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Comparing the Tactical Behavior of Young Soccer Players in Full- and Small-Sided Games

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ABSTRACT

The objective was to assess and compare the tactical conduct of players aged U-8, U-10, and U-12 during full- and small-sided games, focusing on tactical modeling and interaction dynamics. Each age group comprised three teams ($n = 180$; 60 per category; 20 per team), engaging in a tournament where teams faced each other once in both formats – 18 matches; 3 per category in each format. Full-sided games (GK + 10 vs.10 + GK; 100 × 68 m) and small-sided games (U-8: GK + 4 vs. 4 + GK (36 × 20 m); U-10: GK + 7 vs. 7 + GK (52.5 × 34 m); U-12: GK + 10 vs. 10 + GK (68 × 45 m). Standard playing times (3 periods of 12 minutes (U-8s); 3 periods of 15 minutes (U-10s); and 3 periods of 20 minutes (U-12s), with a 5-minute break. Variables were examined using descriptive analysis (mean, standard deviation, and confidence interval), with paired t-tests and Wilcoxon tests employed for inter-format comparisons. Despite players benefiting from more time and space in full-sided games (increased ball receptions and overall ball involvement), results from small-sided games indicate three key advantages: 1) More goals (U-8s: $z = -3.44$, $p = .050$) and shots on target (U-8: $z = -3.25$, $p = .001$; U-10: $z = -2.72$, $p = .007$); 2) Game space management—ball circulation in larger amplitude (U-10: $t = -4.20$, $p = .001$; U-12: $t = -4.35$, $p < .001$); and with more transitions (U-10: $t = -3.60$, $p = .002$; U-12: $t = -4.16$, $p = .001$) and 3) Fast decision-making—larger ball velocity circulation (U-08: $t = -3.54$, $p = .003$; U-10: $t = -5.13$, $p < .001$; U-12: $t = -5.80$, $p < .001$).

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According to Garganta and Pinto (1994), players and teams' performances are primarily founded on the tactical and strategic aspects, because the main problems are shown are of a tactical nature (Garganta & Pinto, 1994). The solutions to these problems can be found through the movements and positions in each space/time, which results in an organization founded on the information available within the playing environment (Garganta, 2009; Garganta & Pinto, 1994; Teoldo et al., 2022). Tactics, i.e., the management, by the players, of the space of play, achieved through movement and positioning, are achieved under a collective strategy and tactical organization, which in turn are related to the structure of the game and the intended goals (Teoldo, 2010; Teoldo et al., 2022).

From this perspective, some authors conducted analyses based on tactical behaviors (fundamental principles of the game of soccer) to comprehend the distinctions among various game configurations, involving variations in the number of players and field dimensions (Castelao et al., 2014; Silva et al., 2014; Teoldo et al., 2011). In these studies, the authors conducted comparisons between the actions performed in various dimensions (GK + 3 vs. 3 + GK − 27 m × 18 m and 36 m × 27 m) and with different numbers of players (GK + 3 vs. 3 + GK, GK + 5 vs. 5 + GK, and GK + 6 vs. 6 + GK—field sizes proportional to each configuration).

In the smaller field, for example, the game was more split, and defensive performance was better, likely due to the proximity between the players and the center of play, thus facilitating actions performed closer to the player in possession, such as defensive coverage (Teoldo et al., 2011). About the change in the number of players, the results of the studies indicate that, in situations with fewer players (GK + 3 vs. 3 + GK), more individual actions are performed with the purpose of breaking the opponent's defensive lines and scoring a goal (Castelao et al., 2014; Silva et al., 2014). As for the GK + 5 vs. 5 + GK and GK + 6 vs. 6 + GK games, actions distant from the center of play were more frequent, as players were more spread throughout the space (Castelao et al., 2014; Silva et al., 2014).

When observing these results and the influence on tactical behaviors resulting from modifications in the number of players and field space, it is important to highlight some aspects mentioned by J. Garganta (2006) and Garganta and Pinto (1994) regarding the necessary considerations in defining playing spaces for young players. According to the authors, proposing games in assimilable scales, in which the demands conform to participants' abilities, may contribute to the teaching and learning process. Furthermore, according to Sarmento et al. (2018), it is essential to consider the correspondence between the stages of growth and development of a child and the level of demand of sports competition. For the development process must assist children and youth in finding an appropriate space in which to develop themselves, thus taking advantage of the process by feeling apt and fulfilled (Garganta et al., 2013).

As observed, recent studies have conducted tactical analyses based on the execution of the fundamental tactical principles of soccer; however, this is not the only possible perspective.

