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Variations in individual player area in youth football matches: the effects of changes of players' age, numerical relations, and pitch zones

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ABSTRACT

The aim of the study was to quantify the individual player area (IPA) that emerges during football matches at youth levels, considering different numerical relations and pitch zones. Two hundred and twenty-eight players, divided by U15, U17 and U19, participated in the study. Jonckheete-Terpstra and Kruskal Wallis nonparametric tests were used to compare the IPA according to variations in players' age, numerical relations and pitch zones considered for analysis. All ages and numerical relation results revealed the highest IPA in the zones closer to the goal and were lower in the middle of the pitch. For 3 × 3 to 10 × 10 numerical relations, the IPA was higher in the U15 and lower in the U17. The greater differences between the age groups concerned numerical relations of 6 × 6 to 10 × 10 ($p \leq 0.001$). The effect size was moderate between the U15 and U17 in numerical relations of 8 × 8 to 10 × 10. Results suggest that the manipulation of IPA during training sessions should respect players' age and be adjusted considering the numerical relation and the tactical purpose of coaches.

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KEYWORDS
Zone; individual player area; numerical relations; age; football

1. Introduction

In football, the use of small-sided and conditioned games (SSCG), for training and teaching at different competitive levels and ages, has been a trend in recent years. This practice has been accompanied and supported by scientific research that aims to identify the effects of different SSCG manipulations on players and teams performance, and compared them with the competition requirements (Aguiar, Botelho, Peñas, Maças & Sampaio, 2012; Sarmento et al., 2018). In this line, several studies have evaluated the effect of manipulations related to the playing area. Results showed that the increased dimension of the playing area often leads players to run more distances (Lemes et al., 2019) and to variations in their tactical behaviour, particularly in the increased

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spatiotemporal relation between teammates or opponents (Folgado et al., 2019; Frencken et al., 2013; Silva, Duarte et al., 2014), with implications for the number of technical actions of players (Nunes et al., 2020). Conversely, the reduction in playing area tends to promote a greater number of ball losses, more physical contacts, more individual duels, and tackles (Dellal et al., 2012).

For the manipulation of playing areas in SSCG, the dimensions of the football pitch (105x68 metres) can be used as a reference, allowing for the classification in large (55%), medium (45%) and small (35%) pitch, according to the percentage of size decrease (Silva, Aguiar et al., 2014). Similarly, the definition of the playing area can be achieved based on the individual playing area (IPA), which is calculated through the total area of the pitch divided by the number of players involved in the training or match situation (Aguiar et al., 2015; Olthof et al., 2019). However, many of the studies do not present any theoretical or practical reason such as for example, the age or level of practice of players, for the manipulations carried out in the IPA (Caro et al., 2019).

In fact, previous studies using SSCG in youth football suggested that older players perform more passes during a game and present more time spent in ball possession, using a wider area of the pitch, while younger players tend to play lengthwise in similar playing areas (Folgado et al., 2014; Olthof et al., 2015). On the other hand, differences on the use of width and length in particular pitch zones have been revealed for players of different ages in SSCG and in official games (Caro et al., 2019; Fradua et al., 2013; Tenga et al., 2015).

These studies suggest that the playing area used is influenced by the ball position on the pitch and can therefore vary depending on the game phase and on the ball location.

In view of the above stated, the analysis of the area occupied by players during the game, as well as its variation according to the pitch zones (defensive zone, middle zone and attacking zone), can make us think about the manipulation of the playing area in training tasks (Zubillaga et al., 2013). In football, the possibilities of individual and collective action (affordances) arise from the complementarity between the individual characteristics of the players and the spatiotemporal dynamics between them on the pitch, enhanced by the competitive environment (Araújo et al., 2006). Therefore, a better understanding of the pitch areas manipulations to be used in training is needed in order to promote the adequate relationship between players and game environment (Travassos et al., 2013).

Thus, in this study we intend to describe the individual area per player, according to age, numerical relations, and the pitch zone. For this, the different individual areas per player in a recreated football match during normal training were quantified, considering different age groups (U15, U17, U19).

It was expected to measure changes in IPA according to different age groups. Also, it was expected to observe variations in IPA considering variations in numerical relationships and the location in the field.

2. Methods

A total of two hundred and twenty-eight male players who competed in the national championships, the highest competitive level for each age group, participated in the study, divided by U15 (n = 76, age 14.4 ± 0.4 years, height 1.61 ± 0.07 weight 52.2 ± 9.0);

