Research in Sports Medicine
An International Journal

ISSN: 1543-8627 (Print) 1543-8635 (Online) Journal homepage: https://www.tandfonline.com/loi/gspm20

Effects of the pitch configuration design on players' physical performance and movement behaviour during soccer small-sided games

Diogo Coutinho, Bruno Gonçalves, Sara Santos, Bruno Travassos, Del P. Wong & Jaime Sampaio

To cite this article: Diogo Coutinho, Bruno Gonçalves, Sara Santos, Bruno Travassos, Del P. Wong & Jaime Sampaio (2019) Effects of the pitch configuration design on players' physical performance and movement behaviour during soccer small-sided games, Research in Sports Medicine, 27:3, 298-313, DOI: 10.1080/15438627.2018.1544133

To link to this article: https://doi.org/10.1080/15438627.2018.1544133

Published online: 05 Nov 2018.

RESEARCH IN SPORTS MEDICINE
2019, VOL. 27, NO. 3, 298–313
https://doi.org/10.1080/15438627.2018.1544133

Routledge
Taylor & Francis Group

Check for updates

Effects of the pitch configuration design on players' physical performance and movement behaviour during soccer small-sided games

Diogo Coutinho [a,b], Bruno Gonçalves [a,b], Sara Santos [a,b,c], Bruno Travassos [b,d], Del P. Wong[e] and Jaime Sampaio [a,b]

[a]Department of Sports Sciences, Exercise and Health, University of Trás-os-Montes and Alto Douro, Vila Real, Portugal; [b]Research Centre in Sports Sciences, Health Sciences and Human Development, CIDESD, CreativeLab Research Community, Portugal; [c]University Institute of Maia, ISMAI, Maia, Portugal; [d]Department of Sports Sciences, University of Beira Interior, Covilhã, Portugal; [e]Sport Science Research Center, Shandong Sport University, Jinan, China

ABSTRACT

This study aimed to identify the effects of different pitch configurations on youth players positional and physical performances. Forty players participated in a Gk + 5vs5 + Gk small-sided game under four conditions: regular condition (regular), pitch with the direction of competitive matches; sided condition (sided), goals were changed to width; different pitch orientation (≠orientation), performed in side-to-side line compared to competitive matches; dynamic pitch (dynamic), boundaries were randomly changed every minute by: regular pitch; decrease 6 m width; diamond shape. The following variables were considered: players' effective playing space, distance between teammates' dyads time spent synchronized, average speed and a ratio between the distance covered at different intensities and distance covered while recovering. Overall, players exhibited better performances in pitches that are more representative of the environmental information seen during competitive matches (regular and ≠orientation). However, coaches may also use different boundary conditions to promote the players' ability to adapt to different context information.

ARTICLE HISTORY
Received 12 March 2018
Accepted 30 October 2018

KEYWORDS
Tactical variables; Global Positioning System; time-motion analysis; spatial references; soccer; variability; complex system

Introduction

Soccer is an invasion team sport where two opposing teams dynamically compete in space and time to gain advantage over the opponents (Folgado, Duarte, Fernandes, & Sampaio, 2014a; Passos, Araújo, & Davids, 2016). This advantage is dependent on the players' ability to interact with the environmental information and unfold functional movement behaviours (Coutinho et al., 2018a; Gonçalves, Marcelino, Torres-Ronda, Torrents, & Sampaio, 2016b; Passos et al., 2016; Travassos, Gonçalves, Marcelino, Monteiro, & Sampaio, 2014). However, since this information changes over time, training

CONTACT Diogo Coutinho damcoutinho@utad.pt Research Center in Sports Sciences, Health Sciences and Human Development, CIDESD, CreativeLab Research Community, Quinta de Prados, Ap. 202, Vila Real 5000-911, Portugal

sessions should develop players' ability to deal with these complex and dynamic environments (Sampaio & Maçãs, 2012). Based on these assumptions, small-sided games (SSG) seems to be considered as a useful training tool to develop players' physical, technical and tactical behaviours (Clemente et al., 2018; Clemente, Wong, Martins, & Mendes, 2014; Coutinho et al., 2018b; Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011; Selmi, Gonçalves, Ouergui, Sampaio, & Bouassida, 2018), while it also exposes the players to these changes in the environmental information (Davids, Araújo, Correia, & Vilar, 2013; Ric et al., 2016). Furthermore, an advantage of SSG is that by manipulating specific task constraints it is possible to highlight the relevant information from the environment, that the players should use to support their movement behaviours (Davids et al., 2013; Gonçalves et al., 2016b; Travassos et al., 2014). For example, a previous study analyzed the players' performance during a 5-a-side SSG while manipulating the number of targets from 2 to 6 (Travassos et al., 2014). It was found an increase in the time spent in the defensive sectors and in the lateral corridors, as well as a higher distance between teams during the SSG with 6 targets. Accordingly, the change in the number of targets, and consequently, the environmental information promoted different tactical behaviours on the teams. In this regard, both coaches and sport scientists should acknowledge how the different changes in the task rules may modify the information available, and consequently, the players' movement behaviour.

Several studies have been developed to better understand how changes in the task constraints, such as pitch size or spatial references, impacts the players physical performance (Clemente et al., 2018, 2014; Gonçalves et al., 2016a; Hill-Haas et al., 2011; Lacome, Simpson, Cholley, & Buchheit, 2018; Olthof, Frencken, & Lemmink, 2017; Owen, Wong, McKenna, & Dellal, 2011). For example, Casamichana and Castellano (2010) analyzed the effect of three pitch sizes on the players physical and physiological performances and found that players covered more total distance, distance covered in low, medium and high-intensity running, distance covered per minute and maximum speed when the pitch size was increased. While the results clearly show that increases in pitches size lead to higher physical demands, to our knowledge no study to date has identified the players' activity demands in pitches with different configurations. For example, playing in a pitch with higher width than length (width x length, 36 × 25 m) may induce different physical demands than in a pitch with the opposite configuration (25 × 36 m). Understanding the physical impact of each training task on the players have been considered as fundamental by the available literature, since these tasks should allow the players to be exposed to stimulus similar to those that they face during the competitive matches (Abade, Gonçalves, Leite, & Sampaio, 2014; Martin-Garcia, Gomez Diaz, Bradley, Morera, & Casamichana, 2018). For instance, players are continuously required to modify their movement pattern from low intensity to high-intensity activities during matches (Carling, Gall, & Dupont, 2012; Martin-Garcia et al., 2018; Taylor, Wright, Dischiavi, Townsend, & Marmon, 2017). As so, it is important to monitor and control the training tasks (Selmi, Marzouki, Ouergui, BenKhalifa, & Bouassida, 2018), in order to promote optimal training adaptations that allow players to be prepared for the competition demands (Abade et al., 2014). However, the literature is scarce in describing the intermittent activity of the players during pitch with different configurations designs. Considering that coaches seem to use these type of tasks during training sessions, e.g.

pitches with higher width than length (Matkovich & Davis, 2009), it is important to understand its effects on the players' physical demands.