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Because of this, the present study aims to analyze and compare the tactical behaviors of young players (under-8 to under-12 age groups) in full-sided games (FSGs) and small-sided games (SSGs), from the standpoint of tactical modeling and interaction dynamics. According to (Garganta, 1997; Garganta, 2009), the process of tactical modeling of games enables the identification of patterns emerging from match events, through technical and tactical variables, according to the characteristics that lead players and teams to success or failure. The modeling refers to the approximation to the real and, in the context of soccer, the utilization of models can contribute to bring to light and explain its logic (Garganta, 1997).

Furthermore, the application of social network analysis to identify teams' interaction dynamics, it is possible to describe the links between players within the field, which enables the detection of patterns regarding the way players interrelate and how the actions of everyone converge to give rise to the whole (Grund, 2012; Ribeiro et al., 2017; Wäsche et al., 2017). According to the authors, this type of analysis is complementary to other approaches, by helping to comprehend the relations established by the players and their impact on the collective plan.

The justification for this study is because it is currently common for young players in European countries to participate in competitions on fields suitable for their age and developmental stage – 5 vs. 5, 7 vs. 7 and 9 vs. 9, for the under-8 (U-8) to under-14 (U-14) (Brito et al., 2017, 2018; Garganta, 2006; Tessitore et al., 2012). Meanwhile, it was common in South America until the early 2020s to find children playing competitive games on pitches with areas like those found in professional competitions. This trend prompted the development of CONMEBOL's strategy notebook for youth teams in 2020. The notebook aims to propose game-based situations adapted to children's age groups and capabilities. However, to better design and plan appropriate learning environments for children, further research must explore how different playing formats and sizes affects their performance (Conmebol, 2020).

It is important to point out that there are differences in the technical and tactical actions performed by players from U-08 to under-12 (U-12). However, it is also important to make clear, that our goal is to compare each category with itself, in two different conditions. We used these three age groups, exactly because we understand that they are the most sensitive phases of cognitive and motor development (Teoldo et al., 2022), requiring, therefore, the creation of a proper game space for each one of them.

Methods

Sample

The sample comprised 180 soccer players from three age groups: U-8 (7.20 ± 0.85 y/o), under-10 (U-10) (9.36 ± 0.58 y/o) and U-12 (11.30 ± 0.70 y/o). For athlete selection, three regional-level clubs were invited, which solely competed in amateur competitions and did not have professional teams within their club structure. These teams could enter a maximum of 20 athletes per team. So, the players from each club already knew each other and had no problems adapting. The proposal was to simulate a competitive context, including the heterogeneity of the groups, as it occurs in various youth category competitions. Therefore, more specific information about the participating children, such as weight, height, experience, etc., was not collected.

All the participants were involved in regular practice at least two times a week, playing at regional level championships affiliated with their respective regional leagues. In addition, all players had previous experience of 11 vs. 11 matches, because in the region all competitions were played in formats like the professional category matches.

Players and legal guardians were informed about the purposes of the study and signed and Informed Consent. All procedures were approved by the Ethics Committee for Research with Human Beings and were carried out following the guidelines of the Declaration of Helsinki (WMA, 1996) and of the National Health Council (466/2012).

Procedures

In each age group, all players participated of one game, at least, and four games, at most. All players from each club and age group have played at least one match, and there are no omissions. As a criterion for participation, all players played the minimum of 50% of the time in each match. Therefore, each team in each category played two matches in FSGs (Full-Sided Games) and SSGs (Small-Sided Games), in which each player participated in at least one and at most four matches.

Each team played against each other in a double-round schedule. The rounds were determined according to game format, whereas full-sided games were played in the first round, and small-sided games were played in the second round. The teams played against each other once every round and participated in four matches (2 FSGs and 2 SSGs). The matches were played on Saturdays, at the same time of day (from 09:00 AM to 01:00 PM) and following the same order – 1st match: U-8; 2nd match: U-10; 3rd match: U-12. Matches were played under the official rules of the game, except for the offside rule in the small-sided games. Substitutions were unlimited in all matches, given that the rule for minimum participation (50% of total match time) was observed. Each team had a coach, who was responsible for organizing the lineups, formation, and substitutions during the matches. All coaches were allowed to give instructions to their players during the matches.

SSGs and FSGs

The field formats, number of players, game duration, size of goalposts and rules (absence of offside in small-sided games for U-10 and U-12) were defined based on the CONMEBOL handbook (2020). Consequently, the standard playing times for each age group were: 3 periods of 12 minutes (U-8s); 3 periods of 15 minutes (U-10s) and 3 periods of 20 minutes (U-12s). A 5-minute interval between periods was given in all age groups. The format and dimensions of the FSGs were standardized for all age groups (GK + 10 vs. 10 + GK; 100 × 68 m), because that was the format in which the players were adapted to play in the regional competitions, they took part in, from U-08 to U-12. It's worth highlighting that the rules applied were the same as those used in

the competitions they participated in, which are identical to those of professional-level games.

