NP7) the percentage time spent at <75%HR_{max} was significantly greater for an RPA of 100 m^2 than for both RPA200 (ES=0.62) and RPA300 (ES=0.74), while with 11 players a side (NP11) the percentage time spent at <75%HR_{max} was significantly greater for RPA100 than for RPA300 (ES=0.57). When the RPA was 300 m^2, players spent a significantly greater proportion of time at 84-90%HR_{max} when there were 7 and 11 players per side (NP7 > NP9, ES=0.48; NP11 > NP9, ES=0.41).

**********PLEASE, INSERT FIGURE 1 HERE**********

Distance covered in absolute speed ranges

Table 4 shows the distance covered (m) by players in the five different speed ranges. Significant differences were observed for all the absolute speed ranges except for 3.0-8.0 $km \cdot h^{-1}$, and these differences were especially noticeable when considering the RPA. The differences were greater from RPA100 to RPA200 and RPA300, while between RPA200 and RPA300 these differences were not important. In relation to a speed <3.0 $km \cdot h^{-1}$, the distance covered with an RPA of 100 m^2 was greater than that for RPA200 and RPA300 regardless of the number of players. The results for the speed ranges 8.0-13.0 and >16.0 $km \cdot h^{-1}$ were the same for NP7 and NP9, namely, the distance covered increased significantly in line with the RPA (such that RPA300>RPA200>RPA100). In both speed ranges (8.0-13.0 and >16 $km \cdot h^{-1}$) a similar pattern was observed for NP11, the difference being that the distance covered did

not differ significantly between RPA200 and RPA300, although both these RPA yielded a distance value that was significantly greater than that for RPA100. As regards speeds between 13.0-16.0 $km \cdot h^{-1}$, the distance covered was greater for RPA200 and RPA300 compared with RPA100 when there were 7 and 11 players per side (NP7 and NP11), while in the case of NP9 the distance covered increased progressively in line with the RPA (i.e. RPA300 > RPA200 > RPA100). The only significant difference associated with the number of players concerned the distance covered at speeds >16.0 $km \cdot h^{-1}$ when the RPA was 200 m^2: the distance covered when there were 11 players per side (NP11) was significantly greater than that for both NP9 and NP7.

**********PLEASE, INSERT TABLE 4 HERE**********

Distance covered in relative speed ranges

Figure 2 shows the distances covered in the three relative speed ranges (<40%V_{max}, 40-60%V_{max}, and >60%V_{max}) for each of the nine large-sided games. The results showed that most of the differences occurred when dimensions were modified, and not when the number of players per team was altered. For relative speeds of <40%V_{max}, significant differences were only observed when there were nine players per side (NP9), with a greater distance being covered when the RPA was 100 m^2 compared with both RPA200 (ES=0.52) and RPA300 (ES=0.84). The results were somewhat more varied for relative speeds of 40-60%V_{max} and >60%V_{max}. When there were seven players per side (NP7), the distance covered with an RPA of 200 m^2 was greater than that for RPA100 (ES=0.38), while the distance corresponding to RPA300 was greater than that for both RPA200 (ES=0.50) and RPA100 (ES=0.68). When there were nine players per side (NP9) the distance covered with an RPA of 300 m^2 was greater than that corresponding to both RPA200 (ES=0.50) and

RPA100 (ES=0.77), although there was no significant difference between the latter two formats. Finally, with 11 players per side (NP11) the results followed the same pattern as for NP7 in that the distance covered with an RPA of 200 m^2 was greater than that for RPA100 (ES=0.55), while the distance corresponding to RPA300 was greater than that for both RPA200 (ES=0.35) and RPA100 (ES=0.75). The only significant difference associated with the number of players concerned the distance covered at >60%V_{max}: with an RPA of 100 m^2 the distance covered in this relative speed zone was significantly greater when there were 11 players as compared with 7 (NP11>NP7, ES=0.27), while with an RPA of 200 m^2 the distance covered was significantly greater with 11 players per side than with either of the other two formats (i.e. NP11>NP9, ES=0.54; NP11>NP7, ES=0.60).

