MATCH RUNNING PERFORMANCE AND PHYSICAL CAPACITY PROFILES OF U8 AND U10 SOCCER PLAYERS

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ABSTRACT

PURPOSE. This study aimed to quantify the match running performances and physical capacities of very young soccer players. Data collected during competitive matches were also correlated with physical capacities and technical skills.

METHODS. Distances covered at different speed thresholds were measured during 31 official matches using GPS technology in U10 (*n*=12; age 10.1±0.1 yr) and U8 (*n*=15; age 7.9±0.1 yr) national soccer players. Counter movement jump performance (CMJ), 20 m shuttle running (20m-SR), linear sprint performance (10, 20, 30 m), shuttle (SHD) and slalom dribble tests (SLD) were performed to determine the players physical capacities and technical skills.

RESULTS. Physical capacities and technical skills were higher in U10 versus U8 players ($p<0.05$, Effect Size [ES]: 0.99-2.37), with less pronounced differences for 10 m sprint performance ($p>0.05$, ES: 0.74). The U10 players covered more total (TD) and high-intensity (HIRD) distance than their younger counterparts ($p<0.05$, ES: 3.07-1.73). HIRD, expressed as percentage of TD, produced less pronounced differences between groups ($p>0.05$, ES: 0.99). TD and HIRD covered across the three 15 min periods of match-play did not decline ($p>0.05$, ES: 0.02-0.55). Very large magnitude correlations were observed between the U8 and U10 players performances during the 20m-SR versus TD ($r=0.79$; $P<0.01$) and HIRD ($r=0.82$; $P<0.01$) covered during match-play.

CONCLUSIONS. Data demonstrate differences in match running performance and physical capacity between U8 and U10 players and large magnitude relationships between match-play measures and physical test performances.

KEYWORDS

Match analysis, GPS, children, football, high-intensity running.

INTRODUCTION

The most common method to quantify the physical demands during training or match-play in team sports (e. g. soccer, rugby, cricket, Australian football) is to determine the distance covered or the time spent at different speeds (Bradley et al., 2009; Mohr et al., 2003). Although this method does not take into account metabolically taxing activities such as accelerations and multi-directional movement (Aughey & Varley, 2013) it does provide an indirect measure of energy expenditure. As such numerous studies have included this approach to examine the physical demands of match-play across tiers and competitive standards (Bradley et al., 2013, 2015; Di Salvo et al., 2013; Mohr et al., 2003), positions (Bush et al., 2015), environments (Mohr et al., 2010), surfaces (Andersson et al., 2008) and phases of the season (Rampinini et al., 2007). Particular attention has focussed on the relationship between match running performance and physical capacity (Bradley et al., 2011, 2013; Krustrup et al., 2003, 2005) to highlight how variance is shared between measures.

Match analysis research has extensively studied elite senior male players of sub-elite to elite competitive standard (Bangsbo et al., 1991; Mohr et al., 2003; Reilly & Thomas, 1976). As for youth players, most information is available for players between 12-17 yr of age (Buchheit et al., 2010; Castagna et al., 2009; Castagna et al., 2010; Harley et al., 2010; Rebelo et al., 2014) with scant research coverage of very young players. It appears that the total and high-intensity running distance covered during matches is greater in older players than their younger counterparts but this difference becomes trivial when data are adjusted for actual playing time (Buchheit et al., 2010) or analysed with age-specific speed thresholds (Harley et al., 2010). As for very young players (<11 yr of age), data describing the activity profile during match play are limited and thus a less clear picture is evident of the movement demands of these developing players. Capranica et al. (2001) compared the activity profiles of young players during matches (11 vs 11 and 7 vs 7) on a regular (100 × 65 m) and small sized pitch (60 × 40 m), respectively. This study demonstrated that running comprised of a higher proportion of game time than walking in both conditions (55 vs 38%) but no information was provided on the distances covered during games in various speed thresholds.

