Exploring how playing football with different age groups affects tactical behaviour and physical performance

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ABSTRACT: The study aimed to compare footballers' performances when playing with teammates and opponents from the same age group with performances when playing with teammates and opponents of different age groups. Three football matches were played: i) under-15 (U15) players played with each other; ii) under-17 (U17) players played with each other; and iii) players under the age of 15 and 17 played with each other in two equivalent mixed age teams. The players' physical performance was measured using the distances covered at different speed categories and tactical behaviour was assessed using several positioning-derived variables. The results showed that, when playing in the mixed age condition, the U15 players increased the distance covered in sprinting intensity (18.1%; ±21.1%) and the U17 players increased the distance covered in jogging zones (6.8%; ±6.5%). The intra-team movement synchronization in longitudinal and lateral displacements was higher when U15 players confronted peers of the same age, in the first half (-13.4%; ±2.0%, -20.3%; ±5.7% respectively), and when U17 players confronting the mixed group, in both halves (-16.9%; ±2.5%, 9.8%; ±4.0% and 7.9%; ±5.7%, 10.6% ±4.4%, respectively). The differences between age groups and the mixed condition may be connected with the level of players' tactical expertise and adaptive positioning according to the dynamic environmental information. In general, these results suggest that mixing the age groups may be useful to promote a wider range of training session stimuli in these young football players.

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INTRODUCTION

Most sports development programmes are designed to respect age and specific playing positional groups, which may prevent optimal responses to training stimulus [1]. Thus, several team sports clubs offer the young players opportunities to participate in training and competitions with younger or older age groups, so as to increase exposure to different stimuli and accelerate development [2, 3]. Hence, it seems necessary to deepen the knowledge about the impact of some age-related task constraints, not only in physical performance but also in tactical behaviour.

While tactical aspects are a key determinant of performance, previous research under this topic has been mainly focused on the physical and physiological description of training and competition demands [4]. In fact, available research usually describes workload variations according to the developmental ages [5, 6]. For instance, Coutinho and Gonçalves [5] described the physiological profile during one week in U15, U17 and U19 players and showed that different training development priorities may compromise progression in the schedule. Thus, understanding the physical and tactical demands during training and competition according to the developmental ages may amplify the information to potentiate players' performance and optimise planning guidelines [7]. However, players of the same age may show different responses and adaptations to the stimuli, so it might be suggested that grouping players by age may hinder optimization of their potential across the development process [8].

The manipulation of task constraints during practice sessions requires highly adaptive behaviour from the players, for example when changing the number of teammates or opponents in a small sided game, or when changing the court dimensions or the number of targets available to score [9, 10]. In this sense, the interpretation of several specific task constraints might lead to optimization of individual and collective self-organization, by improving team tactical behaviour that promotes high levels of functional coordination patterns [11].

Intra-team movement synchronization performance has been largely studied in soccer in order to better understand players' interactions and the respective performance outcome [12, 13]. For instance, Gonçalves and colleagues [9] identified the effects associated with the limitation of the pitch area, by using a variable that helps explain pitch exploration (SEI, spatial exploration index). The results showed that limiting spatial exploration impaired the collective self-organization while decreasing the physical and physiological performances. Other studies quantified the intra-team movement synchronization and showed that competing against stronger teams promotes higher levels of synchronization behaviours and elicits greater physical and physiological demands [14].

Particularly in soccer, the classification of players according to age groups, specific positions and physical and physiological performance profiles is well established [15-17]. However, there are no results available that could help understanding players' tactical behaviour when they are training with other age groups. In fact, this specific information can optimize the training process by providing useful information on the development of performance. Thus, the present study aimed to compare footballers' performances when playing with teammates and opponents from the same age group with performances when playing within teammates and opponents of different age groups.

MATERIALS AND METHODS

Subjects

The participants were 44 male elite young Portuguese soccer players from the under-15 and under-17 age groups (U15 players: n=22, age 13.6±0.4 years, height 1.66±0.04 m, weight 56.1±5.2 kg and playing experience 5.1±1.3 years; U17: n=22, age 15.3±0.4 years, height 1.73±0.03 m, weight 64.4±3.2 kg and playing experience 7.2±1.4 years). All participants were part of the same club, competing at the elite youth level in Portugal. The goalkeepers participated in the protocol, but were excluded from the analysis. Both U15 players and U17 players participated in four training sessions per week, with an average duration of 90 minutes, and one official match during the weekend. All players and their parents were informed about the research procedures, requirements, benefits and risks and their written consent was obtained before the study began. Additionally, players were informed that they were free to withdraw at any time without any penalty. The investigation was approved by the local Institutional Research Ethics Committee and conformed to the recommendations of the Declaration of Helsinki.