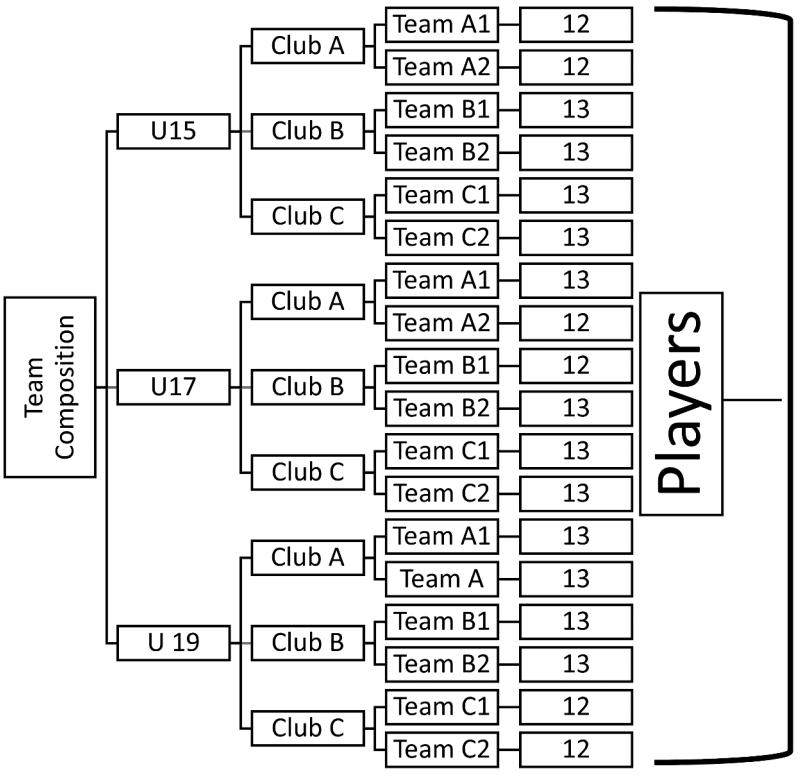

Figure 1. The team composition.

U17 (n = 76, age 15.6 ± 0.5 years, height 1.74 ± 0.05, weight 63.1 ± 7.5) and U19 (n = 76, age 17.7 ± 0.5 years, height 1.78 ± 0.09, weight 75.3 ± 9.3). Three different teams participated in each age group (Figure 1). The team composition was defined by the head coach to ensure balanced and competitive matches. Each game had an average of 25 players. Each game had three to four players as substitutes who came in for other players. Each team had three training session, lasting ninety-minute, and one official game per week. Goalkeepers, despite being present during the situation, were not considered for the calculation of the indicators used in the study, given the specificity of their functions. All players' legal guardian were informed of the study and gave their written consent before the latter began. This study was approved by the Ethics Committee under the number CE-UBI-Pj-2020-043.

2.1. Data collection

For each age group, a recreated football match in their normal training was played between each team, with a total of three matches per level. This situation was performed at the beginning of the session, after twenty minutes of warm-up, consisting of running and passing exercises. In each recreated match, the coaches distributed the players in two balanced teams, according to the coach perception, and considering players specific positions. The game length varied according to age and the official rules of the respective

level: U15 – 2 halves of 35 minutes; U17 – 2 halves of 40 minutes; and U19 – 2 halves of 45 minutes. The rest time between the 1st and 2nd half was 10 minutes in all games. The games were played on artificial turf pitches with the official football measures. Positional data of all the players were collected using inertial WIMU TM devices (RealTrack Systems, Almeria, Spain). Data were analysed using the SPRO TM analysis programme (RealTrack Systems, Almeria, Spain). Following the manufacturer guidelines, the units were turned on at least 30 minutes before the beginning of each session. Devices were placed on players, in appropriate vests, before the warm-up. All games were video recorded through a camera (Panasonic HC-V160) placed at a higher level in the middle zone of the pitch, for posterior notational analysis.

2.2. Data processing

Based on the collected video, notational analysis was performed considering the following ball related actions (Folgado et al., 2019): individual player gaining ball possession; individual player disposing the ball possession; player touching the ball; ball over the end line; ball over the side line; ball shooting; ball hitting crossbar/post; goal scoring; fouls. The software LongoMatch 1.3.7 (Fernandez, 2017) was used for this analysis, capturing the time of each action, for synchronising the ball events with the GPS positional data (Figure 2). A visual representation of each simulated match was processed, presenting the ball position, displacement, and the time of each action. This representation was used for possible notational errors correction, by comparing it with the original video.

To calculate the IPA by different numerical relations, the rectangle formed by the players of each team closest to the ball at the time of the pass was considered. The players in the periphery of the ball area defined the limits (Caro et al., 2019) for each numerical relation, taking width as the shortest distance that allowed to include all the players of the numerical relation in the sideline-sideline axis, and length as the smallest distance that allowed all players to be included in the goal-goal axis (Figure 3). In this study, the IPA

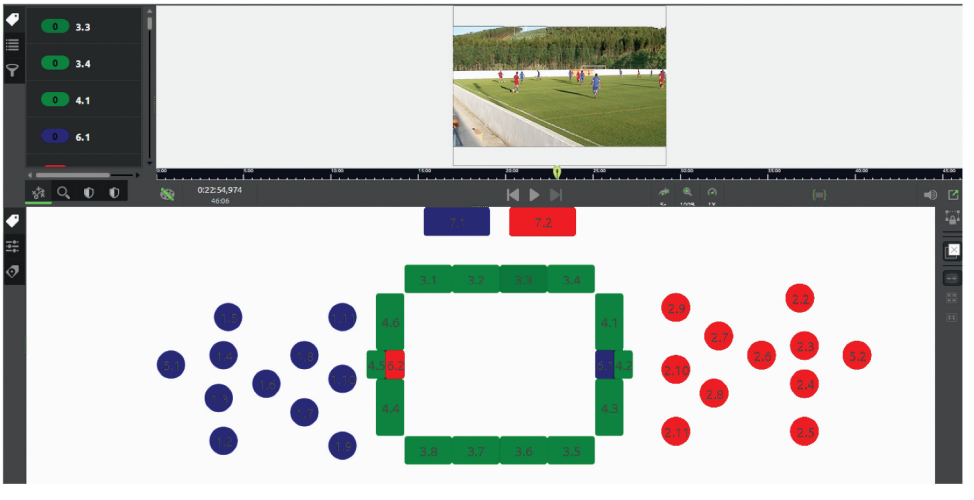

Figure 2. Notational analysis using the software LongoMatch for GPS and technical events synchronisation.