Whereas the SSGs format and dimensions were determined according to each age group: U-8s (GK + 4 vs. 4 + GK; 36 × 20 m); U-10s (GK + 7 vs. 7 + GK; 52.5 × 34 m); U-12s (GK + 10 vs. 10 + GK; 68 × 45 m). The goalposts also had different sizes, according to each age group: 3 × 2 m (SSG, U-8s); 6 × 2 m (SSG, U-10s and U-12s); 7.32 × 2.44 m (FSGs, all age groups). These playing formats were chosen based on the guiding handbook of Conmebol (2020) and to expand the discussions present in a recent published study (Teoldo & Silvino, 2022), analyzing the demands of the full- and small-sided games context for children, in contrast to what professional players require in matches at the highest competitive level in Brazil.

All matches were played in a natural grass field. Full-sided games were officiated by the main referee and two assistant referees, whilst small-sided games were officiated only by the main referee. In all matches, extra balls were available near the side-lines and goal-lines, so that the ball could be replaced as quickly as possible.

Variables and analysis

All matches were video recorded at approximately four meters high, by a camera placed parallel to side-line, with focus toward the halfway line. Match footage was analyzed afterward, according to the definition of the variables of the tactical modeling and interaction dynamics approaches (Table 1).

For the analysis of all the variables that considered the space of the game as an evaluation criterion (i. e.: number of variations corridor), we considered the campogram presented by (J. Garganta, 1997) with the field divided in three corridors (left, central and right) and four sectors (defensive, defensive midfielder, offensive midfielder and offensive midfielder), configuring twelve zones.

All data were obtained through notational analysis and registered in a spread sheet. All games were analyzed twice, as each team was analyzed separately, resulting in a total of 18 analyses in the small-sided games and 18 analyses in the full-sided games. In total, more than 4200 actions were analyzed. Interactions were registered based on the social network analysis method, whereas all completed passes between players were considered as the linking criteria. Following the analysis of matches, data were organized and statistically analyzed for the comparison of behaviors between both classes of matches in each age group. Since all players participated for at least 50% of the time in the games, there was no significant difference in playing time for each player throughout the competition, thus normalizing the data within each category.

Material

A video camera and a tripod were used for recording video footage of the match. A laptop computer (HP, 15-AY103DX, Intel Core i5 processor) was used to analyze matches, supported by spreadsheets of the Microsoft Excel 2013 for

Table 1. Tactical modeling and interaction dynamics variables.

VARIABLE	CRITERIA	REFERENCE
	TACTICAL MODELLING	
Offensive Sequence (OS)	The moment that starts in the first ball touch by a player, and ends in the last contact performed by this player or by a teammate in the same sequence. The criteria that define this variable is the concept of ball possession (J. Garganta, 1997).	Garganta (1997)
Number of Variations of Corridor (NVC)	The number of times the ball is circulated, through passing, toward a different corridor, during an offensive sequence. We considered three corridors, following the same campogram presented by J. Garganta (1997).	Garganta (1997)
Number of balls Received (NR)	The number of balls received by players in each offensive sequence.	Dugrand (1989)
Number of ball touches (Nt)	The number of ball touches by the players during a given sequence.	Morris, (1981); Withers et al. (1982); Gréhaigne, (1989); Dugrand (1989)
Velocity of Ball Transmission (VBT)	Index obtained through NR and Nt, where VBT = NR/Nt. Values range from 0 to 1, and values closer to 1 denote higher velocity, whereas values closer to 0 denote lower velocity.	Dugrand (1989)
Duration of the Offensive Sequence (DOS)	Duration, in seconds, of each offensive sequence.	
Form of ball Acquisition and Recovery (FAR)	Refers to the start of the offensive process, and is classified into four categories: (I) tackle; (II) interception; (III) opponent's error; (IV) fragments of the game.	Garganta (1997)
Offensive Sequence Outcome (OSO)	Refers to the end of the offensive process, and is classified in four categories: (I) goal; (II) shot at goal; (III) positive offensive sequence; (IV) negative offensive sequence.	Adapted from Garganta (1997)
	INTERACTION DYNAMICS	
Total Interactions (TI)	Absolute number of all interactions.	Clemente et al. (2016)
Network Density (D)	Ratio of maximum possible connections between nodes. Quotient between the number of existing connections and the number of potential connections. Values range from 0 to 1, and density is higher when values are closer to 1, and lower when values are closer to 0.	Clemente, et al. (2016)
Clustering Coefficient (CC)	Measures the degree of interconnectivity between teammates. Values range from 0 to 1, whereas 1 is the maximum cooperation value, and 0 denotes the absence of cooperation.	Clemente et al. (2014)
Reciprocity (R)	Measures the tendency of pairs of players to form connections between them. Subdivided in: Link reciprocity (LR) and Dyad reciprocity (DR). Values range from 0 to 1, and the network is more symmetric when values are closer to 1, and more asymmetric when values are closer to 0.	Clemente et al. (2016)
Network Centrality (C)	Measures the degree of distribution of a network, and is associated to the degree of homogeneity. Values range from 0 to 1, whereas higher homogeneity is represented by values closer to 1, and lower homogeneity to values closer to 0.	Clemente et al. (2014)
Network Influence (I)	Identifies the specific value of team participation. Values range from 0 to 1, and network influence closer to 1 indicates higher dependency on smaller group of players, and when closer to 0, represent a more regularly distributed network.	Clemente et al. (2016)

