Game Demands of Seven-A-Side Soccer in Young Players

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[1]*Physical Education Department, Faculty of Sports and Education Sciences, Campus of Melilla, University of Granada, Melilla, Spain;* [2]*Faculty of Physical Activity and Sport Sciences, Polytechnic University of Madrid, Madrid, Spain;* [3]*Sports and Physical Activity Faculty, European University of Madrid, Madrid, Spain;* [4]*Football Training and Biomechanics Laboratory, Italian Football Federation (FIGC), Technical Department, Coverciano (Florence), Italy;* [5]*School of Sport, Health and Exercise Science, Bangor University, Wales, United Kingdom; and* [6]*Physical Education Department, State University of Londrina, Londrina, Paraná, Brazil*

Abstract

Barbero-Alvarez, JC, Gómez-López, M, Castagna, C, Barbero-Alvarez, V, Romero, DV, Blanchfield, AW, and Nakamura, FY. Game demands of seven-a-side soccer in young players. *J Strength Cond Res* 31(7): 1771–1779, 2017—The aim of this study was to examine the activity patterns and physiological demands of 7-a-side youth soccer matches across 2 chronological age categories (U12 and U14). Twenty-two soccer players of a national youth soccer academy were investigated. Players of each age category performed 2 training matches (2 × 25 minutes) and were monitored by global positioning system and heart rate monitor units. Players of both categories covered similar total distance (5,348 ± 307 m), at similar mean heart rate values (86 ± 4% of maximum). However, the number of high-intensity runs (82.5 ± 17.4 vs. 69.7 ± 15.2) and total distance covered during sprints (264 ± 207 vs. 128 ± 74 m) were significantly ($p \leq 0.05$) higher in U14 compared with U12. The results suggest a highly demanding nature of 7-a-side soccer for skilled players, with physical maturity possibly influencing the match-related high-intensity performance at these ages.

Key Words youth soccer, time motion analysis, global positioning system, association football

Introduction

It is frequently questioned whether the practice of 11-a-side soccer is suitable for players of 14 years and younger (13). Indeed, it has been suggested that younger players regularly lose the ball and have a greater tendency to perform unsuccessful passes and shots during the course of a match (5). In addition, the general difficulty of the game and the inferior technical abilities of players in these age categories often create an imbalance between offensive and defensive competencies, therefore making it difficult to score goals.

To increase the effectiveness of practice, it has been proposed that reductions in the pitch size, the number of players per team, and the goal-frame dimensions would allow younger soccer players to execute a greater number of successful passes, shots, and tactical formations (5). With the aim to facilitate young soccer players' technical skills learning, Garganta and Pinto (22) proposed the use of games with simpler rules, fewer players, and smaller pitch dimensions. These changes aim to improve players' perception of the ball, spatial location of teammates and opponents, and their involvement with the ball, therefore increasing the number of scoring opportunities. This is partly supported by the observation that more passes and fewer tackles are performed in 7-a-side game than in 11-a-side game among prepubescent boys (13). This with the purpose to increase players' ball possession as a result of reduced team members (13,37).

From the cardiovascular fitness development perspective, small-sided games using fewer players (e.g., 3-a-side vs. 6-a-side) have a higher relative area per player (i.e., higher density) and may be more effective in inducing significantly (4%) greater cardiovascular responses (37). Indeed, the cardiovascular strain (i.e., heart rate [HR]) during selected small-sided soccer games was comparable with the response elicited by high-intensity interval running (36,37). Consequently, games played on smaller pitches and with fewer players have been effectively used by professional adult soccer players to improve aerobic and anaerobic fitness and to facilitate the concomitant development of technical skills and tactical awareness (23).

With the aim to extend the reported benefits of small-sided games to younger players, 7-a-side soccer has been introduced by national governing bodies. This with the purpose of prompting learning progression and enhancing physical abilities of young soccer players (33). It was assumed that the resulting increase in actions involving the

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ball would allow more shots on goal and therefore foster players' scoring opportunities. This positively affects young soccer players' skills and physical abilities development (28).

The physical activity patterns and physiological requirements of both adult and youth 11-a-side soccer have been extensively investigated (6,8,9,13,16,20,40). Although 7-a-side soccer is commonly practiced at an early age and is well regulated by the Royal Spanish Football Federation (33), there are currently few reports on the physical and physiological demands of this practice (13). Furthermore, these studies have not addressed the movement pattern of players in detail, thus limiting the understanding of 7-a-side game demands. Additionally, no information is available on the demands of 7-a-side games of young soccer players competing in different chronological ages, as considered by national developmental championships. This knowledge could help matching game characteristics to the needs and features of players at different developmental stages.