Experimental procedure

The study protocol practice sessions started with a 20-min standard warm-up that included low-intensity running, ball possessions exercises and a dynamic stretching workout. Following this period, a match was played (11-a-side with a goalkeeper) with two halves of 25 min, interspersed by 10 min of passive recovery. This duration was deliberately manipulated to minimize the effects of fatigue in the study variables [18]. In all experimental conditions, the head coach used subjective evaluations to balance both teams using specific positional roles and physical, technical and tactical levels [19]. All games respected the official soccer rules and were played on an official size natural turf pitch (105 x 70 m). Three games were performed under the follow conditions: i) players were divided into respective age groups, U15 players and U17. In the first game, there were only U15 players participating in the protocol. The players were assigned according to specific positions and were assembled into two balanced teams that played with each other (see Figure 1i and ii). In the second game, there were only U17 players participating in the protocol, which was replicated from the previous one (see Figure 1ii and 1iii). In the third game, both players under the age of 15 and 17 played with each other in two equivalent mixed teams (see Figure 1iii). The head coach used subjective evaluation to rank the players of both age groups using the physical, technical and tactical levels [19]. Then, both teams were assembled using 5 players of the U15 age group and 5 players of the U17 age group according to the specific position in two technically equivalent teams that played with each other (see Figure 1-iii). The design of the study aimed to compare the players' performances when playing with teammates and opponents from the same age group with performances when playing with teammates and opponents of different age groups.

Time-motion

Players' positional data were collected at 5 Hz using GPS units (SPI-Pro, GPSports, Canberra, ACT, Australia) fitted into appropriate harnesses that place the device on the upper back of each player. The raw data were retrieved from GPS units and processed in MATLAB using dedicated routines (MathWorks, Inc., Massachusetts, USA). For complete data filter guidelines, see Folgado and Duarte [14]. The total distance covered by players and the distance covered at different movement speed categories were selected to measure the players' physical responses. The following speed zones were used: walking (0.0-3.5 km/h); jogging (3.6-14.3 km/h); running (14.4-19.8 km/h); and sprinting (>19.9 km/h) [9].

Positional variables

The positional data were processed for all possible outfield couplings of players (n=45) to obtain the following variables: (i) distance between players, expressed in absolute values (m); (ii) variability in the distance between players, expressed by the coefficient of variation (CV); (iii) regularity in the distance between players, expressed by approximate entropy (ApEn); (iv) frequency of near-in-phase synchronization in longitudinal and lateral displacements, expressed in % of time; (v) SEI, expressed in absolute values (m). ApEn was used to assess regularity in players' dynamic positional data and was applied to intra-team dyads positioning. The values used to calculate ApEn were 2.0 to the vector length (m) and 0.2 standard deviations to the tolerance factor (r). The ApEn results range between 0 and 2 (arbitrary units) and lower values represent more repeatable, regular,

predictable sequences of data points [20]. The ApEn technique identifies patterns of movement through the players' positioning providing information about tactical decision-making [21, 22]. The relative phase was used, aiming to identify interpersonal coordination. The relative phase calculation was calculated using a Hilbert transform [23] to access frequency of near-in-phase synchronization for longitudinal and lateral movements of all dyads, expressed by the % of time dyads between the interval of -30º to 30º [14]. The spatial exploration index (SEI) was obtained for each player by calculating his mean pitch position, computing the distance from each positioning time-series to the mean position and, finally, computing the mean value from all obtained distances. The SEI assesses players' pitch exploration, wherein higher values seem to be associated with players that cover greater distances [9].