Windows. The Social Network Visualizer (SocNetV 2.5 beta) was used to insert matrices and generating quantitative data from network analysis.

Reliability analysis

Test—retest reliability for the observations comprised of a 20-day interval for reanalysis to avoid any potential familiarity effects (Robinson & O'Donoghue, 2007). Reliability calculation was performed using the Cohen's Kappa test. One analyst was involved in this procedure, with nine years of experience in analysis. Reliability was verified through the reassessment of a number of actions that was superior to the percentage (10%) indicated by literature (Tabachnick & Fidell, 2012). An intra-observer reliability analysis presented values 0.973 (SE = 0.007). Two external observers, with an average experience of 10.5 years, conducted an analysis of a total of 10% of the sample to verify data reliability and presented the following values: 0.912 (SE = 0.032) and 0.963 (SE = 0.025). These reliability values are classified by (Landis & Koch, 1977) as "almost perfect" (0.81–1) in terms of their level of agreement.

As the selected variables are quantitative, objective, and do not require a subjective judgment, it was not necessary to consider more than one analyst to carry out this process. However, to ensure the reliability and validity of the data, an external analyst was consulted to oversee the criteria and procedures employed. This was done to ensure that all standards and procedures were properly followed.

Statistical analysis

Statistical procedures were carried out through SPSS (Statistical Package for Social Sciences), v. 24.0. Descriptive analysis (means, standard deviation and confidence interval) was performed. The normality of data distribution was verified through the Shapiro-Wilk test. Players' behavior in FSG and SSG was compared through the paired t-test for the variables with normal data distribution. As for the variables whose data did not meet normality criteria, the Wilcoxon test was performed to examine the differences in behavior between both game formats. The effect size (d) was obtained through the subtraction of average values and division of the result by the combined standard deviation (parametric data: d=tc2(1-R) n; non-parametric data: r=z/√n) (Lenhard & Lenhard, 2016). The obtained value was converted to r (Cooper et al., 2009), which can be classified as small (0.10); medium (0.30); and 0.50 (large) (Cohen, 1992). Significance level was set to $p < .05$.

Results

Table 2 displays the means and standard deviation of the variables offensive sequence (OS), number of variations of a corridor (NVC), number of balls received (NR), number of ball touches (Nt), offensive sequence outcome (OSO) and form of ball acquisition and recovery (FAR).

In small-sided games (SSGs) for both the U-10 and U-12, the number of OS (U-10: $t = -3.60$, $p = .002$, $r = 0.44$; U-12: $t = -4.16$, $p = .001$, $r = 0.54$) and the NVC (U-10: $t = -4.20$, $p = .001$, $r = 0.52$; U-12: $t = -4.35$, $p < .001$, $r = 0.61$) were significantly higher. In the U-8, the NR ($t = 2.37$, $p = .030$, $r = 0.36$) and the Nt ($t = 4.11$, $p = .001$, $r = 0.45$) were significantly lower in SSGs. In the U-10 this difference was found only for the Nt ($t = 5.03$, $p < .001$, $r = 0.43$) for the SSGs.

As for the OSO, the number of goals scored in the SSGs was significantly higher than in the FSGs for the U-8s (z = −3.44, $p = .050$, $r = 0.31$). With respect to the shots at goal, the U-8 (z = −3.25, $p = .001$, $r = 0.61$) and U-10 (z = −2.72, $p = .007$, $r = 0.43$) age groups displayed a significant increase in SSGs, whereas the U-12 (z = 2.28, $p = .023$, $r = 0.36$) exhibited a significant increase in negative offensive sequences in the SSGs. Regarding the Forms of ball Acquisition and Recovery (FAR), the fragments of the game displayed significantly higher values in SSGs for all age groups (U-08: z = −3.44, $p = .001$, $r = 0.66$; U-10: z = −3.34, $p = .001$, $r = 0.65$; U-12: $t = -2.88$, $p = .010$, $r = 0.46$). In the U-10 ($t = 2.75$, $p = .014$, $r = 0.34$), tackles per minute were significantly more frequent in the FSGs. The U-12 displayed significantly higher values of interception ($t = -3.30$, $p = .004$, $r = 0.47$) when participating in SSGs.