While the analysis of the physical profile variation according to the task constraints has been extensively investigated, in turn, the effects of manipulation of the different constraints on tactical behaviour are still scarce (Aguiar, Gonçalves, Botelho, Lemmink, & Sampaio, 2015; Frencken, Van der Plaats, Visscher, & Lemmink, 2013; Gonçalves et al., 2016b). For example, Frencken et al. (2013) analysed how decreasing the pitch width, pitch length and both pitch width and length compared to a control situation affected players' movement behaviour. The results showed that players decreased their longitudinal and lateral inter-team distance, as well as the surface area, a result of decreasing the pitch size. While this study adds important and novel findings regarding how players adapt their movement behaviour according to changes in the pitch width and length, in turn, no study to date has analyzed how different pitch orientations (e.g. playing in the official pitch length direction or in the pitch width direction) might lead to different movement behaviours.

Overall, these game-based situations help players to be attuned to the key information that sustains the emergence of functional movement behaviours over the game (Coutinho et al., 2018a; Davids et al., 2013; Travassos, Duarte, Vilar, Davids, & Araujo, 2012). In this regard, the coaches aim is to manipulate the key task constraints to highlight the relevant information and help players to properly sustain their movement behaviours on this information. Considering that this information is constantly changing, coaches may increase the levels of task variability to promote also the ability to cope with these dynamic environments. In fact, the variability has been related to higher levels of learning (Herzfeld & Shadmehr, 2014), better attunement with environment information (Seifert, Button, & Davids, 2013) and leading to the emergence of functional exploratory behaviours (Coutinho et al., 2018c; Santos, Memmert, Sampaio, & Leite, 2016; Schollhorn, Mayer-Kress, Newell, & Michelbrink, 2009). While the previous reports claim the key role of the variability in overall performance development, in turn, no study to date has analyzed how this variability may modify players behaviour during game-based tasks. Accordingly, this variability may be achieved by modifying the tasks constraints during the task itself, such as modifying the pitch size during the game without having to stop it. This type of dynamic constraints may emerge as a useful solution to increase variability so that the players may be required to constantly adapt their actions based on the new configurations of play and the resultant information available. However, research in this domain is scarce and it would be important to understand how players adjust their movement patterns during these dynamic tasks.

Despite previous considerations, the manipulation of SSG and the effect of such manipulations should also account with the age, the level of expertise or the level of game knowledge of the players (Bekris, Gissis, Ispyrlidis, Mylonis, & Axeti, 2018). In fact, it has been suggested that players from different age groups interact differently with the surrounding information, leading to distinct movement behaviours (Barnabé, Volossovitch, Duarte, Ferreira, & Davids, 2016; Folgado, Lemmink, Frencken, & Sampaio, 2014b; Olthof et al., 2017). For example, Folgado et al. (2014b) found that older age groups showed higher commitment with the soccer principles of play, such as stretching and creating space. However, more information on how youth players deal with different task constraints is needed, as well as how their movement behaviour adapts to dynamic task constraints. Therefore, the present study aims to identify the effects of different pitch configurations design on positioning and physical behaviour of U13 and U15 soccer players.

Methods

Subjects

Forty youth soccer players from two age groups, under-13 and under-15 participated in this study (Table 1). The sample size was calculated with G*Power (Version 3.1.5.1 Institut für Experimentelle Psychologie, Düsseldorf, Germany) for an effect size of 0.6, an α of 0.05, and a power of 0.8 (1–β) (Faul, Erdfelder, Lang, & Buchner, 2007). The total sample size computed by this method was a minimum of 19 players. Two goalkeepers were part of the study but were excluded from the data analysis, once their positioning is very restricted to a specific pitch area and their game dynamics are different from the outfield players. An informed and written consent was provided to the coaches, players, and their parents, as well as by the club, before the beginning of the study. All participants were notified that they could withdraw from the study at any time. The study protocol followed the guidelines stated in the Declaration of Helsinki and was approved by the Local Ethics Committee.

Procedures

All players were tested during two sessions in the competitive period (February). While in the first session, the players were familiarized with SSG conditions, the second session was used for testing purposes. Four teams of the same age performed each game situation, accounting for 2 game situations in each condition per age group. Before the experimental tasks, the players performed a standardized 15-min warm-up based on running and a ball possession game (5-a-side without goals), followed by the 4 conditions. Accordingly, each condition lasted for 6-min, interspersed by a 3-min of passive rest between conditions, accounting for a total time of 33-min. All SSG were played with the official game rules, apart from the offside that was not applied. Before the SSG, the players were instructed to perform the task according to their own playing positional role. Several balls were placed around the field to ensure its replacement as fast as possible, decreasing the time that the ball was out of play. No coach feedback or encouragement was allowed during the conditions.

Table 1. Participants characteristics.