Statistical analysis

A descriptive analysis was performed using means and standard deviations. The comparisons among games were assessed via standardized mean differences, computed with pooled variance and respective 90% confidence intervals. The considered variables of each player were calculated and compared at two different moments in two experimental scenarios. Thus, the players' performances when playing with teammates and opponents from the same age group were compared with the performances when playing with teammates and opponents of different age groups in both halves. Differences in means for both pairs of scenarios were also expressed and graphically represented in percentage units with 90% confidence limits (CL). Thresholds for effect size statistics were 0.2, trivial; 0.6, small; 1.2, moderate; 2.0, large; and >2.0, very large [24]. The smallest worthwhile differences were estimated from the standardised units multiplied by 0.2. Magnitudes of clear effects were described according to the following scale: 25-75% possibly; 75-95% likely; 95-99% very likely; >99% most likely [24].

RESULTS

Time-motion variables showed different trends in U15 players between scenarios, when comparing the 1st half and 2nd half, in distance covered while walking (difference in means (%); ±90% CL, 1st half,

TABLE 1. Descriptive physical analysis (mean±SD). Difference in means and uncertainty in the true differences comparisons among considered age scenarios.

Variables	Age group scenarios				Difference in means (%; ±90% CL) Uncertainly in the true differences	
	Data from U15		Data from U17			
	U15 vs. U15	U15/17 vs. U15/17	U17 vs. U17	U15/17 vs. U15/17	(a)	(b)
Distance Covered						
Walking (<3.5 km/h)						
1st Half	211.3±37.7	182.4±56.0	195.6±53.4	183.1±51.8	-16.5±11.4 likely ↓	-6.6±9.5 possible ↓
2nd Half	179.4±46.8	201.5±52.2	214.1±35.4	216.0±55.1	12.2±13.9 likely↑	-1.2±11.4 unclear
Jogging (3.6-14.3 km/h)						
1st Half	2145.1±246.9	2331.8±349.3	2061.1±280.4	2197.9±262.8	8.3±5.1 very likely↑	6.8±6.5 likely ↑
2nd Half	2263.9±325.2	2190.4±364.6	2006.6±205.3	2083.5±260.4	-3.5±4.6 possible ↓	3.6±4.2 possible ↑
Running (14.4-19.8 km/h)						
1st Half	429.0±128.5	427.1±130.2	440.7±172.8	448.8±106.9	-0.7±17.3 unclear	5.4±15.1 unclear
2nd Half	433.7±88.2	370.3±93.9	379.3±166.3	377.0±80.5	-15.7±13.2 likely ↓	7.5±22.8 unclear
Sprinting (>19.9 km/h)						
1st Half	179.2±76.7	218.5±104.5	234.4±107.9	234.4±71.0	18.1±21.1 possible ↑	10.0±33.8 unclear
2nd Half	152.4±68.5	182.1±89.3	193.0±102.5	163.4±80.7	29.3±64.2 unclear	-8.5±41.0 unclear

Note: CL=confidence limits; ↑=increase; ↓=decrease. Comparisons among age scenarios are identified as: (a) age group U15 vs mixed age groups, and (b) age group U17 vs mixed age groups.

likely -16.5% ±11.4% decrease and 2nd half, likely 12.2% ±13.9% increase) and jogging intensities (1st half, likely 8.3%; ±5.1% increase and 2nd half, possible -3.5%; ±4.6% decrease). A possibly increase in the distance covered while sprinting was also found in games against mixed opposition (18.1%; ±21.1% increase) in the 1st half. The U17 players showed a likely/possible increase in distances covered while jogging, keeping similar intensity levels at very high intensity running when comparing the age group to mixed conditions in both halves (see Table 1 and Figure 2).

The absolute distances between players showed an inverse tendency, in both age groups, between the two scenarios (same age group and mixed) in both halves. While U15 players presented possibly increased distances in the mixed condition in the 1st half, U17 players showed a possible decrease in the 2nd half. Although with a similar tendency, CV showed trivial results in U15 players and possible results in U17 players between the two scenarios in the 1st half. In the second half, although both teams presented trivial results, U15 players increased the CV values when playing mixed with the different age group, in opposition to U17 players with decreased CV values (see Table 2 and Figure 2).

In U15 players, the ApEn values showed a possible decrease during the 2nd half when compared to the mixed scenario (-3.4%; ±3.0% small). However, in the U17 players, ApEn values were likely higher in the mixed condition, in both halves, showing less regularity in the distance between players (1st: 7.4%; ±2.9%, small; 2nd: 8.8%; ±2.7%, moderate).