**********PLEASE, INSERT FIGURE 2 HERE**********

DISCUSSION

The aim of the present study was to analyze the influence of different large-sided games on the physical and physiological variables in under-13s soccer players. The effects on heart rate (HR) and the physical demands of altering the number of players (7, 9, and 11) and the relative pitch area (100, 200, and 300 m^2) were measured during two 12 min repetitions. The combination of these two variables enabled us to analyze the demands on players in nine different large-sided games (3 levels for the number of players x 3 RPA), something which has not previously been reported in relation to under-13s soccer. The main finding was that HR and physical performance were influenced more by the RPA variable. To be precise, as was hypothesised, the demands on players increased more as a result of an increase in the RPA per player than as a result of a decrease in the number of players per team. Our research threw up another interesting result which might warrant special attention, and this is that for

higher numbers of players (more than 7 per team), the RPA appears to have more influence on player demands than increasing the number of players does.

Importantly, many of the references used in this discussion used small-sided games (<7 players per team) in their studies, which should lead us to be cautious when comparing those results to the current study. However, results from the studies of small-sided games can help us to understand better how variable or rule changes affect the demands on players and whether a similar trend occurs when large-sided games are studied. Altering the number of players had no effect on the $\%HR_{mean}$. In fact, the only difference observed in this regard concerned sessions involving an RPA of 300 m^2, where players spent a greater percentage of time at 84-90$\%HR_{max}$ when there were 7 or 11 players per side (NP7 and NP11) compared with 9 a side (NP9). In contrast to the results obtained here, other authors (34,10,11,7) have found that reducing the number of players increased the physiological demands on players. A possible explanation for this discrepancy could be that the large-sided games used in the present study never involved fewer than seven players, which would likely imply fewer ball contacts (13) and, therefore, limit the effect on physiological response. Probably, for 7-a-side games, increasing the number of players would not be significant enough as to affect the training load. In terms of physical performance the number of players per team only had a notable effect in relation to high intensity running, specifically at >16 $km \cdot h^{-1}$ and >60$\%V_{max}$. The absence of further effects in this regard could be due to the fact that increasing the number of players while maintaining the same relative pitch area per player inevitably implies an increase in the absolute dimensions of the playing area (14).

The relative pitch area (in m^2) per player did have an effect on the physiological and physical response of these under-13 players. An increase in the relative pitch area per player was associated with an increase in the relative mean and maximum values of HR, as well as in the total distance covered (TD), the distance covered in both absolute (>8 $km \cdot h^{-1}$) and

relative speed categories (above 40% of V_{max}), and in the player load (PL). Although some studies do not support the idea that an increase in relative space leads to an increase in the physiological and physical demands on players (15,17), others have found that the demands on players increase in line with pitch size (14,16,18). Overall, our results suggest that the physiological and physical demands on players were more similar for the two larger relative areas, that is, RPA300 and RPA200, compared with the smaller relative area of 100 m^2 per player.

There were certain limitations to our study which should be highlighted, for example the use of HR as the only physiologic parameter. Undoubtedly, the inclusion of blood lactate (7) or another overall training load like the subjective ratings of perceived exertion (35), leads to a more comprehensive understanding of how the athlete is responding to the different large-sided game formats and assists in improving the quality of competition formats. There is also a need for further studies that not only examine the physiological and physical demands on players, but also analyze the possible effects of tactical variables. This would help to increase our understanding of how teams are "obliged" to adapt their interactive behaviour in response to task constraints (36) that could be interpreted differently according to the skill level of the players involved (37). It should also be noted that the present study did not examine the possibility of a fatigue effect among players across the different training sessions, because the duration of the bouts or halves could affect the demands on the players (38). This aspect should be taken into account to help in the design of large-sided games that are more closely adapted to the age of the participants and the task duration.

Finally, this study has added usable information about the influence of different large-sided games on HR and physical performance in under-13 soccer players. One thing which should be taken into account is the impossibility of establishing a clear cause-effect relationship between the number of players per pitch area and soccer performance due to be

an open modality with severe intervention factors. However, our results did show a link between physical and physiological demands and the two variables in interaction (dimension and number of players per team). The results of the study will contribute to understanding how the demands on players are influenced by different large-sided games at junior level. That is to say, whether changes in the number of players whilst maintaining the relative dimensions of each participant constant, will result in higher changes in HR, or whether changing the dimensions of each participant will have a major effect on time motion.