Similarly, Randers et al. (2014) found that the total distance covered by young players was unchanged between matches (5 vs 5 and 8 vs 8) played on a 30 × 40 m and 53 × 68 m sized pitch, respectively. This trend was further confirmed by Goto et al. (2015) whereby U9 and U10 age groups covered a total distance of ~4000 m and a high-intensity running distance of ~600 m during a match. Although a similar trend was evident in all the above studies, no study has been published on U8 populations. Thus, this study aimed to quantify the match running performances and physical capacities of very young soccer players during official games of the Federazione Italiana Giuoco Calcio (FIGC). To achieve this Global Positioning System (GPS) technology was used as the validity and accuracy of this type of technology have been extensively investigated in a multitude of team sports (Aughey, 2011; Coutts & Duffield, 2010; Gray et al., 2010; Rampinini et al., 2015).

METHODS

Youth Players

Twelve U10 and fifteen U8 Italian national team youth soccer players were recruited for this study. Mean age, stature, and body mass in U10 and U8 players were 10.1±0.1 and 7.9±0.1 yr, 1.41±0.01 and 1.33±0.01 m and 34.1±0.9 and 29.1±1.2 kg, respectively. The mean peak height velocity (PHV) indirectly estimated by the leg length (Sherar et al., 2005) was -3.1±0.1 and -4.6±0.1 yr in U10 and U8 players, respectively. Players trained approximately 4 hr per week and partook in 1 or 2 match per week. The players and their parents were fully informed of any risks associated with the experiments before giving their written consent to participate to the study. The study was approved by the appropriate institutional ethics committee with all procedures adhering to the Declaration of Helsinki (2000) of the World Medical Association.

Experimental Design

Each player completed the battery of field tests to determine individual physical capacity and technical skills the week before the first match observations. Match data were collected across an eight-week period and data were only analysed if the player completed the entire game. All matches were played in accordance with the rules outlined by the FIGC.

Physical Capacity and Technical Skill Tests

Players underwent: counter movement jump performance (CMJ), 20 m shuttle running (20m-SR), linear sprint performance (10, 20, 30 m), shuttle (SHDT) and slalom dribble tests (SLDT) (Markovic et al., 2004; Cooper et al., 2005; Mahar et al., 2011; Huijgen et al., 2010). Each test was conducted on a different day for each age group with at least 24 h of recovery. The players were instructed and verbally encouraged to give a maximal effort during every testing session.

Players performed three CMJ keeping their hands on the hips during the jump to prevent any influence of arm movements (Chaouachi et al., 2009) and the best jump was classed as the criterion measure. Jump height was estimated from flight time using a photocell mat (Optojump, Microgate, Italy) connected to a portable computer. A photocell system (Microgate, Italy) was used to record times at 10, 20 and 30 m. Each test was performed three times with 2-3 min recovery and the best performance was recorded. During the 20 m sprint test an additional photocell was positioned at 10 m in order to obtain a flying-10m (FL10m) sprint time (Harley et al., 2010). In 20m-SR players were instructed to run back and forth between two cones placed 20 m apart from each other at a increasing speed controlled by audio bleeps from a CD player. According to Mahar et al. (2011), this test was interrupted when a player failed twice to reach the appropriate marker or the player felt unable to complete another shuttle at the required speed. The total distance covered during the test was recorded as the test result. Technical skills were examined in the SHDT and SLDT tests which were both performed over a 30 m distance (Leemink et al., 2004). SHDT consisted of maximal sprints while dribbling a ball with three 180° turns. SLDT consisted of maximal sprints while dribbling a ball between twelve cones placed in a zigzag pattern. Timing data were measured using photocells system and the fastest of the three trials was recorded (Leemink et al., 2004).

Match Running Performance

Distances covered at different speed thresholds were measured during 31 official matches using GPS technology in U10 (58 observations) and U8 (61 observations). Only players completing the entire match were considered for further analyses with 62 observations excluded for this reason. The duration of each period was the same in U10 and U8 games (3 × 15 min) but the pitch dimensions (60 × 40 m and 45 × 25 m, respectively) and the number of players (7 vs 7 and 5 vs 5) were different for U10 and U8. A rolling substitute policy, whereby each individual player can interchange with any substitute an unlimited number of times during the match was adopted according to the rules of the FIGC. During matches, players wore a portable GPS device (K-Gps 10 Hz, K-Sport, Italy) positioned on the upper back in a custom-made vest. The mean number of satellites connected during the match was 9.5±1.8. The recorded data was exported using specific software (K-Fitness, K-Sport, Italy) and subsequently combined in a customised spreadsheet for analysis. According to Saibene & Minetti (2003), thresholds between walking and jogging were estimated using the equation:

$$v = \sqrt{(Fr \cdot g \cdot L)} \quad \text{(Eq. 1).}$$

Where v is the speed of progression ($m \cdot s^{-1}$), Fr is Froude number, g is acceleration due to gravity (9.81 $m \cdot s^{-2}$ on Earth) and L is leg length, in m. An Fr of 0.5 was utilized since it has been shown corresponding to the spontaneous transition speed between walking and running. The other speed thresholds were established according to Harley et al. (2010) using the mean peak speed of FL10m in each group ($v_{peak}Grp$). This velocity was compared relative to the corresponding value reported in elite senior players ($v_{peak}Snr$). The [$v_{peak}Grp \cdot v_{peak}Snr^{-1}$] ratio was then applied to the commonly used thresholds for senior players by Bradley et al (2009) to produce group specific speed zones.

The speed thresholds for various activities for U10 and U8 were: 1) walking (<6.7 and <6.3 $km \cdot h^{-1}$, respectively); 2) jogging (6.8-9.6 and 6.4-8.4 $km \cdot h^{-1}$, respectively); 3) running (9.7-13.2 and 8.5-11.5 $km \cdot h^{-1}$, respectively); 4) high-speed running (13.3-18.2 and 11.6-17.3 $km \cdot h^{-1}$, respectively) and 5) sprinting (≥18.2 and ≥17.3 $km \cdot h^{-1}$, respectively; Table 1). Total distance (TD) was the sum of the distances covered in each of above speed thresholds. High-intensity running distance (HIRD) was the summation of running, high-speed running, and sprinting distances.

Statistical Analysis

Data were expressed as mean ± SD. Differences between groups were determined using a unpaired *t*-test while a one-way analysis of variance (ANOVA) with repeated measures was used to determine differences between distances covered in the first, second, and third match periods. Tukey's post-hoc test was used to verify localised effects. Statistical significance was set at $p<0.05$. All analyses were performed using statistical software package (Prism 6.0; GraphPad, San Diego, CA, USA). Effect sizes (ES) were calculated to determine the meaningfulness of the difference with the magnitudes classified as trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2) and large (>1.2) (Batterham & Hopkins, 2006). Relationships between the distances covered (TD and HIRD) and physical and technical variables were evaluated using Pearson's product moment test. For this analysis only, the players (n=12 for U8 and n=10 for U10) that completed at least 3 matches were considered. The magnitudes of the correlations were considered as trivial (<0.1), small (0.1-0.3), moderate (0.3-0.5), large (0.5-0.7), very large (0.7-0.9), nearly perfect (>0.9) and perfect (1.0) in accordance with Hopkins et al. (2009).

RESULTS

Physical Capacity and Technical Skill Tests

CMJ performance was greater in U10 than U8 players (0.23±0.03 vs 0.21±0.03 m, $p<0.05$, ES: 0.99). Sprinting performances across 20 m (4.15±0.17 vs 4.38±0.027 s, $p<0.05$, ES: 1.27) and 30 m (5.72±0.22 vs 6.31±0.31 s, $p<0.05$, ES: 2.37) were faster in addition to FL10m (1.66±0.07 vs 1.75±0.11 s, $p<0.05$, ES: 1.27). Less pronounced differences were evident between U8 and U10 players for sprints across 10 m ($p>0.05$, ES: 0.74). U10 players had a 40% higher 20m-SR test performance than U8 players (1215±77 vs 872±78 m, $p<0.01$, ES: 1.60) Similarly, SHDT

(10.66±0.57 vs 11.80±0.83 s, $p<0.01$, ES: 1.77) and SLDT performances (22.34±1.28 vs 29.41±2.72 s, $p<0.01$, ES: 4.50) were better in U10 than U8 players.