The synchronization tendencies from the teammates dyads in longitudinal movement showed an opposite trend according to the level of opposition in the 1st half. While U15 players showed higher values when playing with players of the same age group, the U17 players presented higher values when playing mixed with the different age group. In the 2nd half both age groups presented higher values of longitudinal displacements when playing with players of different age groups. The synchronization when in lateral movement showed a similar tendency between halves. In U15 players lateral displacements presented higher values when playing with players of the same age group in both halves, unlike U17 players, who showed higher results when playing mixed with the different age group in both halves (see Table 2 and Figure 2).

The SEI results presented opposite trends in the 1st (-14.1%; ±1.6%, most likely) and 2nd (4.5%; ±4.2%, likely) halves in U15 players, unlike U17 players, who presented similar and unclear results in both conditions.

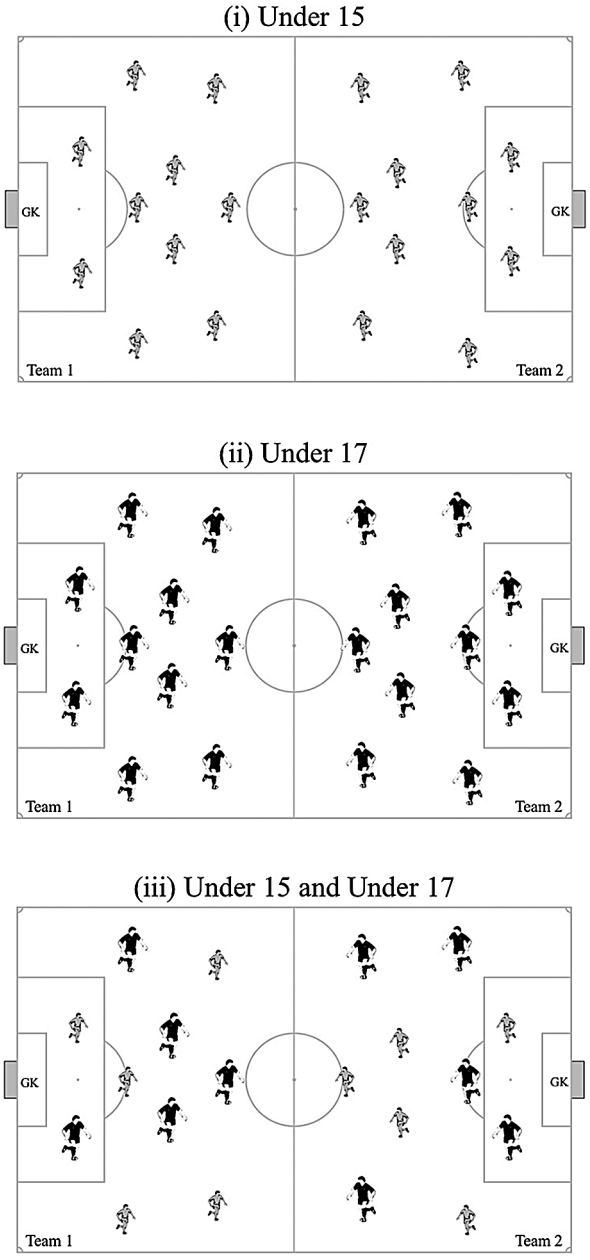

FIG. 1.

DISCUSSION

The present study aimed to identify the effects of playing soccer with different age groups in physical and tactical performance. In this sense, several positioning-derived variables were measured to add information about players' tactical behaviour.

The time-motion variables showed that playing in the mixed age group condition increased the physical stimuli in the U15 players, since the distance covered in sprinting intensity was higher in the 1st half. The obtained results can be linked with higher requirements imposed by the game with the presence of U17 players and also a greater physical readiness during the 1st half. These findings appear to be in line with previous research demonstrating that young players generally experienced greater physical demands during the 1st half of a game when compared to the 2nd half [25]. Still, the different training focus of U15 and U17 players, linked to the development of maturation status, may help to explain the present results. It has been suggested that the U15 players' training should be primarily focused on the development of physical and motor skills and then

on technical and elemental tactical skills [5], while U17 players' training sessions should be focused mainly on the development of tactical skills [6]. The present results are in line with previous research that showed a decrease in the tactical behaviour efficiency in U15 players. Conversely, U17 players are capable of greater knowledge about tactical principles, showing a better cognitive structure that promotes a more appropriate decision-making process [26]. Additionally, the peak age of velocity occurs between 13.8 and 14.2 years [27]. In this regard, the obtained results may be influenced by the specific training focus of U15 players on the development of physical and motor skills. Likewise, the increase of the jogging zones by the U17 players in the mixed scenario (in both halves) may be associated with greater biological maturation, allowing players to respond with a better decision making performance. Thus, players express

TABLE 2. Descriptive tactical analysis (mean±SD). Difference in means and uncertainty in the true differences comparisons among considered age scenarios.