Age Groups	N	Age (years)	Height (cm)	Mass (kg)	Playing Experience (years)	Training sessions per week (n)	Training session duration (min)	Competitive Matches per week (n)	Official Pitch Size (m)
Under-13	20	11.3 ± 0.5	152.3 ± 6.9	38.0 ± 9.3	4.9 ± 2.7	3	~90	1	64 × 43 m
Under-15	20	13.3 ± 0.6	161.4 ± 8.1	55.8 ± 6.9	7.0 ± 1.6	4	90–105	1	104 × 64 m

Experimental task

The team composition was established by the head coach based on his subjective evaluation of the players technical, tactical, physical skills and participation in competitive matches (Casamichana & Castellano, 2010). Accordingly, each team played in the Gk + 1 + 3 + 1 formation, and therefore, it was composed by one goalkeeper, one central defender, three midfielders and one forward. The SSG consisted of a Gk + 5vs5 + Gk SSG on an artificial turf pitch measuring 36 m × 25 m (length × width), and it was played once by each team under four experimental scenarios (see Figure 1): (i) regular pitch (regular), the SSG was performed in the same goal-to-goal direction that players usually play in reference to official match pitch (average playing area per player = 75 m^2); (ii) sided pitch (sided), the targets locations were changed from the pitch length to the pitch width (higher width than length; average playing area per player = 75 m^2); (iii) different orientation pitch (≠orientation), taking as reference the official pitch, the SSG was performed in the side line to side line direction (lateral to lateral; average playing area per player = 75 m^2); (iv) dynamic pitch (dynamic), the pitch boundaries were randomly changed at every minute for one of the following scenarios: regular pitch (average playing area per player = 75 m^2); small pitch (average playing area per player = 58 m^2); diamond pitch (average playing area per player = ~ 29 m^2). The order of the SSG was kept constant in both teams and age groups to allow the comparison of the results. However, in the last condition (dynamic), there were three scenarios that were firstly random assigned (e.g. regular, diamond, small, regular, small, diamond), and then applied in the same order to all teams and age groups. In addition, during this last condition, the players were exposed twice to each space (2 min).

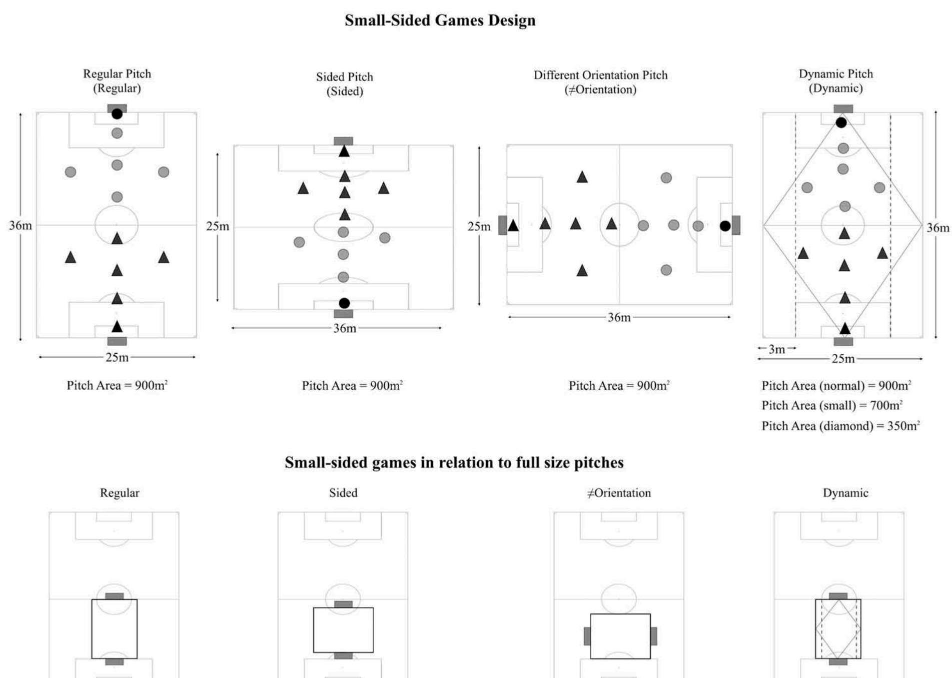

Figure 1. Schematic representation of the SSG pitch designs.

All the conditions have the same pitch area (900 m^2), apart from the dynamic condition, in which the small and diamond shape scenarios presented smaller areas (small = 700 m^2; and diamond shape = 350 m^2).

Pitch positioning derived-variables

Positional data, the distance covered and game pace during the SSG conditions were gathered using 5 Hz global positioning system (GPS) units (SPI-PRO, GPSports, Canberra, ACT, Australia). Validity and reliability of these systems had already been provided (Coutts & Duffield, 2010; Johnston et al., 2012). The typical error measurement is below 5% when considering the total distance covered and between 5% and 10% during peak speed (Johnston et al., 2012). During data collection, the number of satellites connected with each device was 9.2 ± 1.1. The players' latitude and longitude coordinates obtained through the GPS units were exported and processed using appropriate routines in Matlab® (MathWorks, Inc., Massachusetts, USA) (see Folgado et al. (2014a) for data correction guidelines). The total distance covered was used and three distance ratios were processed to relate the distance covered at high to very high (Higher Ratio: above 16 km/h), moderate (Moderate Ratio: 10.0–15.9 km/h) and low intensity (Lower Ratio: 7.0–9.9 km/h) with distance covered at very low intensities (0.0–6.9 km/h) normalized for each 100 m to allow comparisons (Abade et al., 2014). These type of work ratios have been used by the available literature to compare and describe the activity demands between different conditions (Casamichana, Castellano, & Castagna, 2012; Coutinho et al., 2018b; Ferraz et al., 2018). From a practical application point of view, this variable allows understanding how much distance the players cover at the different speeds taking into consideration 100 m while walking. From a processing perspective, and taking the high ratio as an example, it is calculated with the following formula: (distance covered in the high ratio/ distance covered while walking)*100, i.e. if a player covered 200 m while walking (<6.9 km/ h) and 25 at high speed (>16.0 km/h) during a game situation, the player's ratio is 12.5 m, meaning that for each 100 m covered while walking, 12.5 m were performed at high speed. Also, the players' average speed displacement (km/h) was used to identify the game pace. The dynamic positional data of the players were used to determine the team effective playing space, processed from the smallest convex hull, that is the smallest polygonal area that it is delimited by the peripheral players (Gonçalves et al., 2018, 2016b). Also, the distance between teammates' dyads (n = 10 dyads per team) was computed (Folgado, Duarte, Marques, & Sampaio, 2015). The level of intra-team coordination tendencies was assessed through the time that teammates dyads spent synchronized in both longitudinal and lateral directions. These two last variables were calculated using the Hilbert transform (Palut & Zanone, 2005) and applied for all possible dyads for the five outfield teammates. The near-in-phase synchronization of each dyad was quantified according to the percentage of time spent between −30º to 30º bin (near-in-phase mode of coordination) (Folgado et al., 2014a).