Match Running Performance

U10 players covered 34% more total distance than their U8 counterparts (3541±511 m *vs* 2229±331 m; $p<0.01$, ES: 3.07, Figure 1). The differences between U10 and U8 players were evident in walking (16%), jogging (60%), running (50%), high-speed running (34%) and sprinting (70%) ($p<0.01$, ES: 0.97-3.13, Figure 2a). HIRD was also found to be greater in U10 than U8 players (1503±391 vs 836±279 m, $p<0.01$, ES: 1.73). When data were expressed in percentages of TD, differences between U10 and U8 players were observed for walking (36±7 vs 49±7%), jogging (22±4 vs 14±2%), running (24±4 vs 20±4%) and sprinting (2±1 vs 1±1%, $p<0.01$, ES: 1.12-2.33, Figure 2b). Less pronounced differences were evident for HIRD between U10 and U8 (42±6 vs 38±8%, $p>0.05$, ES: 0.99). During each of the three periods, TD (1244±202, 1154±196, 1142±189 m and 759±135, 733±148, 735±128 m in U10 and U8, respectively) and HIRD (552±192, 485±136, 466±126 m and 291±130, 263±105, 283±98 m in U10 and U8, respectively) were unchanged ($p>0.05$, ES: 0.02-0.55, Figure 3). Overall, very large magnitude correlations were observed between the U8 and U10 players 20m-SR performances versus TD (r=0.79; $P<0.01$) and HIRD (r=0.82; $P<0.01$) (Figure 4a and 4b). No relationships were found between match running performance and any other physical or technical test results.

DISCUSSION

This is the first study to quantify the match running performance and physical capacities of very young Italian soccer players. These findings will contribute greatly to our understanding of the demands placed on very young players and this work could be useful to sports science staff working within club academies. The data demonstrate that during a 45 min match, U8 and U10 players cover a total distance of ~2200 and 3500 m, respectively. Thus, it seems that very young Italian players cover lower total distance during matches than their English counterparts (Goto et al., 2015). However, comparing present findings with those from previous studies is problematic given the differences in populations, match characteristics and GPS technology (Randers et al., 2014; Goto et al., 2015). Indeed, different game formats and pitch sizes were present and it is known that playing with fewer players on smaller pitches results in some changes to the physical demands (Randers et al., 2014). Moreover, matches with a greater area per player induce higher heart rates, blood lactate concentrations, and perceived effort (Castellano et al., 2015). In any case, when expressing the present data in relative terms ($m•min^{-1}$), U10 players covered ~78 $m·min^{-1}$ which is substantial different from the U8 players (50 $m·min^{-1}$) but similar to the ~80-90 $m·min^{-1}$ reported in the literature for young players (Randers et al., 2014; Goto et al., 2015). As expected, these values fall well short of the distances covered in senior matches which vary from 100-130 $m·min^{-1}$ dependent on competitive standard, tier, position and phase of the season, (Bradley et al., 2013, 2015; Di Salvo et al., 2013; Mohr et al., 2003; Bush et al., 2015; Rampinini et al., 2007).

The total distance covered is the most commonly reported physical metric in match analysis but not necessarily the most informative or useful, especially given that a large proportion of this distance is covered at low intensity (Bradley & Noakes, 2013). The distance covered at high-intensity seems a much more appropriate physical metric given its ability to distinguish between various soccer populations (Mohr et al., 2003) and its relationship with physical capacity (Krustrup et al., 2003). In the present study, U8 and U10 players covered ~800 and 1500 m, respectively. These values are higher than those reported by other studies. For instance, Goto et al. (2015) found that U9 and U10 players covered just 600 m at high-intensity. Although we cannot rule out that this finding may be related to different physical capacities of the players in this study, it is likely that pitch dimensions and tactical-technical aspects may have impacted the distances covered in games. Indeed, Casamichana & Castellano (2010) observed greater high-intensity running distances during matches played on large compared to small pitches. Additionally, one of the most influential factors when comparing studies are the speed thresholds used to define high-intensity. The present study adhered to the individual approach recommended by Harley et al. (2010). This method created age-specific speed thresholds based on the peak velocity of a flying 10 m sprint. Although this approach was adopted by some studies (Goto et al., 2015), arbitrary thresholds were used by others (Randers et al., 2014). Interestingly, when the present data are expressed as a percentage of the total distance covered, no differences are observed between U8 and U10 players and the values at the upper end of the range are similar to those reported by Harley et al. (2010) for U12 – U16 players. Finally, problems will continue to persist when comparing findings from different studies until speed thresholds are standardized for various soccer populations (youth, senior, female and disabled players) (Bradley & Vescovi, 2015).