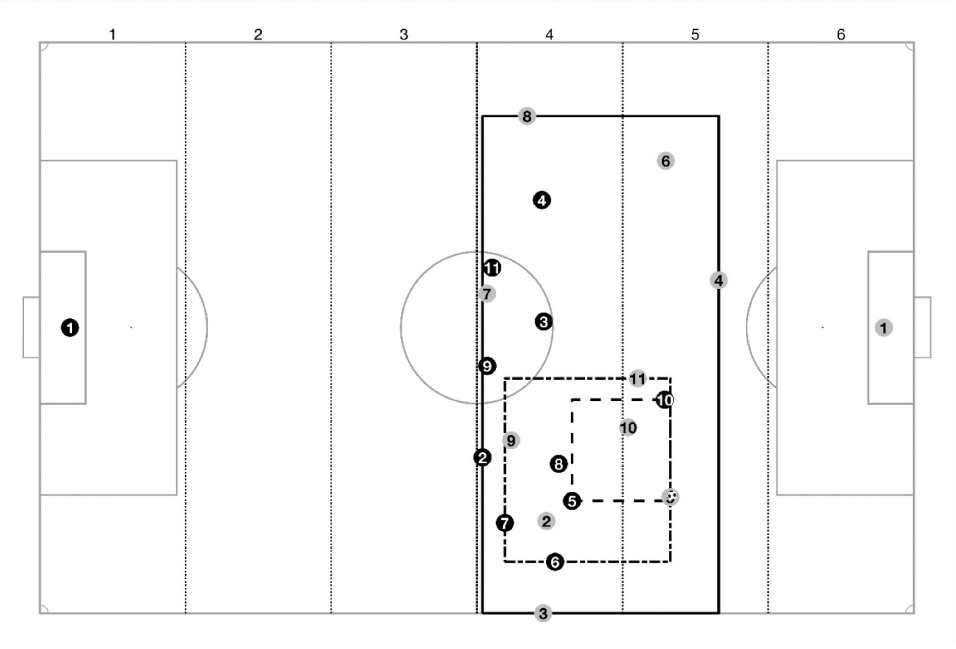

Figure 3. Example of playing area calculation involving 2 × 2 (dashed line), 5 × 5 (dotted-dashed line) and 10 × 10 (solid line) players, according to the different six pitch zones.

was determined by dividing the playing area by the number of players (Casamichana & Castellano, 2010). This means that, in a playing area with 4 players (the 2 players, from each team, closest to the ball), the division of the playing area by the 4 players was calculated, and so on, up to a 10 × 10 numerical ratio.

For passing location, the pitch was divided into different six zones, following existing literature (Fradua et al., 2013; Figure 4). Zone 1 (Z1) corresponds to the zone closest to the analysed team goal and zone 6 (Z6) corresponds to the zone closest to the opponent's goal. The IPA was calculated according to the passing location. Five thousand and seventy-six game situations were recorded (1379 – U15, 2182 – U17 and 1515 – U19).

2.3. Statistical analysis

Initially, the IPA was calculated for each numerical relation and the results grouped by age. The normality of data was analysed through the Kolmogorov-Smirnov test, revealing a non-normal and strongly asymmetric distribution. Thus, a descriptive analysis was performed through the median, interquartile range. The lack of normality led to the adoption of the Jonckheere-Terpstra test when comparing age groups. Pairwise comparisons between each age group and numerical relations were performed by calculating the standardised effect sizes (ES; Pallant, 2007). Therefore, the effects were described according to the following scale: null (0.00–0.10); weak (0.11–0.29); moderate (0.30–0.49) and strong (>0.5; Cohen, 1988). In the comparison between the different areas for each level, the Kruskal-Wallis H test was used. The identification of the differences detected by both