Therefore, the aim of this study was to examine the activity patterns and physiological demands of 7-a-side youth soccer matches across 2 chronological age categories. We hypothesized that 7-a-side soccer would elicit age-related demands with older players experiencing more high-intensity and sprint activities than their younger counterparts and that reduction in work rate would be detectable over the matches in both age categories.

Methods

Experimental Approach to the Problem

In this study, a naturalistic observation design was used to evaluate the external (i.e., match activities) and internal load (i.e., exercise HR) imposed to young soccer players during a 7-a-side match. To avoid the opponent-level effect on game demands, training matches were considered. In this regard, the activity pattern and HR of under 12 (U12) and under 14 years (U14) young soccer players were tracked during 7-a-side training matches. Match activities were represented as speed and accelerations at arbitrary absolute threshold to allow group comparisons. Furthermore, a novel variable was considered to estimate performance efficiency (i.e., performance efficiency index). The cardiovascular strain was examined using time spent in selected arbitrary HR zone.

Subjects

Twenty-two soccer players (age: 13.1 ± 0.6 years [range: 11.2–13.9 years]; height: 1.65 ± 5.1 m; body mass: 52.5 ± 25 kg) were randomly chosen among members of a national youth soccer academy (Football Federation of Madrid, Madrid, España). Players were participating in the U12 ($n = 11$) and U14 ($n = 11$) national championships at the time of the investigation and possessed at least 4 years of experience in soccer training and competitions.

Players trained 3 times a week (90 minutes per session), with a competitive match taking place during the weekend. Training sessions consisted mainly of technical and tactical skill development (80% of the training time). Physical conditioning was performed twice a week and aimed to anaerobic and aerobic performance development (4). Anaerobic training consisted of plyometrics and sprint training drills. Aerobic fitness was developed using small-sided games (37) and short or long interval running (23).

Two training matches (7-a-side) per age groups, with variables average considered for calculations, were performed during the last stage of the competitive season. Matches were played at the same hour of the day (16:30) on a regular size, artificial-grass soccer pitch with each half lasting 25 minutes (10-minute interval). Air temperature and relative humidity during the matches were 23.5 ± 0.5° C and 35 ± 10.5%, respectively. To avoid dehydration, ad libitum drinking was permitted to the players.

Written informed consent was received from all players and parents after verbal and written explanation of the experimental design and potential risks and benefit of the study. The local institutional review board approved the research design before the start of the study. All players were familiarized with the testing procedures used in this study through preinvestigation familiarization sessions.

Performance Analyses

Players' activity profile was assessed using global positioning system (GPS) technology. During training matches, players wore in integrated GPS, accelerometer, and HR monitoring device (SPI Elite; GPSports Systems, Canberra, Australia). The device was inserted in a purpose-built harness that enabled speed, distance, and HR to be recorded. The SPI Elite, GPSports device uses a 1 Hz GPS sampling rate. Speed was reported directly from the GPS sensor and proprietary software rules are applied to filter the data to improve accuracy in the GPS software (Team AMS v2015.3). Distance and acceleration were calculated from GPS-derived speed data. The software filtering reportedly improves accuracy by correcting speed data when the unit is in fact stationary (function of relative position inaccuracies) and correcting humanly impossible changes in speed. All the units were tested for accuracy before the start of the data acquisition having players covering a set distance (i.e., pitch perimeter) at a constant speed and sprinting over 30 m (7). In the week before the start of this study, the GPS devices were tested for operations in the same pitches of this study matches. Data analyses showed that for distance at different speed, the association with photo-cell gate time was in the range of that previously reported by validity reliability studies (7,19,27,35). Furthermore, they were similar to those from manufacturer specifications (±0.1 $m \cdot s^{-1}$ at constant speed). Absolute position accuracy of the GPS units was of 2.5 m with relative position accuracy of ±0.5 m.

Match activities were determined according to Castagna et al. (16):

- Standing (ST, speed from 0 to 0.4 $km \cdot h^{-1}$);
- Walking (W, speed from 0.4 to 3.0 $km \cdot h^{-1}$);

- Jogging (J, speed from 3.0 to 8.0 $km \cdot h^{-1}$);
- Medium-intensity running (MIR, speed from 8.0 to 13.0 $km \cdot h^{-1}$);
- High-intensity running (HIR, speed from 13.0 to 18.0 $km \cdot h^{-1}$);
- Sprinting (SPR, speed >18.0 $km \cdot h^{-1}$);
- High-intensity activity (HIA; HIR + SPR).

Peak game running speed over 1-second interval (i.e., the highest speed recorded during the game) was also collected individually.

Data for total distance covered was computed at 5-minute intervals. A game-fatigue index was also calculated based on the relative difference between total distances covered during the final 5-minute period of the game in comparison with the first 5 minutes.

