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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.

1 INTRODUCTION

2 The most common method to quantify the physical demands during training or match-play in team
3 sports (e. g. soccer, rugby, cricket, Australian football) is to determine the distance covered or the
4 time spent at different speeds (Bradley et al., 2009; Mohr et al., 2003). Although this method does
5 not take into account metabolically taxing activities such as accelerations and multi-directional
6 movement (Aughey & Varley, 2013) it does provide an indirect measure of energy expenditure. As
7 such numerous studies have included this approach to examine the physical demands of match-play
8 across tiers and competitive standards (Bradley et al., 2013, 2015; Di Salvo et al., 2013; Mohr et al.,
9 2003), positions (Bush et al., 2015), environments (Mohr et al., 2010), surfaces (Andersson et al.,
10 2008) and phases of the season (Rampinini et al., 2007). Particular attention has focussed on the
11 relationship between match running performance and physical capacity (Bradley et al., 2011, 2013;
12 Krustup et al., 2003, 2005) to highlight how variance is shared between measures.

13 Match analysis research has extensively studied elite senior male players of sub-elite to elite
14 competitive standard (Bangsbo et al., 1991; Mohr et al., 2003; Reilly & Thomas, 1976). As for
15 youth players, most information is available for players between 12-17 yr of age (Buchheit et al.,
16 2010; Castagna et al., 2009; Castagna et al., 2010; Harley et al., 2010; Rebelo et al., 2014) with
17 scant research coverage of very young players. It appears that the total and high-intensity running
18 distance covered during matches is greater in older players than their younger counterparts but this
19 difference becomes trivial when data are adjusted for actual playing time (Buchheit et al., 2010) or
20 analysed with age-specific speed thresholds (Harley et al., 2010). As for very young players (<11 yr
21 of age), data describing the activity profile during match play are limited and thus a less clear
22 picture is evident of the movement demands of these developing players. Capranica et al. (2001)
23 compared the activity profiles of young players during matches (11 vs 11 and 7 vs 7) on a regular
24 (100 × 65 m) and small sized pitch (60 × 40 m), respectively. This study demonstrated that running
25 comprised of a higher proportion of game time than walking in both conditions (55 vs 38%) but no
26 information was provided on the distances covered during games in various speed thresholds.

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

37

38 **METHODS**

39 Youth Players

40 Twelve U10 and fifteen U8 Italian national team youth soccer players were recruited for this study.
41 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
42 and 1.33±0.01 m and 34.1±0.9 and 29.1±1.2 kg, respectively. The mean peak height velocity (PHV)
43 indirectly estimated by the leg length (Sherar et al., 2005) was -3.1±0.1 and -4.6±0.1 yr in U10 and
44 U8 players, respectively. Players trained approximately 4 hr per week and partook in 1 or 2 match
45 per week. The players and their parents were fully informed of any risks associated with the
46 experiments before giving their written consent to participate to the study. The study was approved
47 by the appropriate institutional ethics committee with all procedures adhering to the Declaration of
48 Helsinki (2000) of the World Medical Association.

49

50 Experimental Design

51 Each player completed the battery of field tests to determine individual physical capacity and
52 technical skills the week before the first match observations. Match data were collected across an

53 eight-week period and data were only analysed if the player completed the entire game. All matches
54 were played in accordance with the rules outlined by the FIGC.

55

56 Physical Capacity and Technical Skill Tests

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

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

78

79 Match Running Performance

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

$$93 \quad v = \sqrt{Fr \cdot g \cdot L} \text{ (Eq. 1).}$$

94 Where v is the speed of progression ($\text{m} \cdot \text{s}^{-1}$), Fr is Froude number, g is acceleration due to gravity
95 ($9.81 \text{ m} \cdot \text{s}^{-2}$ on Earth) and L is leg length, in m. An Fr of 0.5 was utilized since it has been shown
96 corresponding to the spontaneous transition speed between walking and running. The other speed
97 thresholds were established according to Harley et al. (2010) using the mean peak speed of FL10m
98 in each group (v_{peakGrp}). This velocity was compared relative to the corresponding value reported
99 in elite senior players (v_{peakSnr}). The [$v_{\text{peakGrp}} \cdot v_{\text{peakSnr}}^{-1}$] ratio was then applied to the commonly
100 used thresholds for senior players by Bradley et al (2009) to produce group specific speed zones.