Statistical analysis

The comparisons between the conditions were analyzed with a specific spreadsheet for post-only crossover trial (Hopkins, 2006; Hopkins, Marshall, Batterham, & Hanin, 2009). The physical and positional related variables effects were estimated in percent units through log-transformation (to reduce the non-uniformity of error) and uncertainty in the estimate was expressed as 90% confidence limits. Smallest worthwhile differences were measured using the standardized units multiplied by 0.2 (Hopkins, 2004). Uncertainty in the true effects of the conditions was assessed based on non-clinical magnitude-based inferences. Probabilities were reported using the following scale: >5%, unclear; 25 to 75%, possibly; 75% to 95%, likely; 95% to 99%, very likely; >99%, most likely (Hopkins et al., 2009). Standardized (Cohen) mean differences and respective 90% confidence intervals were also computed as magnitude of observed effects, and, thresholds were: <0.2, trivial; 0.6, small; 1.20, moderate; 2.0, large; and >2.0, very large (Hopkins et al., 2009).

Results

Physical performance

Table 2 and Figure 2 shows the physical variables outcome comparisons among considered SSG scenarios in U13 age group. Overall, higher values were found in the regular condition. Accordingly, higher game pace and total distance covered were found in the regular scenario, which shown very likely higher values than sided and dynamic conditions, and possibly higher than ≠orientation scenario. Similarly, higher distance covered at higher speeds was found in the regular condition, which shown very likely higher values than the sided condition and likely higher than the ≠orientation and dynamic scenarios. Also, the regular condition presented most likely higher values in the moderate ratio than sided scenario and very likely higher than the dynamic condition. The results also showed higher values in the low ratio in the regular condition than the other scenarios.

Table 3 and Figure 3 shows the physical variables outcome comparisons among considered SSG scenarios in U15 age group. The results revealed higher mean values in all variables for the regular condition. In this sense, the regular condition showed most likely higher values in the game pace and total distance covered than the sided and dynamic conditions and then the ≠orientation scenario. The regular condition has also presented likely/most likely higher mean values in the distance covered in the moderate and low ratios than the sided, than the ≠orientation and the dynamic condition.

Tactical behaviour

Table 2 and Figure 2 presents the comparisons of the positional variables among considered SSG scenarios in U13 age group. The results showed a likely lower EPS values in the regular condition compared to the ≠orientation condition, however the regular condition it also presented possibly higher values in the EPS than both sided and dynamic conditions. In the regular condition, there was a most likely decrease in the distance between dyads compared to the ≠orientation scenario. The percentage of time spent synchronized in the longitudinal direction revealed most likely higher values for the regular than sided, and a very likely higher values for the regular scenario when comparing with both the ≠orientation and dynamic.

Table 3 and Figure 3 presents the comparisons of the positional variables among considered SSG scenarios in the U15 age group. The results from the EPS showed higher values for the regular scenario, with possibly higher values compared to the sided and most likely higher than the dynamic condition. Following the higher values in EPS, the

Table 2. Descriptive physical and movement behaviour variables (mean±SD).

	U13 Age Group					Difference in means (%; ±90% CL) Uncertainty in the true differences		
Variables	Regular (Mean±SD)	Sided (Mean±SD)	≠Orientation (Mean±SD)	Dynamic (Mean±SD)	Smallest Worthwhile Change (%)	Regular vs Sided	Regular vs ≠Orientation	Regular vs Dynamic
Positional Variables								
Effective Playing Space (m^2)	62.94 ± 14.18	57.66 ± 9.90	75.81 ± 25.33	58.43 ± 14.61	5.0	−7.5; ± 10.8 Possibly ↓	17.2; ±15.9 Likely ↑	−7.5; ±10.6 Possibly ↓
Distance between Dyads (m)	8.19 ± 1.92	8.07 ± 1.93	9.29 ± 2.48	8.22 ± 1.97	4.9	−1.6; ± 3.5 Likely Trivial	12.5; ±4.6 Most Likely ↓	0.2; ±3.6 Very Likely Trivial
Longitudinal Synchronization (%)	61.61 ± 8.23	46.28 ± 7.88	56.56 ± 13.64	54.25 ± 12.70	4.2	−25.2; ±3.5 Most Likely ↓	−10.0; ±5.3 Very Likely ↓	−14.2; ±6.5 Very Likely ↓
Lateral Synchronization (%)	49.36 ± 9.74	49.27 ± 10.62	47.23 ± 13.79	37.63 ± 12.27	5.8	−0.6; ±5.4 Likely Trivial	−6.9; ±6.6 Possibly ↓	−26.8; ±7.0 Most Likely ↓
Physical Variables								
Game Pace (km/h)	5.12 ± 0.87	4.58 ± 0.84	4.88 ± 0.70	4.27 ± 0.86	3.9	−10.6; ±3.0 Most Likely ↓	−4.2; ±4.4 Possibly ↓	−17.1; ±4.1 Most likely ↓
Total Distance Covered (m)	511.38 ± 87.92	458.16 ± 84.37	488.23 ± 69.95	427.41 ± 86.32	3.9	−10.5; ±3.1 Most Likely ↓	−4.0; ±4.3 Possibly ↓	−16.9; ±4.1 Most likely ↓
High Ratio (m/100 m)	5.59 ± 5.90	1.74 ± 2.95	2.73 ± 3.35	2.91 ± 4.25	27.0	−74.0; ±19.7 Very Likely ↓	−51.9; ±31.3 Likely ↓	−59.6; ±32.2 Likely ↓
Moderate Ratio (m/100 m)	44.65 ± 23.18	30.07 ± 13.83	38.06 ± 14.69	29.22 ± 13.36	11.9	−28.7; ±8.1 Most Likely ↓	−5.3; ±18.5 Unclear	−28.9; ±13.9 Very Likely ↓
Low Ratio (m/100 m)	148.32 ± 14.62	143.32 ± 17.01	144.90 ± 14.25	133.65 ± 12.13	2.1	−3.5; ±2.5 Likely ↓	−2.3; ±3.3 Possibly ↓	−9.8; ±2.5 Most Likely ↓

Difference in means and uncertainty in the true differences comparisons among the considered pitch SSG scenarios for the U13 age group
Note: CL = Confidence limits. Symbols: ↓ = decrease; ↑ = increase.