Figure 1a displays the means and standard deviation of the Duration (in seconds) of the Offensive Sequence (DOS). Significant differences for all age groups were observed (U-08: $t = 9.98$, $p < .001$, $r = 0.78$; U-10: $t = 6.75$, $p < .001$, $r = 0.74$; U-12: $t = 8.27$, $p < .001$, $r = 0.78$), whereas the FSGs displayed longer offensive sequences. Figure 1b displays the values of Velocity of Ball Transmission (VBT). For all age groups, significant differences were found, whereas SSGs displayed higher VBT values than FSGs (U-08: $t = -3.54$, $p = .003$, $r = 0.42$; U-10: $t = -5.13$, $p < .001$, $r = 0.65$; U-12: $t = -5.80$, $p < .001$, $r = 0.63$).

Table 3 displays the means and standard deviation of the variables related to the teams' interaction dynamics. Interactions were significantly less frequent for the U-8 ($t = 9.64$, $p < .001$, $r = 0.81$) and U-10 ($t = 2.93$, $p = .009$, $r = 0.37$) age groups. The opposite was observed for the values of network influence, as two age groups displayed significantly higher values in SSG (U-8: $t = -5.44$, $p < .001$, $r = 0.67$; U-10: $t = -3.37$, $p = .004$, $r = 0.54$). No significant differences were observed for the remaining variables when both game formats were compared, except for the U-8, in which density increased significantly in SSG (z = −2.47, $p = .014$, $r = 0.43$).

Discussion

This study aimed to analyze the tactical behavior of young soccer players (U-8 to U-12 age groups) in FSGs and SSGs, from the perspective of tactical modeling and interaction dynamics. Our findings may elucidate some differences in players' and teams' behaviors, according to game formats, such as: (1) characterization of the offensive sequences; (2) characteristics of ball circulation; (3) offensive sequence outcomes; (4) defense-attack transitions; (5) players' participation; and (6) interaction dynamics.

Table 2. Means and standard deviation for the tactical modeling variables: offensive sequence (OS); number of variations of corridors (NVC); number of balls received (NR); number of ball touches (Nt); offensive sequence outcome (OSO); form of ball acquisition and recovery (FAR).

	U-8				U-10				U-12			
	FSG		SSG		FSG		SSG		FSG		SSG	
	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)
OS	1.50 (±0.26)	1.36–1.63	1.67 (±0.24)	1.55–1.79	1.39 (±0.26)	1.25–.1.52	1.64 (±0.31)	1.49–1.79*	1.22 (±0.24)	1.10–1.34	1.54 (±0.26)	1.41–.167*
NVC	1.24 (±0.34)	1.07–1.41	1.58 (±0.74)	1.21–1.95	1.21 (±0.26)	1.08–1.34	1.69 (±0.49)	1.45–1.94*	1.13 (±0.32)	0.97–.129	1.64 (±0.35)	1.47–1.82*
NR	4.44 (±0.86)	4.01–4.87	3.78 (±0.84)	3.37–4.20*	4.32 (±1.03)	3.80–4.83	4.09 (±1.08)	3.55–4.62	3.81 (±0.80)	3.42–4.21	4.32 (±0.84)	3.90–4.73
Nt	10.38 (±2.46)	9.16–11.70	8.04 (±2.19)	6.95–9.13*	10.36 (±2.02)	9.35–11.36	8.43 (±2.08)	7.39–9.47*	9.39 (±2.34)	8.23–10.56	8.99 (±2.07)	7.97–10.02
OSO (p/min)												
Goal	0.06 (±0.08)	0.02–0.10	0.12 (±0.10)	0.07–0.17*	0.07 (±0.08)	0.03–0.10	0.09 (±0.12)	0.03–0.15	0.07 (±0.07)	0.04–0.10	0.06 (±0.07)	0.02–0.10
Shots	0.10 (±0.07)	0.07–0.14	0.28 (±0.15)	0.20–0.35*	0.12 (±0.11)	0.07–0.17	0.25 (±0.16)	0.17–0.33*	0.12 (±0.08)	0.08–0.16	0.14 (±0.10)	0.10–0.19
Positive OS	0.87 (±0.34)	0.69–1.04	0.79 (±0.29)	0.65–0.93	0.82 (±0.35)	0.65–1.00	0.94 (±0.28)	0.80–1.08	0.77 (±0.22)	0.66–0.88	0.94 (±0.22)	0.83–1.05
Negative OS	0.45 (±0.35)	0.28–0.63	0.48 (±0.20)	0.38–0.58	0.38 (±0.32)	0.22–0.54	0.36 (±0.18)	0.27–0.45	0.26 (±0.16)	0.18–0.34	0.39 (±0.18)	0.30–0.48*
FAR (p/min)												
Tackle	0.35 (±0.17)	0.27–0.44	0.26 (±0.13)	0.20–0.33	0.40 (±0.21)	0.29–0.50	0.27 (±0.14)	0.19–0.34*	0.26 (±0.11)	0.20–0.32	0.24 (±0.12)	0.18–0.30
Interception	0.19 (±0.10)	0.15–0.24	0.25 (±0.12)	0.19–0.30	0.19 (±0.21)	0.09–0.30	0.21 (±0.13)	0.14–0.28	0.14 (±0.09)	0.10–0.19	0.26 (±0.13)	0.20–0.32*
Opp. Err.	0.50 (±0.23)	0.38–0.61	0.36 (±0.18)	0.27–0.45	0.40 (±0.18)	0.31–0.49	0.42 (±0.22)	0.31–0.53	0.36 (±0.11)	0.30–0.41	0.40 (±0.15)	0.33–0.48
Frag. of the game	0.45 (±0.15)	0.38–0.53	0.80 (±0.24)	0.68–0.92*	0.40 (±0.14)	0.33–0.46	0.74 (±0.24)	0.62–0.86*	0.46 (±0.19)	0.37–0.56	0.64 (±0.15)	0.56–0.71*