The number of high-intensity accelerations (AC) was also calculated from GPS data using the manufacturer's software (Team AMS software V R1-2011-8, GPSports). It was assumed 1.5 $m \cdot s^{-2}$ as threshold value for AC. This value was purposely lower than the 2.78 $m \cdot s^{-2}$ used for elite Australian footballers (3), to account for the differences linked to age and developmental stage in sprinting performance (29,31). A previous investigation reported that most sprinting activities during a soccer game are "leading" and not "explosive" ones (20). This means that in soccer, sprinting is generally characterized by a gradual acceleration from an active condition (i.e., jogging, running, etc.). Therefore, adopting an excessively high threshold for intense accelerations would cause an underestimation of their occurrence during the match. During actual match-play, this study's players showed maximal accelerations in the range of 2.3 and 2.9 $m \cdot s^{-2}$. As consequence of that and due to the classification proposed by Osgnach et al. (32), we assumed 1.5 $m \cdot s^{-2}$ as an appropriate threshold for classifying AC in young soccer players.

Heart Rate

Heart rate was monitored with short-range telemetry every 1 second during the training matches (GPS Elite; GPSports). Data analyses were performed with dedicated software package (Team AMS software V R1-2011-8, GPSports).

The HR zones were as follows:

- from 0 to 60% maximal HR (HRmax),
- from 60 to 75% HRmax,
- from 75 to 85% HRmax,
- from 85 to 90% HRmax,
- from 90 to 95% HRmax, and
- from 95 to 100% HRmax.

Peak HR attained during the Yo-Yo intermittent recovery test (i.e., level 1) was considered to be the players' HRmax as per the Krustrup et al. (25) study. The Yo-Yo intermittent recovery test was performed during the week preceding this study data collection with player well rested and at least 2 day after a high-intensity training or match (25).

In this study, players' work-efficiency was evaluated using an individual efficiency index (Eff_{index}) derived by dividing the distance covered per minute (meters per minute) by the ratio between mean HR and HRmax (7). The value was then multiplied by 100, being expressed in arbitrary units (AU). Eff_{index} is highly correlated with several key on-field performance indices in professional players (unpublished data Barbero-Alvarez, PhD 10-2011). For instance, the correlation between Eff_{index} and distance covered at high-intensity (>14.4 $km \cdot h^{-1}$) was 0.74 in soccer players. The coefficient of variation (CVs) and the intraclass correlation coefficient (ICCs) for Eff_{index} were 1.2% (95% confidence interval [CI] = 0.9–1.6%) and 0.97 (95% CI = 0.89–0.99), respectively.

The ICC for the variables considered in this study for match activities ranged from 0.88 to 0.92 (CI = 0.80–0.96) and was assessed in a pilot study performed before data collection with a population of soccer players of similar age (12–14 years, $n = 18$).

Statistical Analyses

Data are reported as mean ± *SD* and 95% CI. Before using parametric tests, the distribution of each variable was examined with the Kolmogorov-Smirnov normality test. Homogeneity of variance was verified with a Levene's test. A 2-way analysis of variance (ANOVA) was applied to explore exact differences (i.e., match variables and HR zones) between age groups (U12 vs. U14). A repeated-measures ANOVA was also used to test distance, peak speed, HR, and Eff_{index} changes in 5 minutes of intervals during the game. A preplanned approach was used to limit chance in incurring in type I errors. The Bonferroni-Holm correction for multiple comparisons was used. Effect size (Cohen's *d*) was reported for each significant variable to assess the magnitude of the observed difference. Performance differences between the first and second half were analyzed using paired t-tests. All analyses were performed with SPSS 19.0 (SPSS Inc., Chicago, IL) software with the level of significance set at $p \leq 0.05$.

Results

During the match, players covered a total distance (TD) of 5,348 ± 307 m (95% CI = 5,208.5–5,488.3 m; range: 4,899–5,959 m), of which 693 ± 152 m (95% CI = 624–763 m; range: 452–1,032 m) were covered at HIR and 193 ± 164 m (95% CI = 110–220 m; range: 19–714 m) in the SPR category, representing 12.9 ± 2.3% and 3.5 ± 2.8% of TD. The distances covered in the MIR, J, and W categories were 1,499 ± 241 m (95% CI = 1,390–1,609 m; range: 1,148–1,910 m), 2,541 ± 156 m (95% CI = 2,470–2,612 m; range: 2,195–2,741 m), and 403 ± 60 m (95% CI = 376–430 m; range: 294–544 m), respectively. Players covered on average 107 ± 6 $m \cdot min^{-1}$ (95% CI = 105–110 $m \cdot min^{-1}$; range: 98–119 $m \cdot min^{-1}$), of which 16.4 ± 4.5% (95% CI = 14.4–18.5%; range: 9.2–27.3%) were at HIA. Peak player running speed during match-play was 23.2 ± 2.2 $km \cdot h^{-1}$ (95% CI = 22.2–24.2 $km \cdot h^{-1}$; range: 20.4–29.1 $km \cdot h^{-1}$).