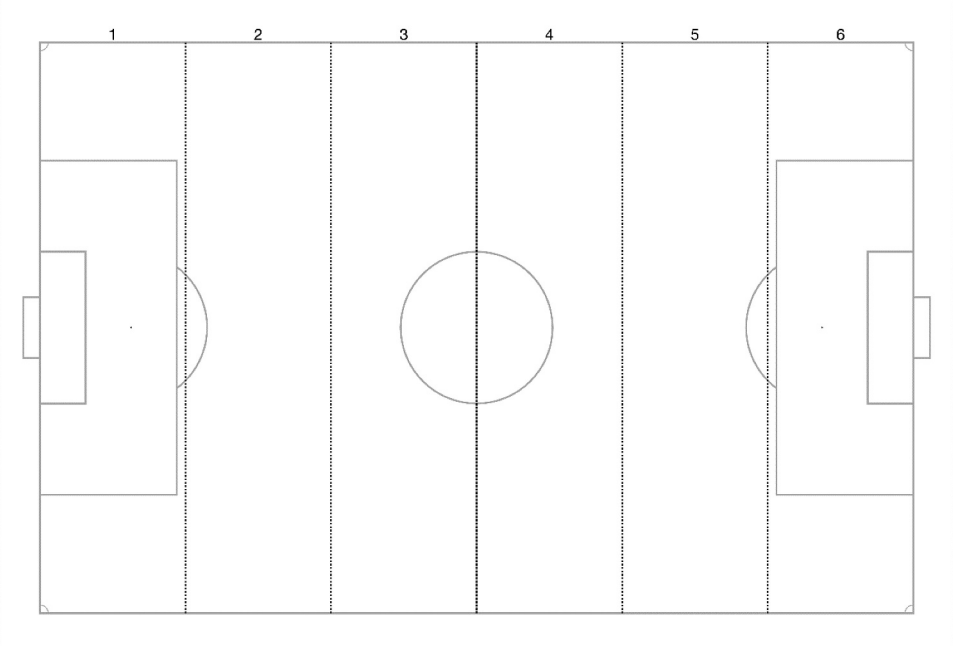

Figure 4. The pitch was divided into different six zones.

non-parametric techniques was performed using Bonferroni Correction. The level of significance was set at $p < 0.05$ for multiple tests. For statistical analysis, the following software was used: IBM SPSS statistic-v.26.0.

3. Results

Figure 5 shows the median of the IPA (m^2) of each numerical relation in each age group. The results revealed higher values for U15 and lower values for U17, in all numerical relations.

Table 1. Comparison between ages in each numerical relationship.

					Effect size		
Players	t_{jt}	z	p-value	Post- hoc	U15 – U17	U15-19	U17-19
2x2	4313886	1.99	0.047	$U15^{b}>U17^{a}$ $U19^{b}>U17^{c}$	0.04		0.07
3x3	4206562	.082	.935				
4x4	4136618	−1.159	.246				
5x5	4018348	−3.258	.001	$U15^{bc}>U19^{ab}>U17^{ac}$	−0.17 (weak)	−0.07 (null)	0.11 (weak)
6x6	4012436	−3.36	.000		0.20 (weak)	0.08 (null)	0.13 (weak)
7x7	3978330	−3.97	.000		0.24 (weak)	0.09 (null)	0.17 (weak)
8x8	3960919	−4.28	.000		0.31 (moderate)	−0.11 (weak)	0.22 (weak)
9x9	3992537	−3.72	.000		−0.31 (moderate)	−0.10 (null)	0.24 (weak)
10x10	3959018	−4.31	.000		−0.36 (moderate)	−0.12 (weak)	0.28 (weak)

Legend: [a] significant differences between U15 and other ages; [b] significant differences between U17 and other ages; [c] significant differences between U19 and other agesTjt: Test Statistic; z: standardised Test Statistic; p: significance value