Variables	Age group scenarios				Difference in means (%; ±90% CL) Uncertainly in the true differences	
	Data from U15		Data from U17			
	U15 vs. U15	U15/17 vs. U15/17	U17 vs. U17	U15/17 vs. U15/17	(a)	(b)
Distance between player						
Absolute values (m)						
1st Half	24.5±8.4	25.7±8.4	26.1±8.2	25.7±8.3	5.7±5.5 possible ↑	-1.9±2.8 very likely tri
2nd Half	25.5±8.0	25.5±7.9	26.7±8.2	25.0±7.8	0.0±5.1 very likely tri	-6.4±2.4 possible ↓
Coefficient of variation (a.u.)						
1st Half	0.35±0.08	0.34±0.08	0.37±0.08	0.35±0.08	-2.7±3.9 likely tri	-6.3±2.6 likely ↓
2nd Half	0.36±0.08	0.36±0.08	0.38±0.09	0.38±0.08	1.2±4.2 likely tri	-1.1±2.7 very likely tri
Approximate Entropy (a.u.)						
1st Half	0.128±0.02	0.131±0.02	0.120±0.02	0.129±0.02	2.2±3.3 likely tri	7.4±2.9 very likely↑
2nd Half	0.121±0.02	0.117±0.02	0.106±0.01	0.116±0.02	-3.4±3.0 possible ↓	8.8±2.7 most likely ↑
Near-in-phase Synchronization						
Longitudinal displacements (time %)						
1st Half	78.5±6.9	68.5±10.4	57.7±9.8	67.2±9.9	-13.4±2.0 most likely ↓	16.9±2.5 most likely ↑
2nd Half	63.0±9.1	65.7±9.8	57.8±11.4	63.0±10.2	4.2±3.0 possible ↑	9.8±4.0 very likely↑
Lateral displacements (time %)						
1st Half	50.7±14.2	40.6±13.1	33.4±8.6	36.9±11.8	-20.3±5.7 most likely ↓	7.9±5.7 possible ↑
2nd Half	38.1±11.7	35.7±12.5	30.6±9.1	33.9±10.8	-7.8±6.1 possible ↓	10.6±4.4 likely↑
Spatial Exploration Index (m)						
1st Half	17.9±1.3	15.4±1.2	14.9±1.4	15.2±1.3	-14.1±1.6 most likely ↓	2.1±5.9 unclear
2nd Half	15.0±1.0	15.7±1.4	15.4±1.8	15.6±1.1	4.5±4.2 likely ↑	1.3±5.1 unclear

Note: CL=confidence limits; ↑=increase; ↓=decrease; tri=trivial. Comparisons among age scenarios are identified as: (a) age group U15 vs mixed age groups, and (b) age group U17 vs mixed age groups.