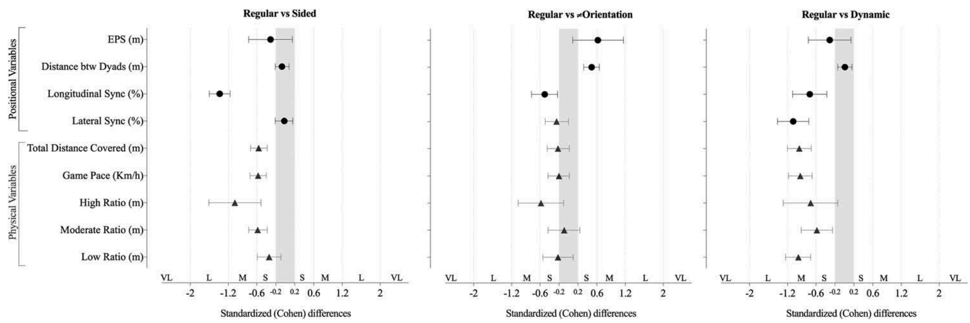

Figure 2. Standardized (Cohen) differences in the positional and physical variables between the SSG scenarios according to the U13 age group. Error bars indicate uncertainty in the true mean changes with 90% confidence intervals. Abbreviations: m = meters; Sync = Synchronization.

regular condition also revealed very likely higher values in the distance between dyads than the dynamic condition. The results from the time spent synchronized in the longitudinal direction showed a most likely higher values for the regular condition than in the sided condition (moderate effects), and likely higher than in the ≠orientation (small effects). Finally, the regular condition presented possibly higher time spent synchronized in the lateral direction than the sided and ≠orientation scenarios and likely higher than the dynamic condition.

Discussion

This study aimed to identify the effects of different pitch configurations design on the tactical and physical behaviour of U13 and U15 soccer players. Overall, different pitch configurations impacted the players' physical performance and their movement behaviour. Previous report has claimed that players' exhibit better performances at home matches, partially because they have a higher facility familiarity (Gómez, Gómez-Lopez, Lago, & Sampaio, 2012). In this regard, is it possible that the higher values found in almost all variables for the regular condition may be related with a higher attunement of players to the key information that players should use to perform during both training sessions and competitive matches.

From the physical perspective, higher mean values were observed for almost all of the variables for the regular scenario. Accordingly, a better understanding of players performance may be achieved if it is considered the complementary relation between the time-motion variables and players positioning (Folgado et al., 2014a). In fact, previous research found that the total distance covered during a testing task performed in the beginning and in the final of the preseason decreased as result of the increased movement synchronization (Folgado, Gonçalves, & Sampaio, 2018). As so, and considering the teams were more dispersed and the distance between players were higher during the regular scenario, is it possible that the players may have to perform more demanding movements in specific moments, to improve the spatial equilibrium on the field, such as ball loss moments. Furthermore, the regular condition revealed in general higher movement synchronization in both longitudinal and lateral directions. Accordingly, it has been shown that players are required to move in order to maintain

Table 3. Descriptive physical movement behaviour variables (mean±SD). Difference in means and uncertainty in the true differences comparisons among the considered pitch SSG scenarios for the U15 age group.

	U15 Age Group					Difference in means (%; ±90% CL) Uncertainty in the true differences		
Variables	Regular (Mean±SD)	Sided (Mean±SD)	≠Orientation (Mean±SD)	Dynamic (Mean±SD)	Smallest Worthwhile Change (%)	Regular vs Sided	Regular vs ≠Orientation	Regular vs Dynamic
Positional Variables								
Effective Playing Space (m^2)	90.87 ± 20.03	84.87 ± 17.52	87.72 ± 12.58	72.76 ± 16.32	4.1	−6.0; ±7.8 Possible ↓	−2.1; ±8.7 Unclear	−20.0; ±6.8 Most Likely ↓
Distance between Dyads (m)	9.94 ± 2.30	9.76 ± 2.30	9.90 ± 2.08	9.12 ± 2.17	4.6	−2.0; ±4.0 Likely Trivial	0.0; ±4.0 Likely Trivial	−8.3; ±3.3 Very Likely ↓
Longitudinal Synchronization (%)	49.81 ± 8.30	38.59 ± 8.38	45.85 ± 15.61	51.11 ± 10.55	5.3	−23.2; ±4.3 Most Likely ↓	−12.3; ±9.5 Likely ↓	2.0; ±6.6 Likely Trivial
Lateral Synchronization (%)	38.90 ± 11.15	36.46 ± 15.30	36.26 ± 11.93	33.21 ± 10.61	8.1	−11.0; ±11.5 Possible ↓	−8.6; ±9.6 Possible ↓	−15.2; ±9.7 Likely ↓
Physical Variables								
Game Pace (km/h)	5.93 ± 0.48	5.22 ± 0.53	5.53 ± 0.41	5.13 ± 0.63	2.0	−12.2; ±2.1 Most Likely ↓	−6.7; ±2.2 Most Likely ↓	−13.9; ±2.9 Most Likely↓
Total Distance Covered (m)	592.37 ± 47.22	520.57 ± 52.73	552.47 ± 40.38	512.17 ± 62.96	2.0	−12.3; ±2.1 Most Likely ↓	−6.7; ±2.1 Most Likely ↓	−13.9; ±2.9 Most Likely↓
High Ratio (m/100m)	7.06 ± 5.81	4.03 ± 3.55	5.34 ± 6.47	4.34 ± 6.62	27.2	−29.7; ±45.6 Unclear	20.5; ±95.5 Unclear	−45.0; ±66.5 Unclear
Moderate Ratio (m/100m)	148.80 ± 36.76	105.15 ± 31.65	129.91 ± 39.54	105.62 ± 50.94	7.9	−30.5; ±6.7 Most Likely ↓	−13.9; ±10.6 Likely ↓	−35.5; ±12.1 Most Likely ↓
Low Ratio (m/100m)	158.89 ± 16.63	146.24 ± 12.74	146.50 ± 10.93	143.11 ± 11.43	1.7	−7.8; ±2.4 Most Likely ↓	−7.6; ±2.6 Most Likely ↓	−9.7; ±3.1 Most Likely ↓

Note: CL = Confidence limits. Symbols: ↓ = decrease; ↑ = increase.