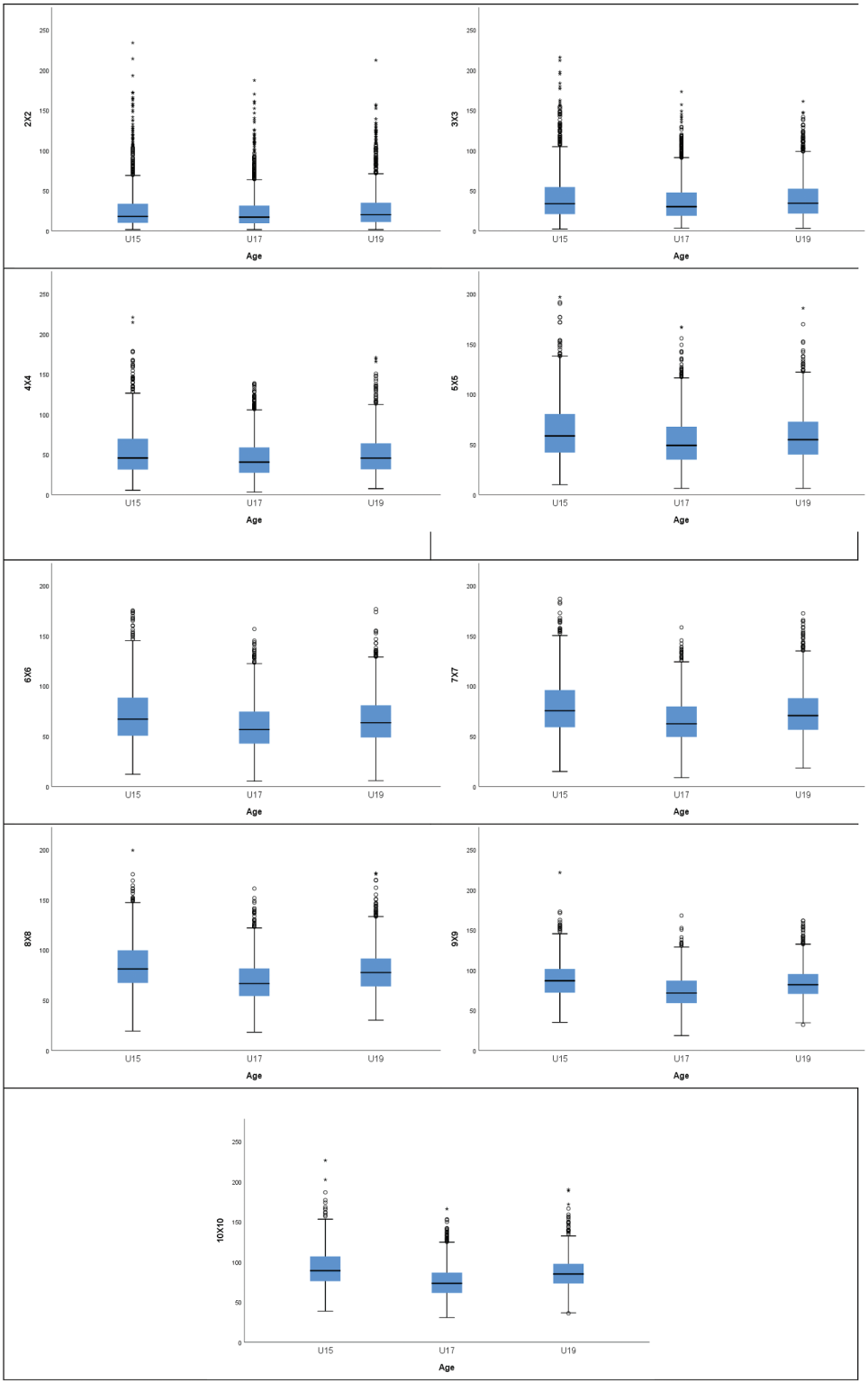

Figure 5. Values IPA (median) in U15, U17 e U19.

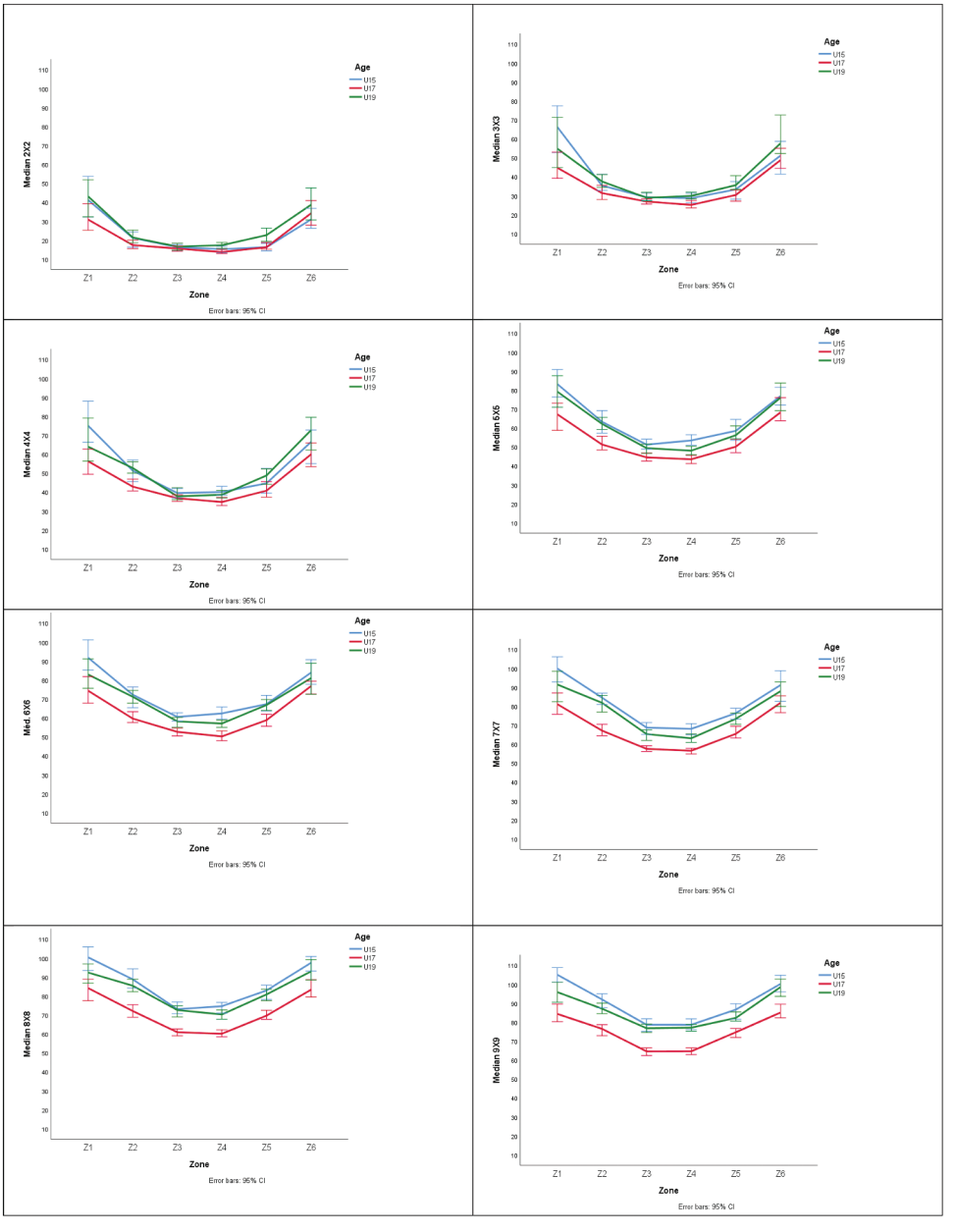

Figure 6. Median in six zones at each age (U15,U17 e U19).