No significant differences between age groups (U12 vs. U14) were found for TD, ST, W, J, MIR, and HIR ($p >$ 0.05), but the distances covered at SPR (128.1 ± 74.3 m

Table 1. Number, duration, and distance for high-intensity, sprint, and accelerations activities.*

	Number	Range	Duration (s)	Time between bouts (s)	Mean distance (m)	Total distance (m)
U12 SPR	12.5 ± 5.8	4–22	1.8 ± 0.4	162 ± 42	10.3 ± 2.6	128 ± 74
U14 SPR	20.9 ± 12.9	9–46	2.2 ± 0.2†	144 ± 66	12.7 ± 1.7‡	264 ± 207‡
U12 HIR	69.7 ± 15.2	52–109	2.5 ± 0.3	42 ± 6	11.1 ± 1.8	773 ± 182.9
U14 HIR	82.5 ± 17.4‡	65–114	2.7 ± 0.2	36 ± 6	12.3 ± 1.5	1,011 ± 333‡
U12 AC	124.2 ± 20.8	92–160	5.1 ± 0.2	23.9 ± 6	15 ± 1	1,862 ± 331
U14 AC	132.5 ± 19.7	93–163	5.1 ± 0.2	24 ± 6	15.4 ± 1.1	2,045 ± 390

*U12 = under 12 years; U14 = under 14 years; SPR = sprinting; HIR = high-intensity running; AC = high-intensity accelerations.
†$p = 0.02$.
‡$p > 0.05$.

–95% CI = 78–178 m; range: 19–236 m vs. 264.5 ± 206.9 m –95% CI = 120–590 m; range: 110–714 m) and HIA (773 ± 182.9 m–95% CI = 650–896 m; range: 471–1,189 m vs. 1,011 ± 333 m–95% CI = 773–1,249 m; range: 724–1,596 m) were significantly longer for U14 ($p = 0.041$; $d = 0.88$ and $p = 0.032$; $d = 0.88$, respectively).

The number, duration, time interval between bouts, average, and total distances covered in the AC, SPR, and HIR categories during the match are reported in Table 1.

The number of HIR was significantly ($p = 0.04$; $d = 0.78$) higher in U14 compared with U12 (82.5 ± 17.4 vs. 69.7 ± 15.2), whereas no significant differences were found for the number of SPR and AC ($p = 0.066$ and $p = 0.36$, respectively). However, total distance covered during SPR and mean sprint time and distance were significantly higher in U14 ($p = 0.041$; $d = 0.88$, $p = 0.014$; $d = 1.3$ and $p = 0.018$; $d = 1.1$, respectively), although no significant differences ($p = 0.24$) were found for peak running speed between age groups (22.7 ± 1.7 $km \cdot h^{-1}$–95% CI = 21.5–23.8 $km \cdot h^{-1}$; range: 20.4–25 $km \cdot h^{-1}$ vs. 23.8 ± 2.5 $km \cdot h^{-1}$–95% CI = 22–25.6 $km \cdot h^{-1}$; range: 20.4–29.1 $km \cdot h^{-1}$).

During the match, players maintained an average 86 ± 4% (95% CI = 85–88%; range: 74–90%) of their HRmax and spent 57.4 ± 20.6% of the playing time at exercise intensities higher than 85% of HRmax. No between-group difference was detected in time spent at each HR zone ($p > 0.05$) (Figure 1).