In elite senior players it has been demonstrated that match running performances are position-dependent (Di Salvo et al., 2007; Rampinini et al. 2007). Buchheit et al. (2010) also observed positional variation in U13 – U18 players regarding the distance covered during matches especially at high-intensity. To our knowledge, no data has been published using very young soccer players. The present study is not able to quantify positional trends as players were frequently interchanged by the coaches during matches in order to improve technical and tactical abilities.

Match performance data can be split into distinct time periods and simple comparisons of the running performance between the first and second halves of the matches can potentially indicate the occurrence of fatigue. Although, the context (scoreline, location, standard of opposition) and pacing cannot be discounted (Paul et al., 2015). The present study found no decrement in total and high-intensity running distances during U8 and U10 matches. In a recent survey of the literature it has been reported that elite senior players exhibit a reduction of both total and high-intensity distance covered between halves (Mohr et al., 2003), although some studies illustrate comparable performances across halves (Bradley et al., 2013, 2014). As for youth soccer, Rebelo et al. (2014) reported that the total distances decrease between the first and the remaining five periods during an 80 min competitive match. Thus, the present findings potentially highlight a different fatigue pattern during matches in relation to age. Interestingly, similar results were reported by Castagna et al. (2003) who observed no between half differences in match running performance for young soccer players. The enhanced capacity of children compared with adults of a similar training status, to maintain performance during a task characterized by repeated high-intensity actions seems to be supported by some evidence (Ratel et al., 2006). It has been shown that during a 30 s all-out cycle sprint the percentage decline in power output is lower in children than in adults (Beneke et al., 2005). The greater fatigue resistance displayed by children compared to adults might be related to muscular characteristics. Indeed, compared to adults, children: 1) have less muscle mass, and thus generate lower absolute power; 2) have higher muscle oxidative activity and lower glycolytic activity (Berg et al., 1986; Eriksson et al., 1971); 3) have a faster phosphocreatine resynthesis (Taylor et al., 1997) and might exhibit a higher clearance of lactate and H^+ ions within muscles (Beneke et al., 2005). However, the different match activity profile between senior and youth soccer players should be interpreted with caution given the multitude of factors potentially impacting results.

Interestingly, this study demonstrated a very large correlation coefficient between 20m-SR test performance and match running performance. The correlations observed in the present study are larger than those observed in elite senior soccer players/referees (Krustrup et al., 2003; Castagna et al., 2009; Bradley et al., 2011) and in adolescent (Buchheit et al., 2010; Castagna et al., 2009; Rebelo et al., 2014), A potential explanation for these findings could be related to different tactical and technical knowledge of the game and its important to note that these relationships are high complex. Elite senior players do not tax their full physiological capacity in games due to tactical and technical constraints (Bradley et al., 2013, 2015, Barnes et al., 2014, Bush et al., 2015) and contextual factors like scoreline (e.g. match performance drops when there is a high score difference). Thus given that young players have a lower tactical knowledge they may tax their capacities more and also evenly across the game. The reader must also be aware of the limitation of using continuous based tests such as the 20m-SR over more intermittent tests such as the Yo-Yo intermittent tests. However, the present findings are similar to Goto et al. (2015) whereby a positive relationship between the Yo-Yo intermittent recovery test performance and the total distance covered in a match was found in both U9 and U10 players.

In conclusion, the data demonstrate differences in match running performance and physical capacity between U8 and U10 players and large magnitude relationships between match play measures and physical test performances. Although physical capacity seems to be an important characteristic for developing young players it should never be placed over and above their technical and tactical development.

PRACTICAL APPLICATIONS

These findings will contribute greatly to our understanding of the demands placed on very young players and this work could be useful to sports science staff working within academies. The data can be used to profile young players' match-running performance whereby selected information such as the peak 5 min period could be replicated to create age-specific high-intensity drills. This approach has been successful for elite senior players as match-specific drills produce comparable physiological responses to small-sided games but provide a more uniform physiological response (Kelly et al., 2013). Furthermore, the findings provide evidence that performance on the 20m-SR test correlates well with physical match performance. As a field-based test, the 20m-SR has the advantage that all players in a team can be tested frequently, rapidly and easily at low cost. Although feasible, more intermittent based tests are advised as they mimic and replicate the characteristics of the soccer more effectively. The present data also highlighted that very young players have the ability to maintain their match running performance across the match. However, a common occurrence in U8-U10 age groups is large numbers of interchanges occur (with substitutes), resultng in a lower involvement of each player in term of minutes played. This means that a typical match does not represent an appropriate physical and technical stimulus for these very young players.