Table 1 presents the significant differences between numerical relations, namely 2 × 2 ($p = 0.047$), 5 × 5 ($p = 0.001$) and 6 × 6 to 10 × 10 ($p = 0.000$), between the different age groups. Moderate differences were observed in 8 × 8 to 10 × 10 and weak differences for other numerical relations between U15 and U17. Between U15 and U19 all the differences were null to weak and between U17 and U19 all the differences revealed a weak effect

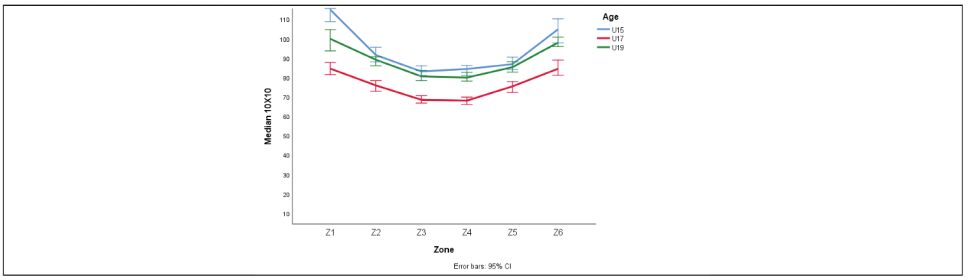

Figure 6. continued.

The results of IPA (m2) for each numerical relation revealed an effect of the pitch zone (Figure 4). Higher values were observed in the zones closer to the goals (Z1 and Z6) and lower values in the middle zone of the pitch (Z3 and Z4), with significant differences in all numerical relations and ages ($p = 0.000$). An effect of age was also observed in the different areas analysed. While in U15 the highest values were always in zone 1, in U17 and U19 they were in zone 1 or zone 6 (Figure 6). It is also worth mentioning that despite variations in age levels or in numerical relations no significant differences were observed between zones 1 and 6, zones 2 and 5 and zones 3 and 4.

4. Discussion

This study aimed to identify the differences between IPA according to age (U15, U17, U19), numerical relations and different pitch zones. In general, results revealed differences between age groups for different numerical relations and considering the pitch zones of play.

As expected, IPA values revealed general differences between players of different age groups (U15, U17, U19). However, there was no gradual increase in IPA concerning age. U15 values revealed the highest IPA values, U17 values corresponded to the lowest ones, and U19 values were associated to intermediate IPA values. According to previous studies, variations in age directly influence the way through which players explore the pitch and, consequently, how they explore own possibilities as well as their teammates', depending on the opponent's behaviour (Menuchi et al., 2018; Nunes et al., 2020). Probably, this variation in space is related to the ability of players to adjust their individual performance behaviours to the playing area, according to their teammates, opponents and ball placement (Travassos et al., 2018). In opposition to our expectations, similar IPA results were observed between U15 and U19 players, with the U17 revealing the lowest values. However, the similarities between the IPA U15 and U19 are sustained by different reasons. While the higher IPA of U15 could be related with the need for more time and space to decrease the ball pressure and to ensure additional time for decision and action (Nunes et al., 2020), the higher IPA for U19 could be related with the higher capability to manage the interacting space with teammates and opponents according to ball placement and game dynamics (Folgado et al., 2014; Travassos et al., 2018). The maturation stage in the young U14 and U15, due to bodily changes that occur as a result of peak height speed, can influence

technical actions and motor skills (Philippaerts et al., 2006), with implications in tactical behaviour and decision-making (Sevil-Serrano et al., 2017).Also, changing the game format from football 7 to football 11 can contribute to less game efficiency in the U14 and U15, creating the need to use more space and time to perform due to the increase in the number of players and the spatial-temporal relations that they need to manage (Lapresa et al., 2006).

Regarding the more reduced space occupation by U17, a possible reason may be related to the time of knowledge acquisition by players of this age. In fact, they are at the beginning of the specialisation stage and, therefore, their knowledge of space is still under development (Machado et al., 2015). In this way, players tend to reduce the distance between them in the attacking stage, resulting in lower IPA values compared to other age groups. Data suggest that, up to U17, players reveal difficulties in adapting to the constant changes occurring in the playing area and individually adjust their actions according to the ball placement. These differences in IPA according to players age suggest that the manipulations of playing areas in SSCG during training sessions should be adjusted according to the age level of players to promote most adjusted contexts of learning (Olthof et al., 2019; Travassos et al., 2018).

Interestingly, the IPA values tend to reveal higher differences between age groups for higher numerical relations of players. Several studies on SSCG suggest that the greater number of players involved the less the variability in players' positioning, making the game more positional (Silva et al., 2015). Thus, while with low number of players the IPA seems stable, increasing the number of players that participating on the game tend to highlight the adaptive behaviours of players to occupy space according to their own individual and relational tactical capabilities. Further research is required on this topic to understand the dynamic of such variations according to players' levels of expertise and individual tactical, technical, and physical capabilities.