$p < .05$.

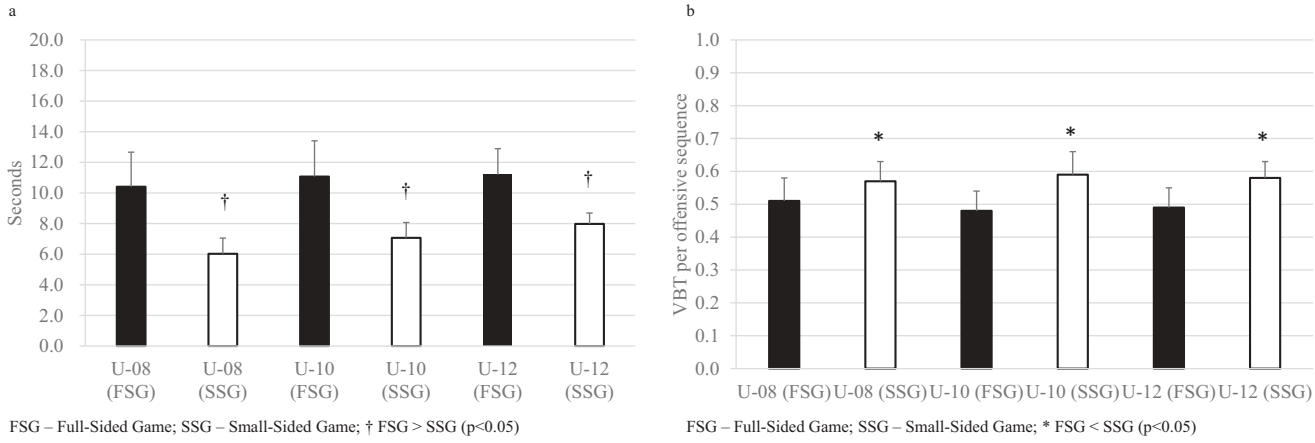

Figure 1. Means and standard deviation for the a – duration of the offensive sequence (DOS) and B – Velocity of Ball Transmission (VBT).

Offensive sequences

With respect to the characterization of the offensive sequences, it is possible to notice that they were more frequent and had shorter duration in SSGs, which suggests a game with more turnovers in ball possession. These results corroborate the discoveries made by Teoldo et al. (2011) and Olthof et al. (2018), who noted increased turnovers in possession and shorter periods of ball possession, respectively, when comparing such behaviors across varying pitch sizes and player numbers on the pitch. According to the authors, the small space, absolute and relative per player, influences the decrease of interpersonal distances and increase an opponents' pressure, which are key factors that contribute to shorter duration of the offensive sequences and more turnovers in possession.