PRACTICAL APPLICATIONS

The results of this study suggest that in large-sided games involving a high number of players (7, 9, and 11), the relative pitch area per player has a greater influence on the physical response of participants than the actual number of players which specifically affects physiological response. Thus, if the relative area available to each individual remains constant, players of this age could be introduced to the greater difficulties associated with large-sided games without this implying increased demands in terms of HR or physical activity. Given that the formats involving a relative pitch area per player of 200 m^2 and 300 m^2 produced a similar response from these under-13 players in terms of HR and patterns of movement, with the demands in both cases being greater than those associated with the 100 m^2 format, youth coaches should consider progressively introducing a larger relative playing area so as to reflect more closely the demands of more senior-level soccer, at the same time as increasing the complexity of the large-sided games they use.

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Figures and tables legends

Figure 1. Percentage time spent in each HR intensity zone for each of the nine large-side games: 100, 200, and 300 refer to the relative pitch area (in m^2) per player, while 7, 9, and 11 correspond to the number of players per team. [a]Significantly greater with respect to 200; [b]Significantly greater with respect to 300; [c]Significantly greater with respect to 9.

Figure 2. Distance covered (m) in the three relative speed ranges for the different large-side games: 100, 200, and 300 refer to the relative pitch area per player (m^2), while 7, 9, and 11 correspond to the number of players per team. [a]Significantly greater with respect to 100; [b]Significantly greater with respect to 200; [c]Significantly greater with respect to 300; [d]Significantly greater with respect to 7; [e]Significantly greater with respect to 9.

Table 1. Protocol followed for the nine different training matches played over a five-week period.

Table 2. Mean, standard deviation (±SD), and effect size (ES) for the variables TD (total distance covered)., PL (player load), and work:rest ratio (W:R) in relation to each of the nine large-side games.
Note: RPA100, RPA200, and RPA300 represent, respectively, the relative pitch areas of 100 m^2, 200 m^2, and 300 m^2 per player, while NP7, NP9, and NP11 correspond to the number of players per team (7, 9, and 11, respectively). [a]Significantly greater than respect to RPA200, [b]Significantly greater than respect to RPA100, ES is the effect size and AU is arbitrary unit.

Table 3. Mean, standard deviation (±SD) in %, and effect size (ES) for the mean and maximum HR with respect to the individual maximum ($\%HR_{mean}$ and $\%HR_{max}$, respectively) for each of the nine large-side games.
Note: RPA100, RPA200, and RPA300 represent, respectively, the relative pitch areas of 100 m^2, 200 m^2, and 300 m^2 per player, while NP7, NP9, and NP11 correspond to the number of players per team (7, 9, and 11, respectively). [a]Significantly greater than respect to NP9; [b]Significantly greater than respect to RPA100.

Table 4. Mean, standard deviation (±SD), in meters, and effect size (ES) for the distance covered in different absolute speed ranges in relation to the nine large-side games.
Note: RPA100, RPA200, and RPA300 represent, respectively, the relative pitch areas of 100 m^2, 200 m^2, and 300 m^2 per player, while NP7, NP9, and NP11 correspond to the number of players per team (7, 9, and 11, respectively), [a]Significantly greater than respect to RPA100; [b]Significantly greater than respect to RPA200; [c]Significantly greater than respect to RPA300; [d]Significantly less with respect to NP11.

Table 1. Protocol followed for the nine different training matches played over a five-week period.

Week	Session/Day	Bouts x duration (n x min)	Players/team (n)	Area/player (m^2)	Pitch length x width (m)
1st	1st/Tuesday	2 x 12	11	300	100 x 60
	2nd/Thursday	2 x 12	9	300	90 x 54
2nd	3rd/Tuesday	2 x 12	9	200	73 x 44
	4th/Thursday	2 x 12	9	100	52 x 31
3rd	5th/Tuesday	2 x 12	7	100	45 x 27
	6th/Thursday	2 x 12	7	200	63 x 38
4th	7th/Tuesday	2 x 12	11	200	82 x 49
	8th/Thursday	2 x 12	11	100	58 x 35
5th	9th/Tuesday	2 x 12	7	300	78 x 46

Table 2. Mean (±SD), and effect size (ES), for the variables TD (total distance covered), PL (player load) and work:rest ratio (W:R) in relation to each of the nine large-sided games.