At the end, the analysis of IPA according to the pitch zones of play revealed that, in general, the zones closest to the goals presented the higher values of IPA. While in the U15, in all numerical relations, the highest values occurred in the zones closest to the own goal, in the U17 and U19, the highest values were found in the zone closest to the opponent's goal. With the increase in the number of players, the highest values in both echelons tended to be associated to the U17 in zone 6 and to the U19 in zone 1.

The study also revealed three similar IPA values for all numerical relations and ages: i) in the zones closest to the goals (Z1 and Z6), values were higher; ii) in Z2 and Z5, values were intermediate; iii) in the middle zone (Z3 and Z4) values were lower. These data revealed zones with similar IPA but with different objectives. Although players' functions depend on their position on the pitch, which leads to different dynamics within the game (Caro et al., 2019), there were similarities in the playing areas according to their relative position on the field in relation to own or opposite goal. For example, while zone 1 is characterised by the beginning of the attacking stage, zone 6 is the space where the attack finishes. Zone 2 is characterised by the security actions of players to continue the attacking stage. Zone 5 is the space of the pitch that is suitable for the players to risk so as to initiate the imbalance in the opponent's defensive stage. Zones 3 and 4 reveal similar objectives, such as preparation of finishing situations. The difference in values in the IPA between the middle and the zones close to the goal posts may be due to the constraints of the offside rule, promoting a greater length distance

between players, since the ones on the defensive line are close to the midfield line when the ball appears in more advanced areas of the pitch (Tenga et al., 2015). On the other hand, when teams have ball possession in zones close to the goal, they tend to place players further from the ball in terms of width and length, to continue the attack, promoting the distance of the team's players. When the ball is on the middle zone, the teams tend to place the players further from the goal, to be more compact, reducing the distances between players and making IPA smaller in the middle zone.

Current findings suggest differences in IPA in youth football compared to professional football. These results may help coaches to adjust the dimensions of the SSCG according to different age groups and to the objectives concerning different field zones. However, further research is required to link such spatial occupation with the team purposes and the types of actions that tend to occur in each zone. Thus, it will be possible to better design SSCG that combine the collective with the individual requirements according to what happens during the game.

One of the present study limitations was the use of recreated matches during training sessions instead of regular matches and considering higher number of teams of different level of practice. Despite ensuring a controlled environment, it lacks the competitive demands present in a regular match. Future studies should be carried out in regular competitions.

Practical implications

This study suggests the need to vary the playing area according to age level, numerical relations and the collective goals of each task according to the field location. In other words, the sectorial training of defenders, midfielders or attackers associated with different objectives must be trained in different spaces. The design of SSCG should respect the proportionality of space occupied by players of each team according to their own individual and collective capabilities for action. Thus, the evaluation of teams' space of play should be done during the season in order to constantly promote new adaptations in players' behaviours according to coaches' purposes. The use of higher proportional IPA in comparison with the game should offer additional time of players to perceive and act during the training sessions, while the use of lower proportional IPA will require faster perception and more precision in actions. The presented values could be used as reference for the design of SSCG in the U15, U17 and U19 age levels if they don't have possibility to measure the IPA values of their own team. Further research should be developed to link the variation in space occupied and the game moment, helping coaches to design more representative tasks in relation to the competitive environment.

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References

Aguiar, M., Botelho, G., Peñas, C., Maças, V., & Sampaio, J. (2012). A review on the effects of soccer small-sided games. *Journal of Human Kinetics*, *33*(2012), 103–113. https://doi.org/10.2478/v10078-012-0049-x

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. https://doi.org/10.1080/02640414.2015.1022571

Araújo, D., Davids, K., & Hristovski, R. (2006). The ecological dynamics of decision making in sport. *Psychology of Sport and Exercise*, *7*(6), 653–676. doi:https://doi.org/10.1016/j.psychsport.2006.07.002

Caro, O., Zubillaga, A., Fradua, L., & Fernandez-Navarro, J. (2019). Analysis of playing area dimensions in spanish professional soccer: extrapolation to the design of small-sided games with tactical applications. *Journal of Strength Conditioning Research*, 35(10), 2795–2801. doi:10.1519/jsc.0000000000003226.

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

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Routledge. doi:10.4324/9780203771587.

Dellal, A., Owen, A., Wong, D. P., 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*(4), 957–969. doi:https://doi.org/10.1016/j.humov.2011.08.013

Fernandez, D. (2017). *LongMatch 1.3.7*. https:// github.com/LongoMatch/longomatch-core/releases

Folgado, H., Bravo, J., Pereira, P., & Sampaio, J. (2019). Towards the use of multidimensional performance indicators in football small-sided games: The effects of pitch orientation. *Journal of Sports Sciences*, *37*(9), 1064–1071. https://doi.org/10.1080/02640414.2018.1543834

Folgado, H., Lemmink, K. A., Frencken, W., & Sampaio, J. (2014). Length, width and centroid distance as measures of teams tactical performance in youth football. *European Journal of Sport Sciences*, *14*(Suppl 1), S487–492. https://doi.org/10.1080/17461391.2012.730060

Fradua, L., Zubillaga, A., Caro, O., Iván 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

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 and Complexity*, *26*(1), 85–93. https://doi.org/10.1007/s11424-013-2284-1

Lapresa, D., Arana Idiakez, X., & Garzón, B. (2006). El fútbol 9 como alternativa al fútbol 11, a partir del estudio de la utilización del espacio de juego. *Apunts*, *86*(4), 34–44. ISSN- 1577-4015.