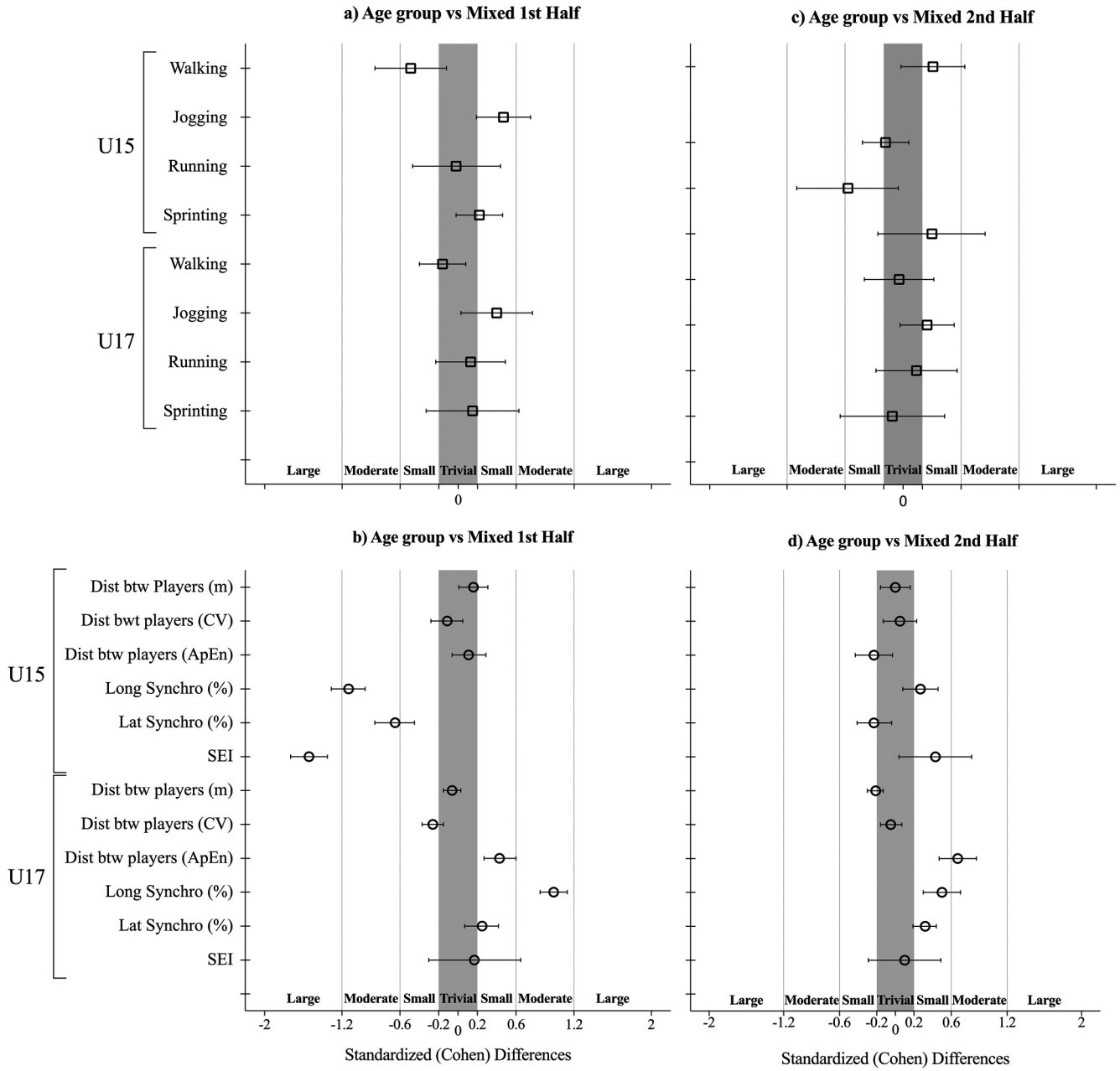

FIG. 2.

better dynamics of interpersonal coordination [28], probably reflected in a better decision-making process and pacing ability, allowing players to preserve their physical performance throughout the game [29]. Thus, these results suggest that mixing the age groups may be useful to promote a wide range of training session stimuli and should be considered as a tool to monitor the demands of young soccer players. However, the use of activity profiles based on physical and physiological variables can also be useful in balancing opposition and better understanding players' performance [6]. Hence, coaches can use this specific stimulus to promote a more representative pattern of competition demands.

The analysis of absolute distances between players showed that U15 players presented a tendency to increase the values in the mixed condition in the first half, while in the 2nd half the results were very likely trivial. The U17 players presented an inverse tendency, showing very likely trivial results in the first half and lower values of absolute distance between players in the mixed condition in the second half. The inter-player distance and the ball location are informational constraints that affect the functional collective behaviour [30]. The opposite results identified in U15 and 17 age groups can be explained by a better understanding of the overall intra-team synchronisation of the U17 players. The more effective results of this

age group may be explained by a better understanding of game logic, characterized by higher biological maturation as a result of the training process [31]. Conversely, the less exposure to competition and specific training exhibited by U15 players may help to explain the increased distances between players in the mixed condition in the first half. These results may be related to some difficulty to understand the importance of reducing the distances between team sectors and consequently failure to offer support to the ball carrier and provide numerical superiority [32].