Characteristics of ball circulation

In terms of ball circulation, we could observe that SSGs demanded higher velocity and amplitude. As for velocity, Dugrand (1989) and Olsen (1988) claim that there is a positive relation between the superior velocity through which teams transmit the ball and offensive effectiveness. Regarding the amplitude, our results are in line to those reported by Folgado et al. (2019), which indicated that in shorter fields, fewer longitudinal actions are performed. Both findings can be explained through the fact that spatial changes are likely to modify playing dynamics, by prompting the decrease of time and space available for players to act (Fradua et al., 2013). Therefore, the utilization of the SSGs formats proposed in the present study enables teams to circulate the ball with increased velocity and amplitude, in offensive sequences of shorter duration, which may contribute to greater offensive effectiveness.

Offensive sequences outcomes

Some authors indicated that games in smaller spaces prompt teams to conclude their offensive sequences with a scoring opportunity (Dellal et al., 2012; Katis & Kellis, 2009; Kelly & Drust, 2009), being probably one of the best indicators of offensive success. In addition to the results of this study confirming this issue, after all, it is noted that there was not only an increase in shots on goal in SSGs for the U-08 and U-10 games, but there was also a significant increase in the number of goals in the U-08 games. These findings may be deemed valuable for players' development process, as the increase of scoring chances is key—if viewed as a motivating element—further reinforcing the idea of not losing sight of the intent of the game (Garganta & Pinto, 1994; Queiroz, 1983). It is important to consider that the fact that the goals are closer together due to a smaller playing area creates an expectation for an increase in the number of shot attempts, as was confirmed by the results of the study.

Defence-attack transitions

Regarding the offensive transitions, they were more frequently carried out in SSGs through fragments of the game, for all age groups, which accords to the results reported in other studies (Olthof et al., 2018; Teoldo et al., 2011). Considering that the players of the sampled age groups (U-8, U-10 and U-12) should be learning contents related to the logic of the game and in harmony with its purpose, through the operational principles (Teoldo et al., 2022), the findings regarding the transitions may indicate both positive and "negative" aspects, from the perspective of sports development. The positive aspect is that players are frequently exposed to offensive and defensive dynamics, fostering necessary behavioral adaptations during phase transitions. Conversely, it may suggest players' ineffectiveness in playing according to these principles, particularly in possession retention, both individually and collectively.

Players' participation

As for players' participation, which was analyzed through the number of balls received (NR) and ball touches (Nt), we observed that the results for the U-8 are in line with the findings of Owen et al. (2011). For the U-10 age group, results like those of the study were only observed for the number of ball touches. Hence, we believe that the decrease of playing space may be related to a reduction in the number of ball touches, due to the opponents' proximity, resulting in

Table 3. Means and standard deviation of interaction dynamics, displayed according to the following variables: *total interactions*, *density*, *clustering coefficient*, *link reciprocity*, *dyad reciprocity*, *centrality* and *network influence*..

	U-8				U-10				U-12			
	FSG		SSG		FSG		SSG		FSG		SSG	
	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)	Media (sd)	CI (95%)
Interactions	26.44 (±5.81)	23.55–29.34	13.06 (±3.55)	11.29–14.82*	31.67 (±8.10)	27.64–35.70	25.22 (±8.17)	21.16–29.29*	33.94 (±7.47)	30.23-.37-66	36.94 (±5.40)	34.26–39.63
Density	0.22 (±0.04)	0.20–0.25	0.33 (±0.16)	0.25–0.41*	0.24 (±0.05)	0.22–0.27	0.28 (±0.10)	0.24–0.34	0.23 (±0.06)	0.20–0.26	0.25 (±0.07)	0.22–0.29
Clustering Coefficient	0.07 (±0.09)	0.03–0.12	0.08 (±0.19)	(-)0.02–0.19	0.04 (±0.05)	0.02–0.07	0.06 (±0.08)	0.02–0.10	0.10 (±0.16)	0.03–0.19	0.08 (±0.09)	0.03–0.12
Link Reciprocity	0.22 (±0.14)	0.16–0.30	0.18 (±0.18)	0.09–0.28	0.18 (±0.09)	0.14–0.23	0.16 (±0.11)	0.11–0.22	0.22 (±0.12)	0.16–0.28	0.19 (±0.08)	0.15–0.24
Dyad Reciprocity	0.16 (±0.10)	0.11–0.22	0.14 (±0.12)	0.08–0.21	0.14 (±0.07)	0.11–0.18	0.13 (±0.08)	0.09–0.17	0.16 (±0.09)	0.12–0.21	0.15 (±0.06)	0.12–0.18
Centrality	0.27 (±0.07)	0.24–0.32	0.23 (±0.11)	0.18–0.29	0.25 (±0.07)	0.22–0.29	0.24 (±0.08)	0.21–0.29	0.24 (±0.09)	0.20–0.29	0.28 (±0.10)	0.23–0.33
Influence	0.03 (±0.01)	0.03–0.04	0.07 (±0.03)	0.06–0.09*	0.03 (±0.01)	0.03–0.04	0.05 (±0.02)	0.04–0.06*	0.04 (±0.04)	0.02–0.06	0.04 (±0.04)	0.03–0.04

*$p < .05$.

demands for greater agility from the players. However, we understood too the number of balls received may also be related to the number of players in the game, as it implies in fewer passing options for a team.