101 The speed thresholds for various activities for U10 and U8 were: 1) walking (<6.7 and <6.3
102 $\text{km} \cdot \text{h}^{-1}$, respectively); 2) jogging (6.8-9.6 and 6.4-8.4 $\text{km} \cdot \text{h}^{-1}$, respectively); 3) running (9.7-13.2 and
103 8.5-11.5 $\text{km} \cdot \text{h}^{-1}$, respectively); 4) high-speed running (13.3-18.2 and 11.6-17.3 $\text{km} \cdot \text{h}^{-1}$, respectively)
104 and 5) sprinting (≥ 18.2 and $\geq 17.3 \text{ km} \cdot \text{h}^{-1}$, respectively; Table 1). Total distance (TD) was the sum

105 of the distances covered in each of above speed thresholds. High-intensity running distance (HIRD)
106 was the summation of running, high-speed running, and sprinting distances.

107

108 Statistical Analysis

109 Data were expressed as mean \pm SD. Differences between groups were determined using a unpaired
110 t-test while a one-way analysis of variance (ANOVA) with repeated measures was used to
111 determine differences between distances covered in the first, second, and third match periods.
112 Tukey's post-hoc test was used to verify localised effects. Statistical significance was set at $p < 0.05$.
113 All analyses were performed using statistical software package (Prism 6.0; GraphPad, San Diego,
114 CA, USA). Effect sizes (ES) were calculated to determine the meaningfulness of the difference with
115 the magnitudes classified as trivial (< 0.2), small (0.2-0.6), moderate (0.6-1.2) and large (> 1.2)
116 (Batterham & Hopkins, 2006). Relationships between the distances covered (TD and HIRD) and
117 physical and technical variables were evaluated using Pearson's product moment test. For this
118 analysis only, the players ($n=12$ for U8 and $n=10$ for U10) that completed at least 3 matches were
119 considered. The magnitudes of the correlations were considered as trivial (< 0.1), small (0.1-0.3),
120 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
121 accordance with Hopkins et al. (2009).

122

123 RESULTS

124 Physical Capacity and Technical Skill Tests

125 CMJ performance was greater in U10 than U8 players (0.23 ± 0.03 vs 0.21 ± 0.03 m, $p < 0.05$, ES:
126 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
127 (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
128 1.75 ± 0.11 s, $p < 0.05$, ES: 1.27). Less pronounced differences were evident between U8 and U10
129 players for sprints across 10 m ($p > 0.05$, ES: 0.74). U10 players had a 40% higher 20m-SR test
130 performance than U8 players (1215 ± 77 vs 872 ± 78 m, $p < 0.01$, ES: 1.60) Similarly, SHDT

131 (10.66±0.57 vs 11.80±0.83 s, $p<0.01$, ES: 1.77) and SLDT performances (22.34±1.28 vs
132 29.41±2.72 s, $p<0.01$, ES: 4.50) were better in U10 than U8 players.

133

134 Match Running Performance

135 U10 players covered 34% more total distance than their U8 counterparts (3541±511 m vs 2229±331
136 m; $p<0.01$, ES: 3.07, Figure 1). The differences between U10 and U8 players were evident in
137 walking (16%), jogging (60%), running (50%), high-speed running (34%) and sprinting (70%)
138 ($p<0.01$, ES: 0.97-3.13, Figure 2a). HIRD was also found to be greater in U10 than U8 players
139 (1503±391 vs 836±279 m, $p<0.01$, ES: 1.73). When data were expressed in percentages of TD,
140 differences between U10 and U8 players were observed for walking (36±7 vs 49±7%), jogging
141 (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,
142 Figure 2b). Less pronounced differences were evident for HIRD between U10 and U8 (42±6 vs
143 38±8%, $p>0.05$, ES: 0.99). During each of the three periods, TD (1244±202, 1154±196, 1142±189
144 m and 759±135, 733±148, 735±128 m in U10 and U8, respectively) and HIRD (552±192, 485±136,
145 466±126 m and 291±130, 263±105, 283±98 m in U10 and U8, respectively) were unchanged
146 ($p>0.05$, ES: 0.02-0.55, Figure 3). Overall, very large magnitude correlations were observed
147 between the U8 and U10 players 20m-SR performances versus TD ($r=0.79$; $P<0.01$) and HIRD
148 ($r=0.82$; $P<0.01$) (Figure 4a and 4b). No relationships were found between match running
149 performance and any other physical or technical test results.