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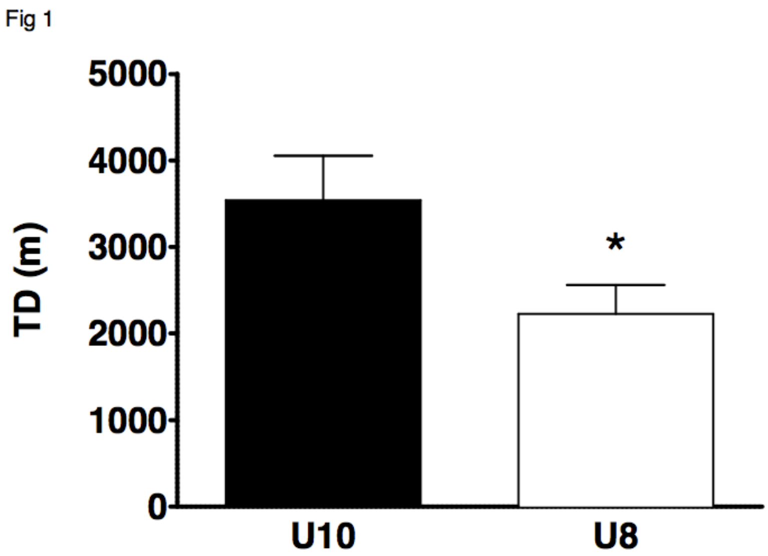

FIGURE 1. Total distance (TD) (mean±SD) covered during the match by U10 (black column) and U8 players (white column). *Significantly different (P<0.05).

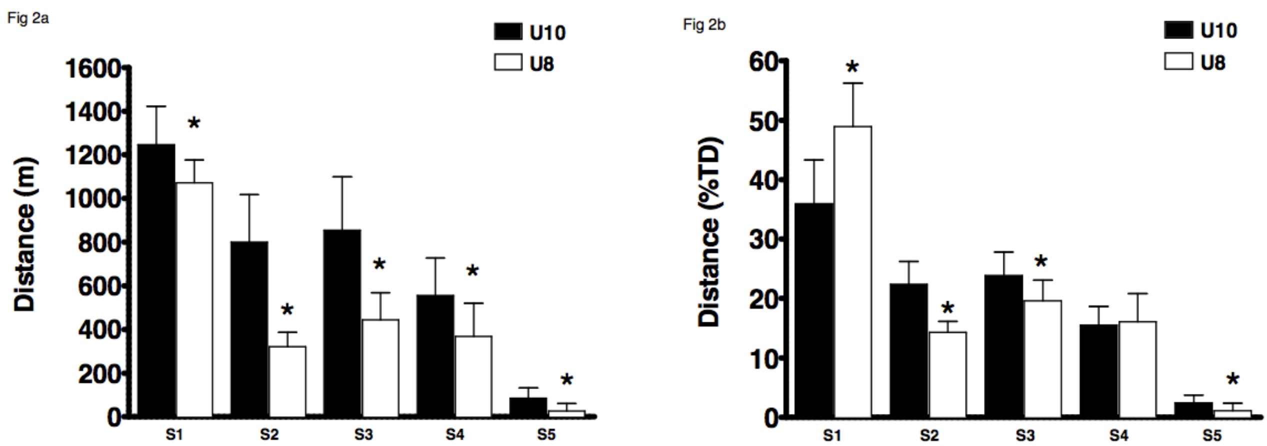

FIGURE 2. Distances expressed in meters (left panel) and as percentages of total distance (right panel) covered in walking (S1), jogging (S2), running (S3), high-speed running (S4) and sprinting (S5) during U10 (black columns) and U8 (white columns) matches. *Significant difference (P<0.05) between groups.