Interaction dynamics

As regards the passing possibilities, i.e., from the perspective of the interactions carried out, some authors claim that the interaction dynamics can assist in identifying potentially relevant patterns that determine success at the collective, group and individual levels (Grund, 2012; Passos et al., 2011; Wäsche et al., 2017). Yet, our findings indicate that the number of players may be regarded as an important factor for these dynamics. For instance, in the U-12 age group, that there was no change in the number of players between formats, the number of players participating in offensive sequences did not differ between both game formats (FSGs and SSGs), which implies similar patterns of interaction.

For the U-8 and U-10 age groups, reducing the number of players in SSGs significantly decreased interactions. This led to fewer players influencing ball circulation dynamics, with the U-8 group showing increased network density, indicating more communication channels due to limited interaction possibilities. Despite fewer interactions, there was a wider distribution in the passing network density, especially in the U-8 category, suggesting increased involvement in smaller playing spaces. However, further investigation with larger sample sizes is needed. Additionally, while some studies suggest interaction dynamics reflect collective performance (Clemente et al., 2015; Grund, 2012; Molm, 1994; Sparrowe et al., 2001), caution is advised in interpretation. More research is needed to identify metrics describing interaction dynamics and their relation to team success, along with analyses of other game formats.

Limitations and future studies

Even understanding that the results of the present study bring contributions for the structuring of official matches for the categories U-08, U-10 and U-12 in the South American scenario, there are some limitations that can be explored in future studies. A more in-depth assessment of the players' previous experiences, along with comparisons between different competitive and technical levels, can provide valuable insights into the training and development process of young players. However, it is worth noting that few studies with this focus have been conducted in the Brazilian and South American scenario.

Furthermore, few studies sought to analyze matches of different formats resorting to tactical modeling and interaction dynamics, thus making investigations employing these approaches necessary to describe how these processes contribute to understanding the properties of complex adaptive systems, such as the game of soccer (Davids et al., 2005; Garganta & Gréhaigne, 1999; Gréhaigne et al., 1997). Finally, it is worth pointing out that even though there are limitations in this study, as mentioned above, we found several evidences that dialogue with the literature and others that bring questions and reflections that may be important to think about the players' development process and the spaces where these processes take place.

Conclusion

Thinking not only about the South American scenario, but also in a global perspective, the results of this study bring important contributions and reflections for the structuring of official games in the formative process. The results lead us to reflect what we understand as participation in the matches, bringing a counterpoint with what has been presented in the literature. Besides, it presented results that consolidate the importance of the adequacy of the game spaces for the players from 6 to 12 years old, thinking in three different perspectives: 1) Achieving the game's objective—more goals and shots. Contributing to their continued participation in the sport by successfully achieving the game's objective more frequently; 2) Game space management—ball circulation in larger amplitude and with more transitions between the phases; and 3) Quick decision making—ball circulation with higher speed. Therefore, we understand that the results found here can contribute significantly to think about a training process compatible with the children's capabilities, to favor both a motivational sense and the optimization of the development process of these children for soccer.

Practical implications

- The appropriateness of game spaces—SSGs—and the progression of these spaces between categories is an important process of gradual evolution that respects the age and development periods of players.
- Placing children in an environment where they can achieve the game's objectives more frequently can be a key element in retaining their interest in the sport.
- The need for the ball to circulate at high speed and amplitude, along with variability in the communication channels established between players, can be fundamental for the development of an understanding of the game's logic in sports. This will require intelligence and creativity to "find these paths" to achieve the game's objective, especially in the U-8 and U-10 categories.
- The use of formal game spaces (FSG) does not need to be completely discarded, if they are not considered the official playing area. Experiencing different playing spaces, like those used by professional players who serve as role models for children, can be an additional element in the developmental process, expanding their experiences in different scenarios.

IRB approval

Players and legal guardians were informed about the purposes of the study, and signed and Informed Consent. All procedures were approved by the Ethics Committee for Research with Human Beings (CEP) of the Universidade Federal de Viçosa (CAAE: 11952919.6.0000.5153), and were carried out following the guidelines of the Declaration of Helsinki (1996) and of the National Health Council (466/2012).

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