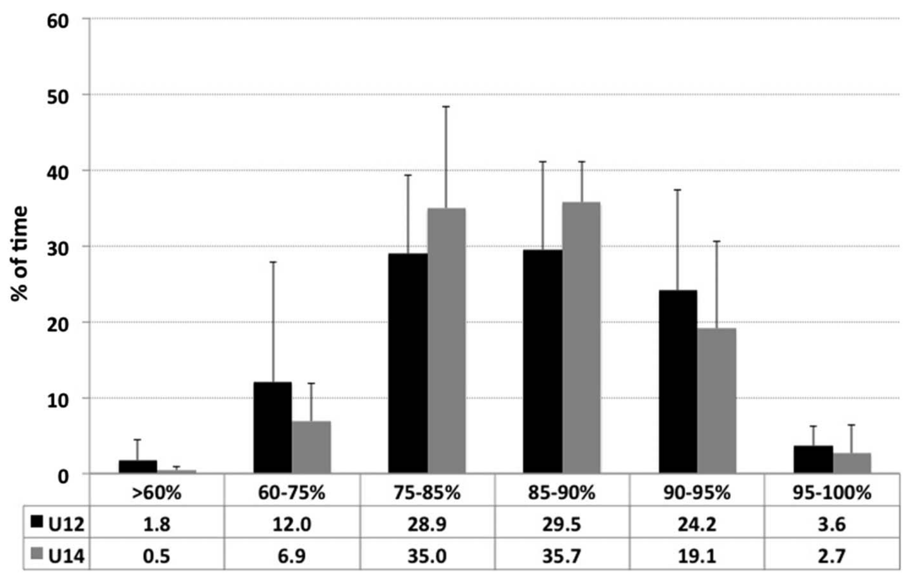
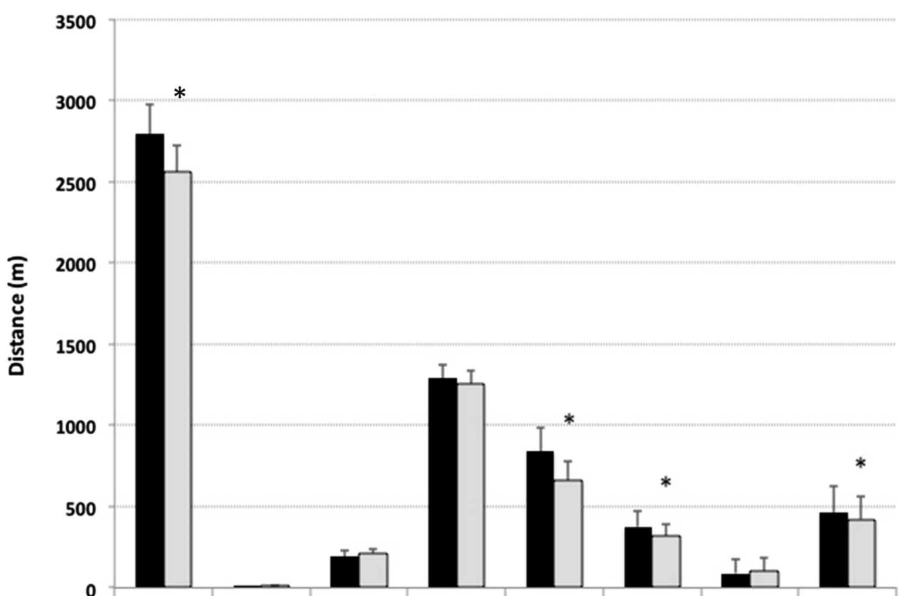


Figure 1. Percentage of game time spent in selected heart rate intensity zones (mean and *SD*). U12 = under 12 years; U14 = under 14 years.



	TD	Standing	Walking	Jogging	MIR	HIR	SPR	HIA
■ 1st Half	2790.8	5.5	189.4	1287.2	841.0	375.5	89.1	464.6
□ 2nd Half	2557.6	7.8	213.3	1253.8	658.2	317.7	103.9	421.6

Figure 2. Total distance and distance covered in different match activities (mean ± *SD*). U12 = under 12 years; U14 = under 14 years; TD = total distance; MIR = medium-intensity running; HIR = high-intensity running; SPR = sprinting; HIA = high-intensity activity.

The pooled Eff_{index} was 124.3 ± 9 AU (95% CI = 120.2–128.4 AU; range: 112–142.4 AU). No significant differences were found for %HRmax and Eff_{index} ($p > 0.05$) between age groups.

First vs. Second Half

The players ($n = 22$; U14 and U12 pooled data) covered more distance ($p < 0.0001$, −233.2 m–95% CI = −308.1 to −158.4 m, $d = 1.34$) during the first half compared with the second. The distance at HIA decreased significantly during the second half ($p = 0.04$, −43 m–95% CI = −85.5 to −0.4 m, $d = 0.29$). Total distance and distance in different match activities during the first and second half of the match are reported in Figure 2.