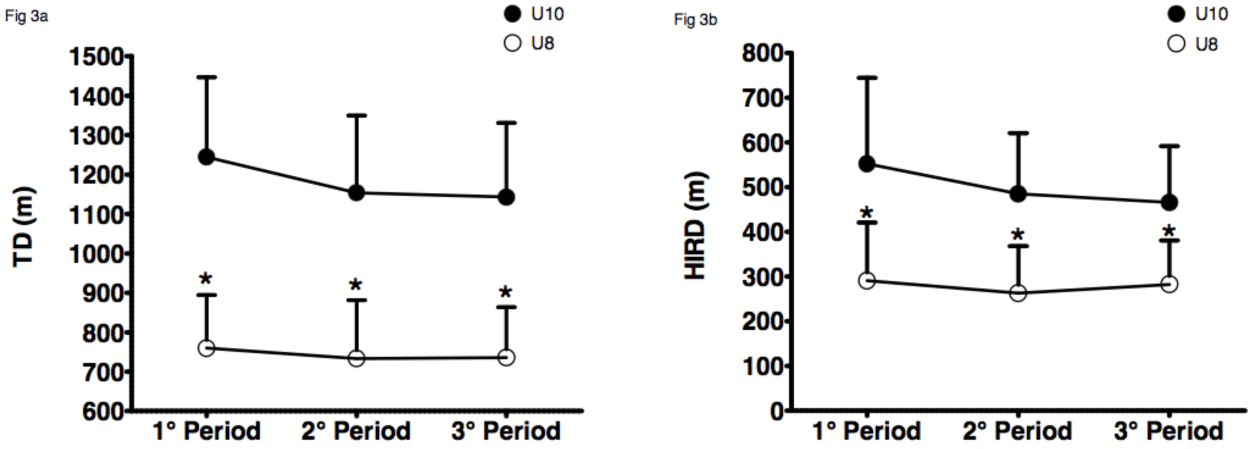

FIGURE 3. Total (TD) (left panel) and high-intensity running distance (HIRD) (right panel) covered by U10 (black circles) and U8 players (with circles) during each period of the match. *Significantly different (P<0.05) from U10.

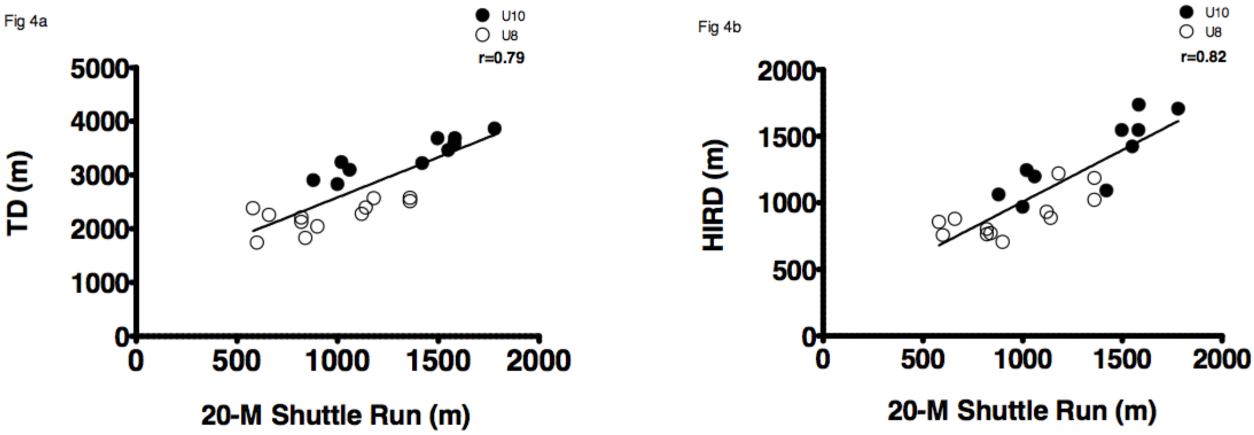

FIGURE 4. Relationship between 20-m shuttle run test performance and total (TD) and and high-intensity running distance (HIRD) covered during matches (right panel) in U10 (black circles) and U8 players (white circles).

Group	Walking	Jogging	Running	HS Running	Sprinting
U10 ($km \cdot h^{-1}$)	<6.7	6.8-9.6	9.7-13.2	13.3-18.2	>18.2

U8 ($km \cdot h^{-1}$)	<6.3	6.4-8.4	8.5-11.5	11.6-17.3	>17.3

TABLE 1. Speed zone thresholds ($km \cdot h^{-1}$) by age-group.