150

151 **DISCUSSION**

152 This is the first study to quantify the match running performance and physical capacities of very
153 young Italian soccer players. These findings will contribute greatly to our understanding of the
154 demands placed on very young players and this work could be useful to sports science staff working
155 within club academies. The data demonstrate that during a 45 min match, U8 and U10 players cover
156 a total distance of ~2200 and 3500 m, respectively. Thus, it seems that very young Italian players

157 cover lower total distance during matches than their English counterparts (Goto et al., 2015).
158 However, comparing present findings with those from previous studies is problematic given the
159 differences in populations, match characteristics and GPS technology (Randers et al., 2014; Goto et
160 al., 2015). Indeed, different game formats and pitch sizes were present and it is known that playing
161 with fewer players on smaller pitches results in some changes to the physical demands (Randers et
162 al., 2014). Moreover, matches with a greater area per player induce higher heart rates, blood lactate
163 concentrations, and perceived effort (Castellano et al., 2015). In any case, when expressing the
164 present data in relative terms ($\text{m}\cdot\text{min}^{-1}$), U10 players covered $\sim 78 \text{ m}\cdot\text{min}^{-1}$ which is substantial
165 different from the U8 players ($50 \text{ m}\cdot\text{min}^{-1}$) but similar to the $\sim 80\text{-}90 \text{ m}\cdot\text{min}^{-1}$ reported in the
166 literature for young players (Randers et al., 2014; Goto et al., 2015). As expected, these values fall
167 well short of the distances covered in senior matches which vary from $100\text{-}130 \text{ m}\cdot\text{min}^{-1}$ dependent
168 on competitive standard, tier, position and phase of the season, (Bradley et al., 2013, 2015; Di Salvo
169 et al., 2013; Mohr et al., 2003; Bush et al., 2015; Rampinini et al., 2007).

170 The total distance covered is the most commonly reported physical metric in match analysis
171 but not necessarily the most informative or useful, especially given that a large proportion of this
172 distance is covered at low intensity (Bradley & Noakes, 2013). The distance covered at high-
173 intensity seems a much more appropriate physical metric given its ability to distinguish between
174 various soccer populations (Mohr et al., 2003) and its relationship with physical capacity (Krustrup
175 et al., 2003). In the present study, U8 and U10 players covered ~ 800 and 1500 m , respectively.
176 These values are higher than those reported by other studies. For instance, Goto et al. (2015) found
177 that U9 and U10 players covered just 600 m at high-intensity. Although we cannot rule out that this
178 finding may be related to different physical capacities of the players in this study, it is likely that
179 pitch dimensions and tactical-technical aspects may have impacted the distances covered in games.
180 Indeed, Casamichana & Castellano (2010) observed greater high-intensity running distances during
181 matches played on large compared to small pitches. Additionally, one of the most influential factors
182 when comparing studies are the speed thresholds used to define high-intensity. The present study

183 adhered to the individual approach recommended by Harley et al. (2010). This method created age-
184 specific speed thresholds based on the peak velocity of a flying 10 m sprint. Although this approach
185 was adopted by some studies (Goto et al., 2015), arbitrary thresholds were used by others (Randers
186 et al., 2014). Interestingly, when the present data are expressed as a percentage of the total distance
187 covered, no differences are observed between U8 and U10 players and the values at the upper end
188 of the range are similar to those reported by Harley et al. (2010) for U12 – U16 players. Finally,
189 problems will continue to persist when comparing findings from different studies until speed
190 thresholds are standardized for various soccer populations (youth, senior, female and disabled
191 players) (Bradley & Vescovi, 2015).