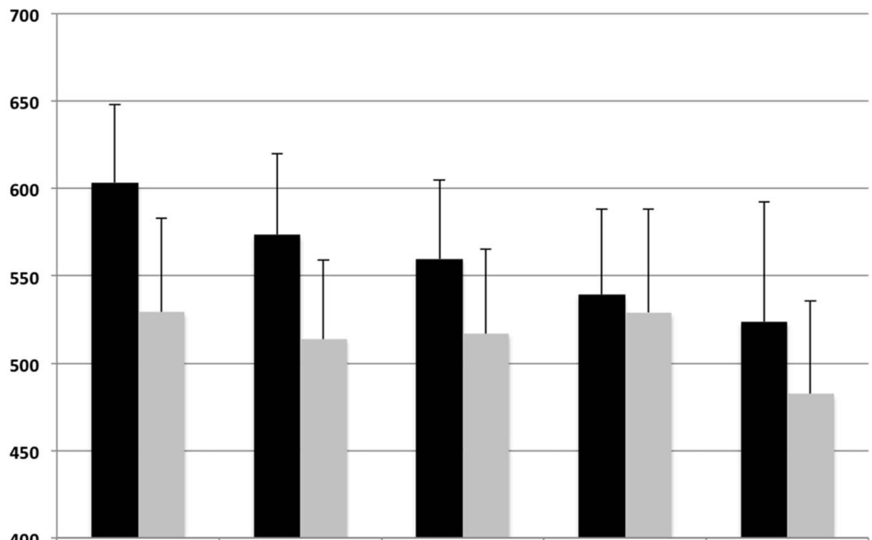
No significant differences were found between halves for J and SPR ($p = 0.052$; 95% CI = −67.3 to 0.3 m; $d = 0.39$ and $p = 0.088$; 95% CI = −2.4 to 31.9 m; $d = 0.18$). Walking significantly increased during the second half ($p = 0.005$, 23.9 m–95% CI = 7.9–39.9 m, $d = 0.69$). The distance covered in the MIR and HIR categories decreased significantly during the second half ($p = 0.000$, −182.9 m–95% CI = −236.2 to −129.5 m, $d = 1.37$ and $p = 0.003$, −57.7 m–95% CI = −92.8 to −22.6 m, $d = 0.67$).

The number of HIR decreased (42.4 ± 11.2 vs. 33.4 ± 11.4) significantly ($p < 0.0001$; −9.1–95% CI = −12.8 to −5.3; $d =$ 0.94) during the second half, but duration (2.5 ± 0.3 seconds vs. 2.8 ± 0.4 seconds) and distance (10.8 ± 1.6 m vs. 12.2 ± 2.3 m) of HIR significantly increased ($p = 0.003$; $d = 0.85$ and $d = 0.7$, respectively). Nevertheless, no significant differences were found for the number, duration, or mean distance of SPR between halves. In addition, the number of accelerations decreased (70.5 ± 10.9 vs. 57.7 ± 8.1) significantly ($p = 0.0001$; −12.8–95% CI = −17.4 to −8.3; $d = 0.47$), during second half.

When analyzing the match data in shorter but equal time segments (5-minute), we observed that longer distance was covered during the first two 5-minute period of the first half (603.4 ± 44.9 m–95% CI = 575.4–636.4 m; range: 506.6–673.4 m and 573.4 ± 49 m–95% CI = 517–561.5 m; range: 470.6–627.1 m). The distance covered during the first 5-minute of the game was significantly ($p \leq 0.05$) longer than the distances covered during the third to 10th 5-minute periods.

The distance covered in the final 5 minutes of the game (482.4 ± 53.5 m–95% CI = 458–506.8 m; range: 396.3–588.9 m) was lower ($p < 0.01$) by 20.2, 16.1, and 14% compared with the first three 5-minute periods, respectively. Therefore, the game-fatigue index expressed as the relative decrease in total distance covered between the first and the last 5 minutes of a game was 20.2% (Figure 3).

Peak sprinting speed was significantly higher in the first half (i.e., 5–10 minutes; 21.1 ± 2.8 $km \cdot h^{-1}$–95% CI = 19.8–22.3 $km \cdot h^{-1}$; range: 15.6–26.5 $km \cdot h^{-1}$) than in the last three 5-minute periods of the match ($p = 0.031$; 95% CI = −3 to −1.6 m; $d = 0.61$ $p = 0.05$; 95% CI = −2.7 to 0 m; $d = 0.5$ and $p = 0.003$; 95% CI = −3.5 to −0.9 m; $d = 0.8$), respectively.



	5 min	10 min	15 min	20 min	25 min
1st Half	603,4	573,4	559,7	539,3	523,8
2nd Half	529,2	513,8	516,9	529,1	482,4

Figure 3. Distance covered in 5-minute intervals for under 12 years and under 12 years players (mean ± *SD*).

Peak sprinting speed during the last 5-minute period of the second half (18.9 ± 2.4 $km \cdot h^{-1}$–95% CI = 17.9–19.9 $km \cdot h^{-1}$; range: 14.6–23.5 $km \cdot h^{-1}$) was significantly lower ($p < 0.01$; $d = 0.5$–0.9) than the first 20 minutes of the first period and the first 10-minute period of the second half, respectively ($p > 0.01$; $d = 0.81$ and $p > 0.05$; $d = 0.48$).