The CV results showed similar tendencies in both age groups, between the two scenarios in the first half. In the second half, although likely trivially, U15 players increased the CV values when playing mixed with the different age group, in opposition to U17 players. Variability is a key characteristic of elite training sessions [33] and can be considered as necessary information to ensure functional adaptations and regulate the behaviour in dynamic environments [34, 35]. The lower values of variability presented by U15 players in the mixed condition in the first half probably result from a decrease in the exploratory behaviour, expressed in the decrease of SEI values, and therefore may represent a better understanding of the spatiotemporal information of that background players' behaviour [36]. In this sense, the lower ApEn values presented when playing with players of the same age in the first half, showing a more predictable behaviour, seem to be the result of a better interpretation of basic cooperative action with the usual teammates. Additionally, the U15 players' results for the distance between players when playing in the age group seem to be underpinned by a tendency of the youngest players to be closer to the ball [13], resulting in less exploration of the pitch. Thus, and probably due to collectively accumulated fatigue, U15 players showed similar absolute distances in both halves, also reflected in the variability of values presented in CV results. In this regard, the ApEn results may be linked with the physical stress imposed on players throughout the games, leading to a stabilization of collective behaviour through the display of more regular and predictable performances [37]. The U17 players, when playing in the mixed condition, showed a tendency to decrease the distance between the players, as well as an increase in ApEn in both halves, revealing less predictability in behaviour. In the U17 players, players are already adapted to the training characteristics and are entering the specialization period, showing a consolidated knowledge about tactical principles [8]. These results are in line with the previous research, which showed that U17 players exhibit improved performance reflected in better collective and tactical behaviour in comparison to younger players [38]. Thus, the higher exposure to competition and specific sport practice seems to help U17 players to better understand the organization and occupation of space, even if the specific constraints impose connections between new and unknown teammates [39, 40].

The intra-team movement synchronization was higher when U15 players played with players of the same age group, in the first half, and for U17 players when played mixed with different age groups, in both halves. These results seem to reflect the differences between the levels of U15 players and U17 players. The team dynamic positioning and distribution in space on the playing pitch are conditioned by the tactical know-how of the game [41]. However, the development of the basic tactical principles and technical skills should be manipulated according to the players' age group, consolidating the importance of long-term athlete development [42]. The U15 players' training focus is usually centred on technical skills and physical conditioning development [5], which may help to explain the lower values of players' longitudinal and lateral displacements, usually linked to a better interpretation of spatiotemporal information. Still, the higher results presented by the U15 player group when competing with each other seem to be in line with previous research suggesting that younger players tend to more often use longitudinal displacements to attain the goal [32]. The increase in the results presented by U15 players in longitudinal displacements in the second half may reflect a tendency to use a more direct style of play, usually linked to lower skilled players when playing against strong opposition [43]. According to a the primary aim of a soccer game, players should be capable of keeping the ball and moving around to look for free spaces, advancing in the pitch and seeking alternatives for scoring [44]. Lateral displacements appear to be linked to major destabilizations during the game [45] and possibly U17 players were more likely to respond appropriately, allowing them to improve anticipation of match situations in both halves.

The results for players' spatial exploration expressed in the SEI variable showed that U15 players explore larger spaces during the 1st half and in the age group condition. In the second half, U15 players explore the available space less and consequently decrease the exploratory behaviour, expressed in the decrease of SEI values. It is suggested that a wider dispersion in the field is a distinctive behaviour of older players and therefore those with better decision making performance even with less time or less space [46]. Thus, the performance shown by both age groups may be connected with a different level of tactical expertise and consequently more difficulties in readapting pitch positioning.

Therefore, these results suggest that mixing the age groups may be useful to promote a wide range of training session stimuli and should be considered from a coaching perspective as a tool to monitor and increase the demands of young footballers. In this sense, training and competing with different age groups may be an excellent way to increase the exposure to different stimuli and promote adaptations that can lead to more accelerated development.

CONCLUSIONS

In conclusion, the physical and tactical performance of players differed according to the age group. The results showed that playing in the mixed age groups condition increased the distance covered in sprinting intensity in U15 players and the distance covered in jogging zones by U17 players. The intra-team movement synchronization was higher when U15 players played with players of the same age

group, in the first half, and for U17 players when played mixed with different age groups, in both halves. From a practical point of view, coaches should be aware of the importance for young players to train and compete with different age groups, so as to increase the development at earlier stages. Thus, playing with different age groups can be an excellent tool for football coaches to simulate the physical, technical and tactical demands of the formal game.

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