Area per player	Global indicators (unit)	Number of players per team								
		NP7			NP9			NP11		
		Mean ±SD		ES	Mean ±SD		ES	Mean ±SD		ES
RPA100	TD (m)	1816	±155	-	1845	±141	-	1766	±181	-
	PL (AU)	267.1	±47.5	-	233.4	±28.7	-	228.6	±49.3	-
	W:R (AU)	0.3	±0.1	-	0.3	±0.1	-	0.3	±0.1	-
RPA200	TD (m)	2085	±153[b]	0.50	2003	±102[b]	0.54	2148	±212[b]	0.70
	PL (AU)	285.1	±29.9	-	246.3	±22.6	-	273.7	±58.6	-
	W:R (AU)	0.4	±0.1[b]	0.45	0.4[b]	±0.0[b]	0.58	0.5	±0.1[b]	0.83
RPA300	TD (m)	2307	±212[ba]	[a=] 0.80 [b=] 0.51	2250	±107[ba]	[a=] 0.85 [b=] 0.76	2314	±134[b]	0.86
	PL (AU)	299.9	±41.3	-	270.9	±25.8[b]	0.57	306.1	±39.3[b]	0.66
	W:R (AU)	0.6	±0.1[ba]	[a=] 0.83 [b=] 0.71	0.5	±0.1[ba]	[a=] 0.71 [b=] 0.81	0.6	±0.1[b]	0.83

Note: RPA100, RPA200, and RPA300 represent, respectively, the relative pitch areas of 100 m^2, 200 m^2, and 300 m^2 per player, while NP7, NP9, and NP11 correspond to the number of players per team (7, 9, and 11, respectively). [a] Significantly greater than respect to RPA200, [b] Significantly greater than respect to RPA100, ES is the effect size and AU is arbitrary unit.

Table 3. Mean (±SD), and effect size (ES) for the mean and maximum heart rate with respect to the individual maximum ($\%HR_{mean}$ and $\%HR_{max}$, respectively), for each of the nine large-sided games.

Area per player	Variables (%)	Number of players per team								
		NP7			NP9			NP11		
		Mean	±SD	ES	Mean	±SD	ES	Mean	±SD	ES
RPA100	$\%HR_{mean}$	82	±3	-	83	±6	-	81	±4	-
	$\%HR_{max}$	98	±5	-	95	±6	-	95	±5	-
RPA200	$\%HR_{mean}$	87[b]	±5	0.52	85	±4	-	89[b]	±2	0.78
	$\%HR_{max}$	97	±4	-	98	±7	-	100[b]	±3	0.52
RPA300	$\%HR_{mean}$	88[b]	±6	0.53	85	±3	-	88[b]	±4	0.65
	$\%HR_{max}$	98[a]	±5	0.31	95	±4	-	100[ab]	±6	[a]0.41 [b]0.44

Note: RPA100, RPA200, and RPA300 represent, respectively, the relative pitch areas of 100 m^2, 200 m^2, and 300 m^2 per player, while NP7, NP9, and NP11 correspond to the number of players per team (7, 9, and 11, respectively). [a] Significantly greater than respect to NP9; [b] Significantly greater than respect to RPA100.

Table 4. Mean (±SD), and effect size (ES) for the distance covered in different absolute speed ranges in relation to the nine large-side games.