During both the first and second half, players maintained 86 ± 4% (95% CI = 85.2–88.6; range: 76–91%) and 86 ± 3% of HRmax (95% CI = 85.5–88.4; range: 77–91%), respectively ($p = 0.98$, 95% CI = −1.7 to 1.7%, $d = 0.0$). No significant differences ($p > 0.05$) were found for time spent with HR above 85% of HRmax between halves. The Eff_{index} was significantly higher during the first half (129 ± 8.4 vs. 118 ± 8.1 AU; $p < 0.0001$, 95% CI = −14.1 to −8, $d = 1.33$) compared with the second half.

Discussion

This is the first study to address in detail the match performance and cardiovascular stress of a 7-a-side game across 2 age categories. Results showed that work rate in 7-a-side soccer matches performed by U12 and U14 players is very high and similar to those reported in adult 11-a-side soccer (39). This can be inferred from average match running speed, involvement with HIAs, and mean match HR throughout the match.

Interestingly, as in top and elite level adult soccer (11 vs. 11), the 7-a-side paradigm showed a progressive decrement of work rate across the match duration, suggesting the onset of match-related fatigue (30). Alternatively, it may reflect the pacing strategy typical of soccer games. Indeed, in this study, a significant decrement of those activities performed at high-intensity in the last stages of the match was evident. Additionally, 7-a-side was shown to be age dependent with U14 players able to producing more HIA and SPR than U12 players, despite similar peak running speed.

The total match distance covered during (i.e., 2 × 25 minutes) 7-a-side soccer (U14 and U12 pooled data) was 5,348 ± 307 m, and the resulting average speed (107.2 ± 6.0 $m \cdot min^{-1}$) was similar to those reported in U14 (105.5 $m \cdot min^{-1}$) players during 11-a-side (i.e., 2 × 35 minutes) soccer (11). This was also apparently higher than the average speed reported in our previous study with 14-year-old players playing 11-a-side during a national level tournament using the same technology (95 ± 13 $m \cdot min^{-1}$) (8). Therefore, results suggest that smaller soccer formats with shorter halves can place higher demand on the players' cardiovascular and metabolic anaerobic systems compared with traditional 11-a-side games. However, it is our opinion that the comparison between partitioned distances covered within specific locomotor categories is more informative about the actual match demands than comparing average speed. It is particularly important to characterize HIA because it was previously shown that distances covered at HIA are the most suitable measures of physical performance in both youth and adult soccer due its power to discriminate between playing positions and teams at different competitive levels (15,30).

Despite differences in the pitch dimension and the number of players per team, pooled data (U12 and U14) indicate that the percentage of the match in HIA (16.4 ± 4.6%) in 7-a-side soccer is similar to the values reported by Castagna et al. (17) (15.9 ± 5.8%) and Barbero-Álvarez et al. (6) (14.9 ± 4.5%) for age-matched players during 11-a-side soccer. On adapting the speed thresholds and movement categories to permit comparison with this study, the data published by Buchheit et al. (11) revealed HIA ranging between 12.7 and 21.1% in highly trained U13 and U14 players. Because HIA for both age groups investigated here during 7-a-side soccer were within the values recorded in the literature for 11-a-side soccer, this is the first study to demonstrate consistency between the relative distances covered at HIA across different soccer game adaptations. Unfortunately, comparisons with elite-level adult soccer players' data (8,9) are not feasible, as the speed thresholds are to some extent arbitrary and not defined by accepted physiological markers, such as ventilatory thresholds (1), which can track growth and maturation along with training effects on physical performance. Youth and adult soccer activities are therefore still not commensurate.

As hypothesized, there was a significant difference in the percentage of total distance covered in the HIR and SPR categories between U12 and U14 groups of players. This difference may be explained by the fact that explosive strength, running speed, and cardiorespiratory endurance show peaks of development at peak height velocity (31,34), which occurs around 13.8 years of age in soccer players (34). Therefore, the better ability of older players to deal with HIA may be attributed to the growth-related changes in the muscular and circulatory systems, probably combined with additional years of training. However, no significant differences between groups were found for the peak running speed during match-play in this study. It should be emphasized that this value is not necessarily the same as that could be found in standardized straight-line sprinting tests (35).