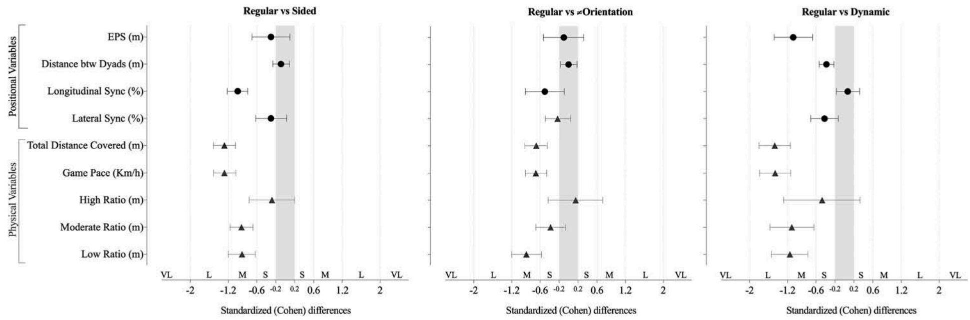

Figure 3. Standardized (Cohen) differences in the positional and physical variables between the SSG scenarios according to the U15 age group. Error bars indicate uncertainty in the true mean changes with 90% confidence intervals. Abbreviations: m = meters; Sync = Synchronization.

this team synchrony (Gonçalves et al., 2016a), which may also have impacted their physical performance. In addition, it has been highlighted that the training tasks may apply a similar stimulus as those found in competition (Abade et al., 2014; Carling et al., 2012). In this regard, it has been found that the amount of high-intensity running has increased during the last years (Martin-Garcia et al., 2018), and therefore, the training tasks may be able to cope with these demands. The results from this study revealed that higher values at the high distance ratio were found in the regular condition. Therefore, coaches may use this task to increase the distance covered at high intensity, while at the same time promote team dispersion and movement synchronization.

The time that the players spent synchronized in both the longitudinal and lateral directions have been used to better understand the level of interpersonal synchronization within dyads of players (Folgado et al., 2014a, 2015, 2018). While this movement synchrony seems to be dependent on the players' local proximity during senior level players (Folgado et al., 2014a), in turn, youth players may be more dependent on the pitch spatial references. That is, in both age groups high values of longitudinal synchronization were found in the regular condition. Thus, it may be possible that less experienced players may not possess sufficient game knowledge to perceive and adapt their movement behaviour based on teammates positioning, and therefore, they may rely their position based on specific spatial references, such as target location.

Interesting results were also found in the time spent synchronized in the lateral direction. Although the sided pitch presented higher width than length, this pitch configuration did not lead to a higher time spent synchronized compared to the regular condition. Accordingly, these results may be linked with a higher use of pitch length than the width in younger age groups. In fact, previous reports have shown that less experienced age groups usually show higher values of length than width, possibly because they seek to approach the target as soon as possible by using the pitch length (Barnabé et al., 2016; Folgado et al., 2014b; Olthof, Frencken, & Lemmink, 2015). However, coaches could use pitches with higher width than length to expose players to these situations so that they become more aware of perceiving and use the available lateral space.

Higher mean values of team dispersion in both age groups were found in both the regular and ≠orientation scenarios. Considering that youth players may adjust more their positioning based on spatial references, such as the distance and angle to the target (Laakso, Travassos, Liukkonen, & Davids, 2017), the target location (Travassos et al., 2014), or the sectorial and corridor lines (Coutinho et al., 2018a) and less on teammates compared to senior players (Gonçalves et al., 2016a), it is possible proper positioning's in youth players may emerge when the task environmental cues are more similar to those found in real match contexts. Therefore, players might have felt ease in perceiving and using the available space in both the regular and orientation scenarios, due to their higher similarity to competitive matches. While it has been highlighted that training tasks should simulate the same perceptual motor-landscape that the players face during the competition (Olthof et al., 2017; Travassos et al., 2012), the key role of movement variability in developing players performance has also been increasingly recognized (Seifert et al., 2013). Thus, exposing the players to different pitch configurations, e.g. the sided or dynamic scenarios, may emerge as an optimal solution to induce movement variability. Additionality, it is not surprising the higher values found in the distance between dyads during the regular scenario for both age groups, since this condition showed higher team dispersion.

This study points out new insights related with players' movement behaviour and physical performance according to different pitch configurations, however, the results may be limited by the reduced number of game situations performed in each SSG condition since it was only performed two game situations per SSG condition. Additionally, despite the overall data collection did not exceed the 33-min, in turn, the SSG conditions were performed always in the same order and thus is it possible that the players' performance in the last conditions may have been affected by their activity in the first game scenarios. Therefore, future studies should account with the order of these game scenarios to better provide an understanding of its effects. Finally, future studies should also aim to compare the effects of the tasks between age groups.

Overall, coaches may use the regular condition to promote the players' movement synchronization, team dispersion and higher physical demands. Considering the similar values between the regular and ≠orientation scenarios, coaches may use the second situation during away games to decrease the players' dependency on the spatial references. Additionally, coaches may also use the sided and dynamic conditions, not only to promote task variability, as well as to promote the players' ability to adapt to the different environmental information that sustains their individual and collective behaviour (Coutinho et al., 2018c). The results from this study suggest that the pitch configuration is an important constraint to be considered by the coaches when designing training tasks for tactical and physical aims.

Conclusion

Changing the pitch configuration has greatly impacted players positional decisions. Accordingly, higher values were found in the regular condition, which is the condition most similar to full sized matches, suggesting that this type of tasks are more representative in relation to available information with the one found in competitive matches, mainly at home matches. However, considering that players may have to deal with different spatial references in away matches, the ≠orientation may be more suitable to decrease the players' dependence on specific spatial references, since this scenario has also revealed high values in most of the variables. Additionally, as youth players seem to be dependent on references to sustain their positional decisions, therefore using different pitch configurations might help players to improve their ability to identify the most relevant cues that support the emergence of functional behaviours.