Area per player	Speed range ($km \cdot h^{-1}$)	Players per team					
		NP7		NP9		NP11	
		Mean ±SD	ES	Mean ±SD	ES	Mean ±SD	ES
RPA100	<3	122 ±26[c]	0.55	117 ±11[c]	0.53	128 ±20[b]	0.35
	3-8	870 ±83	-	891 ±76	-	847 ±96	-
	8-13	630 ±104	-	619 ±134	-	572 ±88	-
	13-16	145 ±32	-	145 ±44	-	153 ±40	-
	>16	48 ±31	-	70 ±32	-	62 ±43	-
RPA200	<3	109 ±13	-	116 ±18[c]	-	101 ±22	-
	3-8	886 ±63	-	842 ±83	-	853 ±81	-
	8-13	762 ±124[a]	0.50	700 ±71	-	747 ±172[a]	0.54
	13-16	211 ±64[a]	0.55	236 ±83[a]	0.57	265 ±61[a]	0.73
	>16	115 ±46[ad]	[a=] 0.65 [d=] -0.59	107 ±57[d]	-0.59	179 ±42[a]	0.81
RPA300	<3	97 ±9	-	101 ±14	-	111 ±24	-
	3-8	817 ±72	-	821 ±32	-	820 ±78	-
	8-13	938 ±136[ab]	[a=] 0.79 [b=] 0.56	848 ±80[ab]	[a=] 0.72 [b=] 0.03	880 ±82[a]	0.88
	13-16	252 ±83[a]	0.65	314 ±60[ab]	[a=] 0.85 [b=] 0.47	302 ±88[a]	0.74
	>16	202 ±78[ab]	[a=] 0.79 [b=] 0.56	164 ±41[ab]	[a=] 0.78 [b=] 0.49	200 ±105[a]	0.65

Note: RPA100, RPA200, and RPA300 represent, respectively, the relative pitch areas of 100 m^2, 200 m^2, and 300 m^2 per player, while NP7, NP9, and NP11 correspond to the number of players per team (7, 9, and 11, respectively). [a] Significantly greater than respect to RPA100; [b] Significantly greater than respect to RPA200; [c] Significantly greater than respect to RPA300; [d] Significantly less with respect to NP11.