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

198 Match performance data can be split into distinct time periods and simple comparisons of the
199 running performance between the first and second halves of the matches can potentially indicate the
200 occurrence of fatigue. Although, the context (scoreline, location, standard of opposition) and pacing
201 cannot be discounted (Paul et al., 2015). The present study found no decrement in total and high-
202 intensity running distances during U8 and U10 matches. In a recent survey of the literature it has
203 been reported that elite senior players exhibit a reduction of both total and high-intensity distance
204 covered between halves (Mohr et al., 2003), although some studies illustrate comparable
205 performances across halves (Bradley et al., 2013, 2014). As for youth soccer, Rebelo et al. (2014)
206 reported that the total distances decrease between the first and the remaining five periods during an
207 80 min competitive match. Thus, the present findings potentially highlight a different fatigue
208 pattern during matches in relation to age. Interestingly, similar results were reported by Castagna et

209 al. (2003) who observed no between half differences in match running performance for young
210 soccer players. The enhanced capacity of children compared with adults of a similar training status,
211 to maintain performance during a task characterized by repeated high-intensity actions seems to be
212 supported by some evidence (Ratel et al., 2006). It has been shown that during a 30 s all-out cycle
213 sprint the percentage decline in power output is lower in children than in adults (Beneke et al.,
214 2005). The greater fatigue resistance displayed by children compared to adults might be related to
215 muscular characteristics. Indeed, compared to adults, children: 1) have less muscle mass, and thus
216 generate lower absolute power; 2) have higher muscle oxidative activity and lower glycolytic
217 activity (Berg et al., 1986; Eriksson et al., 1971); 3) have a faster phosphocreatine resynthesis
218 (Taylor et al., 1997) and might exhibit a higher clearance of lactate and H⁺ ions within muscles
219 (Beneke et al., 2005). However, the different match activity profile between senior and youth soccer
220 players should be interpreted with caution given the multitude of factors potentially impacting
221 results.

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

235 relationship between the Yo-Yo intermittent recovery test performance and the total distance
236 covered in a match was found in both U9 and U10 players.

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

242

243 **PRACTICAL APPLICATIONS**

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

260

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265

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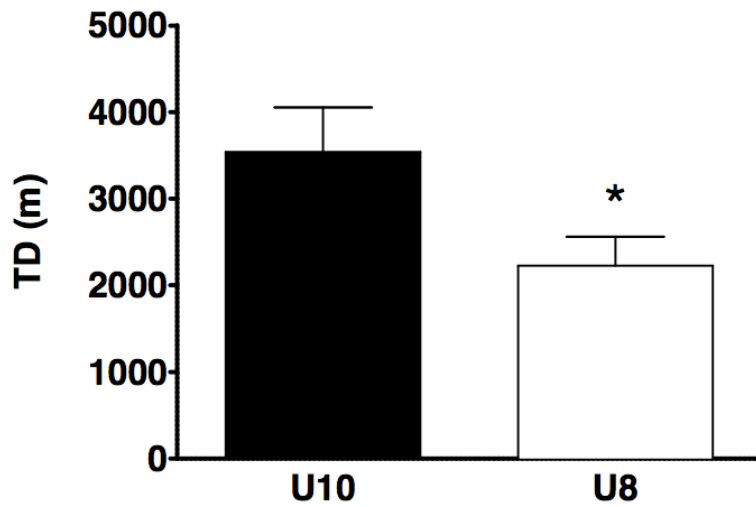
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382