Acknowledgments

This work was supported by the Portuguese Foundation for Science and Technology (FCT, Portugal) through a Doctoral grant endorsed to the first author (SFRH/BD/105081/2014) under the Human Potential Operating Program (POPH). Project NanoSTIMA: Macro-to-Nano Human Sensing: Towards Integrated Multimodal Health Monitoring and Analytics, NORTE-01-0145-FEDER-000016, Fundo Europeu de Desenvolvimento Regional (FEDER) - NORTE 2020.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the Portuguese Foundation for Science and Technology (FCT, Portugal) through a Doctoral grant endorsed to the first author (SFRH/BD/105081/2014) under the Human Potential Operating Program (POPH). Project NanoSTIMA: Macro-to-Nano Human Sensing: Towards Integrated Multimodal Health Monitoring and Analytics, NORTE-01-0145-FEDER-000016, Fundo Europeu de Desenvolvimento Regional (FEDER).

ORCID

Diogo Coutinho http://orcid.org/0000-0001-6605-9505
Bruno Gonçalves http://orcid.org/0000-0001-7874-4104
Sara Santos http://orcid.org/0000-0002-4090-5790
Bruno Travassos http://orcid.org/0000-0002-2165-2687
Jaime Sampaio http://orcid.org/0000-0003-2335-9991

References

Abade, E. A., Gonçalves, B. V., Leite, N. M., & Sampaio, J. E. (2014). Time-motion and physiological profile of football training sessions performed by under-15, under-17 and under-19 elite Portuguese players. *International Journal of Sports Physiology and Performance*, *9*(3), 463–470.

Aguiar, M., Gonçalves, B., Botelho, G., Lemmink, K., & Sampaio, J. (2015). Footballers' movement behaviour during 2-, 3-, 4- and 5-a-side small-sided games. *Journal of Sports Sciences*, *33*(12), 1259–1266.

Barnabé, L., Volossovitch, A., Duarte, R., Ferreira, A. P. P., & Davids, K. (2016). Age-related effects of practice experience on collective behaviours of football players in small-sided games. *Human Movement Science*, *48*, 74–81.

Bekris, E., Gissis, I., Ispyrlidis, I., Mylonis, E., & Axeti, G. (2018). Combined visual and dribbling performance in young soccer players of different expertise. *Research in Sports Medicine*, *26*(1), 43–50.

Carling, C., Gall, F., & Dupont, G. (2012). Analysis of repeated high-intensity running performance in professional soccer. *Journal of Sports Sciences*, *30*(4), 325–336.

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.

Casamichana, D., Castellano, J., & Castagna, C. (2012). Comparing the physical demands of friendly matches and small-sided games in semiprofessional soccer players. *Journal of Strength and Conditioning Research*, *26*(3), 837–843.

Clemente, F. M., Sarmento, H., Rabbani, A., Van Der Linden, C. M. I., Kargarfard, M., & Costa, I. T. (2018). Variations of external load variables between medium- and large-sided soccer games in professional players. *Research in Sports Medicine*, 1–10. doi:10.1080/15438627.2018.1511560

Clemente, F. M., Wong, D. P., Martins, F. M. L., & Mendes, R. S. (2014). Acute effects of the number of players and scoring method on physiological, physical, and technical performance in small-sided soccer games. *Research in Sports Medicine*, *22*(4), 380–397.

Coutinho, D., Gonçalves, B., Travassos, B., Abade, E., Wong, D. P., & Sampaio, J. (2018a). Effects of pitch spatial references on players' positioning and physical performances during football small-sided games. *Journal of Sports Sciences*, 1–7. doi:10.1080/02640414.2018.1523671

Coutinho, D., Gonçalves, B., Wong, D. P., Travassos, B., Coutts, A. J., & Sampaio, J. (2018b). Exploring the effects of mental and muscular fatigue in soccer players' performance. *Human Movement Science*, *58*, 287–296.

Coutinho, D., Santos, S., Gonçalves, B., Travassos, B., Wong, D. P., Schöllhorn, W., & Sampaio, J. (2018c). The effects of an enrichment training program for youth football attackers. *PLoS One*, *13*(6), e0199008.

Coutts, A. J., & Duffield, R. (2010). Validity and reliability of GPS devices for measuring movement demands of team sports. *Journal of Science and Medicine in Sport*, *13*(1), 133–135.

Davids, K., Araújo, D., Correia, V., & Vilar, L. (2013). How small-sided and conditioned games enhance acquisition of movement and decision-making skills. *Exercise and Sport Sciences Reviews*, *41*(3), 154–161.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191.

Ferraz, R., Gonçalves, B., Coutinho, D., Marinho, D. A., Sampaio, J., & Marques, M. C. (2018). Pacing behaviour of players in team sports: Influence of match status manipulation and task duration knowledge. *PLoS One*, *13*(2), e0192399.

Folgado, H., Duarte, R., Fernandes, O., & Sampaio, J. (2014a). Competing with lower level opponents decreases intra-team movement synchronization and time-motion demands during pre-season soccer matches. *PLoS One*, *9*(5), e97145.

Folgado, H., Duarte, R., Marques, P., & Sampaio, J. (2015). The effects of congested fixtures period on tactical and physical performance in elite football. *Journal of Sports Sciences*, *33*(12), 1238–1247.

Folgado, H., Gonçalves, B., & Sampaio, J. (2018). Positional synchronization affects physical and physiological responses to preseason in professional football (soccer). *Research in Sports Medicine*, *26*(1), 51–63.

Folgado, H., Lemmink, K. A., Frencken, W., & Sampaio, J. (2014b). Length, width and centroid distance as measures of teams tactical performance in youth football. *European Journal of Sport Science*, *14*(Suppl 1), S487–492.

Frencken, W., Van der Plaats, J., Visscher, C., & Lemmink, K. (2013). Size matters: Pitch dimensions constrain interactive team behaviour in soccer. *Journal of Systems Science & Complexity*, *26*(1), 85–93.

Gómez, M. A., Gómez-Lopez, M., Lago, C., & Sampaio, J. (2012). Effects of game location and final outcome on game-related statistics in each zone of the pitch in professional football. *European Journal of Sport Science*, *12*(5), 393–398.