It was recently suggested that soccer involves relatively few repeated-sprint sequences throughout the match (12). Recently, Barbero-Álvarez et al. (6) showed a total of 10.1 ± 3.6 sprints of short duration (2.2 ± 0.5 seconds) in 14-year-old players playing one 35-minute half. Interestingly, in this study, 7-a-side soccer has been demonstrated to induce more sprinting activity, especially in U14 (20.9 ± 12.9), but this is partly explained by the longer period played. This finding suggests that this soccer format can elicit substantial involvement in near maximal or maximal match speed activities, with a peak speed of 23.7 ± 2.8 $km \cdot h^{-1}$, which is comparable with 11-a-side soccer (22.9 ± 2.9 $km \cdot h^{-1}$) (8).

The large accelerations impose high energetic and mechanical demands on the players and are decisive for gaining advantage over the opponents to permit ball possession or create space to receive the ball (32,38). In this study, the number of accelerations, defined as change in velocity $>1.5\ m \cdot s^{-2}$, was 124.2 ± 20.8 and 132.5 ± 20.8 for U12 and U14, respectively. This may suggest that multiple accelerations take place within each minute of match-play, suggesting that soccer can be characterized as a repeated acceleration activity. Therefore, coaches and physical trainers should aim to improve the ability of players to repeat several accelerations with short recovery intervals and not only the ability to repeat sprints (10,21). Future studies should determine whether the ability to repeat accelerations is able to discriminate between different levels of soccer players and also its sensitivity to training interventions.

In both age groups, the total distance covered during the second half was less than that of the first half. Furthermore, total distance when partitioned into 5-minute segments was also reduced during the matches. These findings are consistent with data reported from adult players (30,37), and therefore suggest that during 7-a-side soccer, young players experience temporary and cumulative fatigue, leading to a progressive reduction in work rate (26). Temporary fatigue is principally a consequence of high involvement during the first half (26). For instance, Rampinini et al. (36) have shown that professional players covering total distances in the first half below the median value of the investigated sample did not experience any reductions in distance covered during the second half. In contrast, players working at higher intensity (above the median value) in the first half decreased their physical performance in the second half. This implies that to increase game tempo during the second half, coaches and physical trainers may make use of substitutions more frequently and improve fitness level of the players (17).

Interestingly, the number of HIR and accelerations was lower in the second half compared with the first half. This is consistent with findings in adult elite soccer (9,14,30) and Australian Football (3), showing that fatigue impairs not only total distance covered but also the ability of athletes to achieve frequently high running speed and changes in velocity. In this study, peak sprinting speed was reduced in the final 15-minute interval, indicating that the ability to develop peak power could also be impaired toward the end of a game.

This is critical for soccer players, since the level of performance and the engagement in key elements of the game, such as tackles and space creation (3), are highly dependent on the ability to repeat HIA and near maximal or maximal accelerations. It is therefore advisable for coaches involved in 7-a-side soccer to make full use of substitutions or to consider unlimited substitutions (i.e., providing rule changes) to avoid decrements in physical and technical-tactical performance and to avoid injuries.

Heart rate is considered one of the most practical measures of cardiovascular demand undertaken by athletes during training and competition (2). The players in this study maintained approximately 86% of HRmax throughout each match. This is highly consistent with 11-a-side youth soccer (17,18), suggesting that a 7-a-side format is extremely demanding from a cardiovascular standpoint. The reduction in Eff_{index} during the second half suggests that for the same cardiovascular stress level, match work-rate was impaired. This index confirms that fatigue ensues during soccer practice, even in shorter matches with fewer players per team.

In light of this study findings, we may conclude that 7-a-side youth soccer should be considered as a demanding exercise mode that is able to impose physical loads that are comparable or even higher to those of 11-a-side soccer (39). The marked decrement of HIAs during the second half suggests that substitutions might be strategically used by the coaches to maintain a high level of physical performance during the final stages of the match. Finally, the age effect on match demands indicates that physical maturity can influence the match-related high-intensity performance at these ages. Due to the interest of this issue, further studies are warranted.

Practical Applications

The main finding of this study was that 7-a-side young soccer induced a pattern of fatigue across halves, which is similar to that reported in adult soccer. Fatigue during soccer is believed to be related to individual fitness level in young soccer players (17,18) and to impact negatively on short passing ability as a function of match progression (24) in adolescents. In recognition of this, a revision of the number of substitutions permitted (enlarged or unlimited) or the match duration should be considered. This is to facilitate the development of the technical, tactical, and physical abilities of 7-a-side youth soccer players through higher cardiovascular intensity. In light of this study findings, the ability to repeat HIAs involving high accelerations with short recovery intervals should be considered as an important part of the physical training programs in youth soccer. In addition, it is strongly suggested to monitor young players' activities using GPS and HR to quantify muscular and cardiovascular stress in different soccer formats. Despite the practical interest of this study findings, gaining more evidence regarding activities pattern of young players are still needed. This explors the effect of maturation on physical and technical skills on male and female players of different competitive levels.

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