Lemes, J. C., Luchesi, M., Diniz, L. B. F., Bredt, S. D. G. T., Chagas, M. H., & Praça, G. M. (2019). Influence of pitch size and age category on the physical and physiological responses of young football players during small-sided games using GPS devices. *Research in Sports Medicine*, *28*(2), 206–216. https://doi.org/10.1080/15438627.2019.1643349

Machado, G. F., Scaglia, A. J., & Costa, I. T. D. (2015). Influência do efeito da idade relativa e do comportamento tático sobre o desempenho tático de jogadores de futebol da categoria sub-17. *Revista da Educação Física/UEM*, *26*(2), 223–231. https://doi.org/10.4025/reveducfis.v26i2.23952

Menuchi, M., Moro, A. R. P., Ambrósio, P. E., Pariente, C. A. B., & Araújo, D. (2018). Effects of spatiotemporal constraints and age on the interactions of Soccer Players when competing for ball possession. *Journal of Sports Science and Medicine*, *17*(3), 379–391. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6090386/pdf/jssm-17-379.pdf

Nunes, N. A., Gonçalves, B., Davids, K., Esteves, P., & Travassos, B. (2020). How manipulation of playing area dimensions in ball possession games constrains physical effort and technical actions in under-11, under-15 and under-23 soccer players. *Research in Sports Medicine*, *29* (2), 170–184. doi:https://doi.org/10.1080/15438627.2020.1770760

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. https://doi.org/10.1016/j.humov.2015.02.004

Olthof, S., Frencken, W., & Lemmink, K. (2019). A match-derived relative pitch area facilitates the tactical representativeness of small-sided games for the official soccer match. *Journal of Strength Conditioning Research*, *33*(2), 523–530. https://doi.org/10.1519/jsc.0000000000002978

Pallant, J. (2007). *SPSS survival manual* (3rd ed., Vol. 15). McGrath Hill.

Philippaerts, R. M., Vaeyens, R., Janssens, M., Van Renterghem, B., Matthys, D., Craen, R., Bourgois, J., Vrijens, J., Beunen, G., & Malina, R. M. (2006). The relationship between peak height velocity and physical performance in youth soccer players. *Journal of Sports Sciences*, *24* (3), 221–230. https://doi.org/10.1080/02640410500189371

Sarmento, H., Clemente, F. M., Harper, L. D., Costa, I. T. D., Owen, A., & Figueiredo, A. J. (2018). Small sided games in soccer – A systematic review. *International Journal of Performance Analysis in Sport*, *18*(5), 693–749. https://doi.org/10.1080/24748668.2018.1517288

Sevil-Serrano, J., Práxedes, A., García-González, L., Moreno, A., & Del Villar, F. (2017). Evolution of tactical behavior of soccer players across their development. *International Journal of Performance Analysis in Sport*, *17*(6), 885–901. https://doi.org/10.1080/24748668.2017.1406781

Silva, P., Aguiar, P., Duarte, R., Davids, K., Araujo, D., & Garganta, J. (2014). Effects of pitch size and skill level on tactical behaviours of association football players during small-sided and conditioned games. *International Journal of Sports Science & Coaching*, *9*(5), 993–1006. https://doi.org/10.1260/1747-9541.9.5.993

Silva, P., Duarte, R., Sampaio, J., Aguiar, P., Davids, K., Araújo, D., & Garganta, J. (2014). Field dimension and skill level constrain team tactical behaviours in small-sided and conditioned games in football. *Journal of Sports Sciences*, *32*(20), 1888–1896. https://doi.org/10.1080/02640414.2014.961950

Silva, P., Esteves, P., Correia, V., Davids, K., Araujo, D., & Garganta, J. (2015). Effects of manipulations of player numbers vs. Field dimensions on inter-individual coordination during small-sided games in youth football. *International Journal of Performance Analysis in Sport*, *15* (2), 641–659. https://doi.org/10.1080/24748668.2015.11868821

Tenga, A., Zubillaga, A., Caro, O., & Fradua, L. (2015). Explorative Study on Patterns of Game Structure in Male and Female Matches from Elite Spanish Soccer. *International Journal of Performance Analysis in Sport*, *15*(1), 411–423. https://doi.org/10.1080/24748668.2015.11868802

Travassos, B., Araújo, D., Davids, K., O'Hara, K., Leitão, J., & Cortinhas, A. (2013). Expertise effects on decision-making in sport are constrained by requisite response behaviours – A meta-analysis. *Psychology of Sport and Exercise*, *14*(2), 211–219. doi:https://doi.org/10.1016/j.psychsport.2012.11.002

Travassos, B., Coutinho, D., Gonçalves, B., Pedroso, P., & Sampaio, J. (2018). Effects of manipulating the number of targets in U9, U11, U15 and U17 futsal players' tactical behaviour. *Human Movement Science*, *61*, 19–26. doi:https://doi.org/10.1016/j.humov.2018.06.017

Zubillaga, A., Gabbett, T., Fradua, L., Ruiz-Ruiz, C., Caro, O., & Ervilla, R. (2013). Influence of ball position on playing space in Spanish elite women's football match-play. *International Journal of Sports Science & Coaching*, *8*(4), 712–722. https://doi.org/10.1260/1747-9541.8.4.713