Gonçalves, B., Esteves, P., Folgado, H., Ric, A., Torrents, C., & Sampaio, J. (2016a). Effects of pitch area-restrictions on tactical behavior, physical and physiological performances in soccer large-sided games. *Journal of Strength & Conditioning Research, Advance Online Publication*, (9), 2398–2408. doi:10.1519/JSC.0000000000001700

Gonçalves, B., Folgado, H., Coutinho, D., Marcelino, R., Wong, D., Leite, N., & Sampaio, J. (2018). Changes in effective playing space when considering sub-groups of 3 to 10 players in professional soccer matches. *Journal of Human Kinetics*, *62*, 145–155.

Gonçalves, B., Marcelino, R., Torres-Ronda, L., Torrents, C., & Sampaio, J. (2016b). Effects of emphasising opposition and cooperation on collective movement behaviour during football small-sided games. *Journal of Sports Sciences*, *34*(14), 1346–1354.

Herzfeld, D. J., & Shadmehr, R. (2014). Motor variability is not noise, but grist for the learning mill. *Nature Neuroscience*, *17*(2), 149–150.

Hill-Haas, S. V., Dawson, B., Impellizzeri, F. M., & Coutts, A. J. (2011). Physiology of small-sided games training in football: A systematic review. *Sports Medicine*, *41*(3), 199–220.

Hopkins, W. (2006). Spreadsheets for analysis of controlled trials, with adjustment for a subject characteristic. *Sportscience*, *10*, 46–50.

Hopkins, W. G. (2004). How to interpret changes in an athletic performance test. *Sportscience*, *8*, 1–7.

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine & Science in Sports & Exercise*, *41*(1), 3–13.

Johnston, R. J., Watsford, M. L., Pine, M. J., Spurrs, R. W., Murphy, A. J., & Pruyn, E. C. (2012). The validity and reliability of 5-Hz global positioning system units to measure team sport movement demands. *Journal of Strength and Conditioning Research*, *26*(3), 758–765.

Laakso, T., Travassos, B., Liukkonen, J., & Davids, K. (2017). Field location and player roles as constraints on emergent 1-vs-1 interpersonal patterns of play in football. *Human Movement Science*, *54*, 347–353.

Lacome, M., Simpson, B. M., Cholley, Y., & Buchheit, M. (2018). Locomotor and heart rate responses of floaters during small-sided games in elite soccer players: Effect of pitch size and inclusion of goal keepers. *International Journal of Sports Physiology and Performance*, 1–13. doi:10.1123/ijspp.2017-0340

Martin-Garcia, A., Gomez Diaz, A., Bradley, P. S., Morera, F., & Casamichana, D. (2018). Quantification of a professional football team's external load using a microcycle structure. *Journal of Strength and Conditioning Research*. doi:10.1519/jsc.0000000000002816

Matkovich, M., & Davis, J. (2009). *Elite soccer drills* (pp. 1). USA: Human Kinetics.

Olthof, S., Frencken, W., & Lemmink, K. (2015). The older, the wider: On-field tactical behavior of elite-standard youth soccer players in small-sided games. *Human Movement Science*, *41*, 92–102.

Olthof, S., Frencken, W., & Lemmink, K. (2017). Match-derived relative pitch area changes the physical and team tactical performance of elite soccer players in small-sided soccer games. *Journal of Sports Sciences*, 1–7. doi:10.1080/02640414.2017.1403412

Owen, A. L., Wong, P., McKenna, M., & Dellal, A. (2011). Heart rate responses and technical comparison between small- vs. large-sided games in elite professional soccer. *Journal of Strength & Conditioning Research*, *25*(8), 2104–2110.

Palut, Y., & Zanone, P. G. (2005). A dynamical analysis of tennis: Concepts and data. *Journal of Sports Sciences*, *23*(10), 1021–1032.

Passos, P., Araújo, D., & Davids, K. (2016). Competitiveness and the process of co-adaptation in team sport performance. *Frontiers in Psychology*, *7*(p), 1562.

Ric, A., Hristovski, R., Gonçalves, B., Torres, L., Sampaio, J., & Torrents, C. (2016). Timescales for exploratory tactical behaviour in football small-sided games. *Journal of Sports Sciences*, 1–8. doi:10.1080/02640414.2015.1136068

Sampaio, J., & Maçãs, V. (2012). Measuring tactical behaviour in football. *International Journal of Sports Medicine*, *33*(5), 395–401.

Santos, S., Memmert, D., Sampaio, J., & Leite, N. (2016). The spawns of creative behavior in team sports: A creativity developmental framework. *Frontiers in Psychology*, *7*(p), 1282.

Schollhorn, W. I., Mayer-Kress, G., Newell, K. M., & Michelbrink, M. (2009). Time scales of adaptive behavior and motor learning in the presence of stochastic perturbations. *Human Movement Science*, *28*(3), 319–333.

Seifert, L., Button, C., & Davids, K. (2013). Key properties of expert movement systems in sport: An ecological dynamics perspective. *Sports Medicine*, *43*(3), 167–178.

Selmi, O., Gonçalves, B., Ouergui, I., Sampaio, J., & Bouassida, A. (2018). Influence of well-being variables and recovery state in physical enjoyment of professional soccer players during small-sided games. *Research in Sports Medicine*, *26*(2), 199–210.

Selmi, O., Marzouki, H., Ouergui, I., BenKhalifa, W., & Bouassida, A. (2018). Influence of intense training cycle and psychometric status on technical and physiological aspects performed during the small-sided games in soccer players. *Research in Sports Medicine*, *26*(4), 401–412.

Taylor, J. B., Wright, A. A., Dischiavi, S. L., Townsend, M. A., & Marmon, A. R. (2017). Activity demands during multi-directional team sports: A systematic review. *Sports Medicine*, *47*(12), 2533–2551.

Travassos, B., Duarte, R., Vilar, L., Davids, K., & Araujo, D. (2012). Practice task design in team sports: Representativeness enhanced by increasing opportunities for action. *Journal of Sports Sciences*, *30*(13), 1447–1454.

Travassos, B., Gonçalves, B., Marcelino, R., Monteiro, R., & Sampaio, J. (2014). How perceiving additional targets modifies teams' tactical behavior during football small-sided games. *Human Movement Science*, *38*, 241–250.