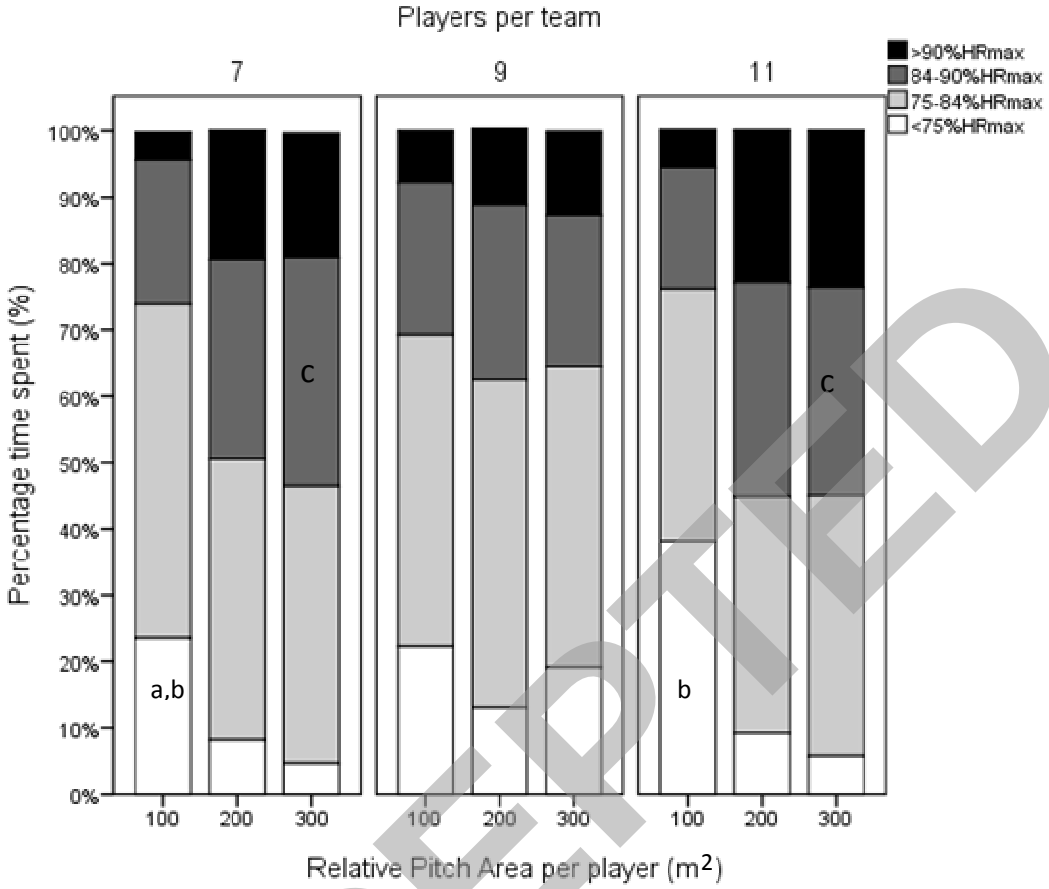

Figure 1. Percentage time spent (%) in each heart rate intensity zone for each of the nine large-side games: 100, 200, and 300 refer to the relative pitch area per player (m^2), while 7, 9, and 11 correspond to the number of players per team. [a] Significantly greater with respect to 200; [b] Significantly greater with respect to 300; [c] Significantly greater with respect to 9.

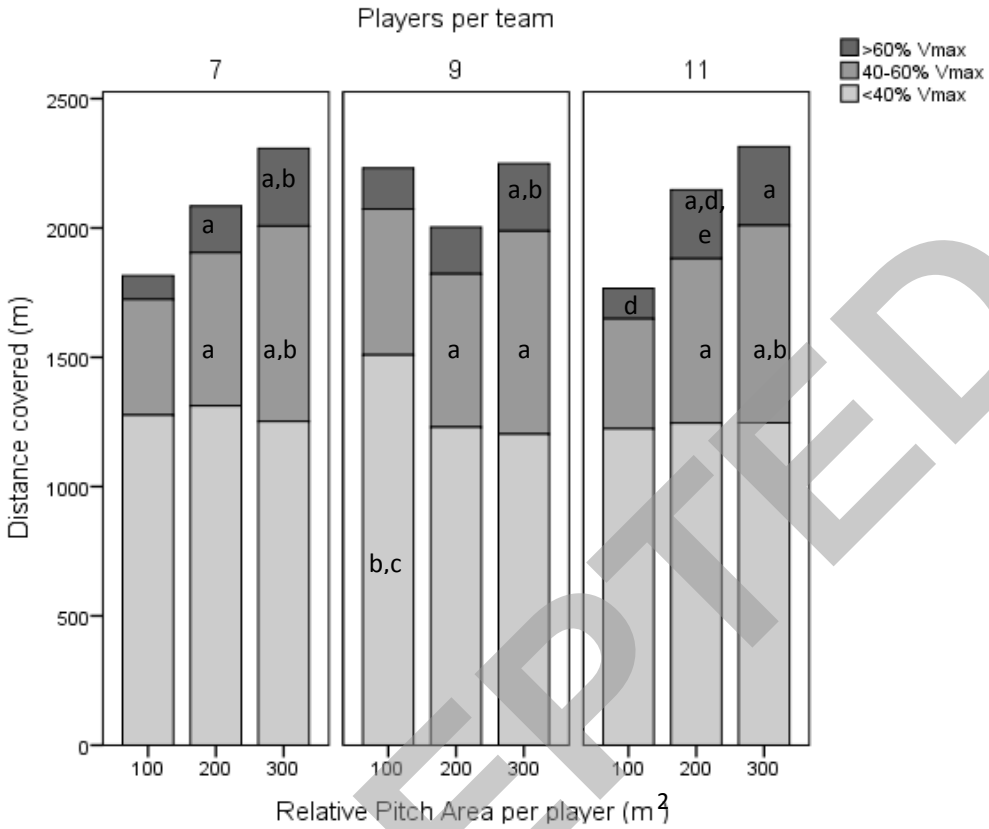

Figure 2. Distance covered (m) in the three relative speed ranges for the different large-side games: 100, 200, and 300 refer to the relative pitch area per player (m^2), while 7, 9, and 11 correspond to the number of players per team. [a] Significantly greater with respect to 100; [b] Significantly greater with respect to 200; [c] Significantly greater with respect to 300; [d] Significantly greater with respect to 7; [e] Significantly greater with respect to 9.