Fig 1



383

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

Fig 2a

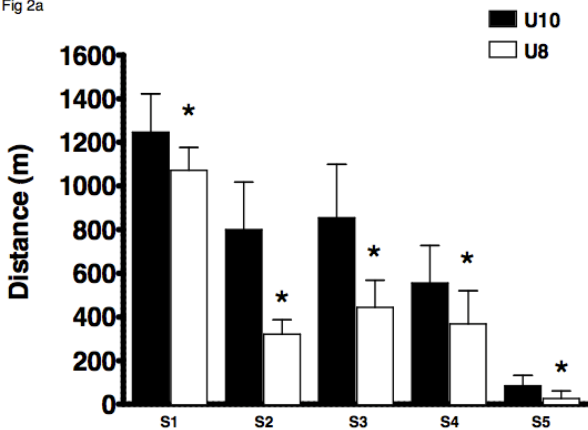
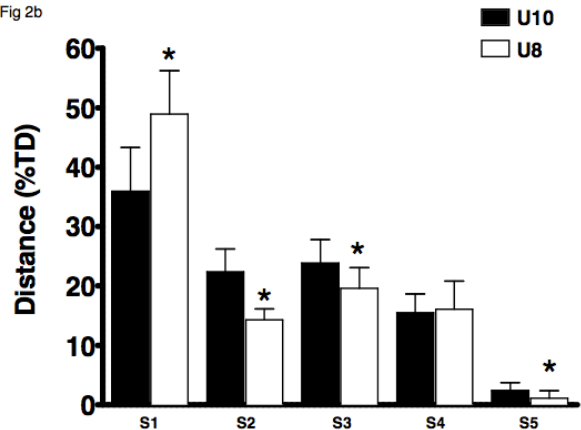
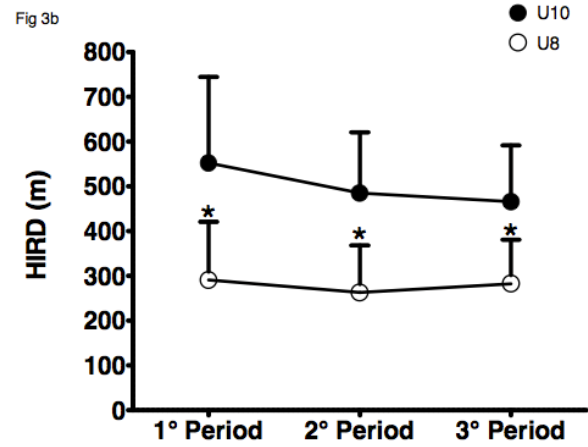
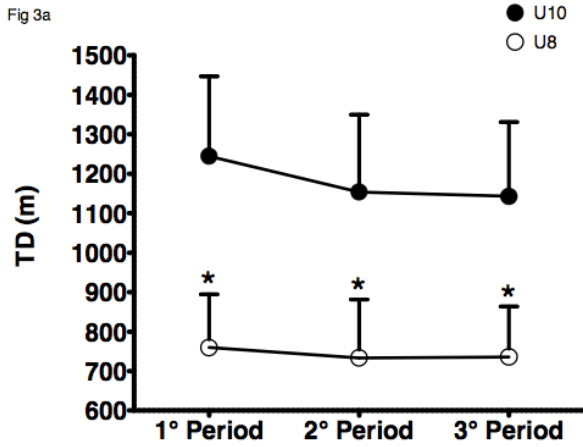


Fig 2b



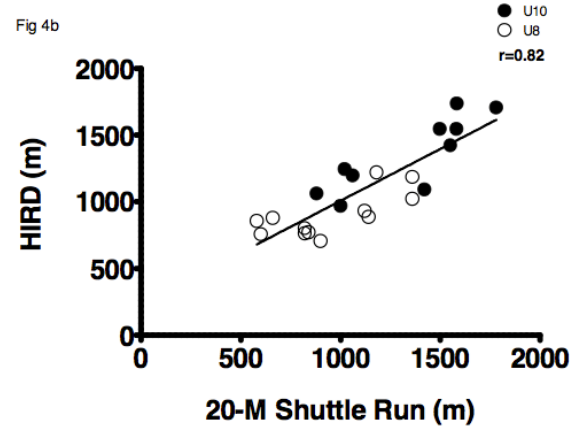
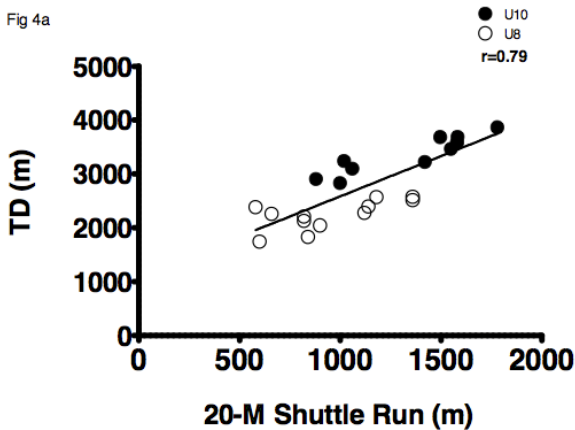
386

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



391

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



395

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

399

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

U8 (km·h ⁻¹)	<6.3	6.4-8.4	8.5-11.5	11.6-17.3	>17.3
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400 TABLE 1. Speed zone thresholds (km·h⁻¹) by age-group.