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Validity of Simple Field Tests as Indicators of Match-Related Physical Performance in Top-Level Professional Soccer Players

Training & Testing

Abstract

The aim of this study was to examine the construct validity of selected field tests as indicators of match-related physical performance. During the competitive season, eighteen professional soccer players (age 26.2 ± 4.5 yrs, mass 80.8 ± 7.8 kg, and height 181.9 ± 3.7 cm) completed an incremental running field test to exhaustion, a vertical-jump and a repeated-sprint ability (RSA) test. Match physical performance was quantified during official matches using a video-computerized, semi-automatic, match analysis image recognition system, (ProZone®, Leeds, UK). The selected measures of match physical performance were: total distance covered (TD), high intensity running (HIR: > 14.4 km · h^{-1}), very high intensity running (VHIR:> 19.8 km · h^{-1}), sprinting (> 25.2 km · h^{-1}) and top running speed. Significant correlations were found between peak speed reached during the incremental field test and TD (r = 0.58, R^2 = 0.34; $p < 0.05$), HIR (r = 0.65, R^2 = 0.42; $p < 0.01$) and VHIR (r = 0.64, R^2 = 0.41; $p < 0.01$). Significant correlations were also found between RSA mean time and VHIR (r = – 0.60, R^2 = 0.36; $p < 0.01$) and sprinting distance (r = – 0.65, R^2 = 0.42; $p < 0.01$). Significant differences were found between the best and worst group as defined by the median split technique for peak speed (TD = 12 011 ± 747 m vs. 10 712 ± 669, HIR = 3192 ± 482 m vs. 2314 ± 347 m, and VHIR = 1014 ± 120 vs. 779 ± 122 m, respectively; $p < 0.05$) and RSA mean time (VHIR = 974 ± 162 m vs. 819 ± 144 m, and sprinting = 235 ± 56 vs. 164 ± 58 m, respectively; $p < 0.05$). In conclusion, this study gives empirical support to the construct validity of RSA and incremental running tests as measures of match-related physical performance in top-level professional soccer players.

Key words
Soccer · match performance · field tests · construct validity · convergent validity · group difference · repeated sprint ability

Introduction

Soccer is a complex sport requiring the repetition of many diverse activities (e.g., jogging, sprinting and jumping) over 90 min [12, 30, 43]. For this reason, several different tests are used to assess the physical performance of soccer players [4, 6, 15, 34, 38, 39]. Among these tests, the assessment of repeated-sprint ability (RSA), muscular power and aerobic fitness are popular among coaches and applied sport scientists [4, 6, 38, 39]. Soccer players are required to repeatedly produce maximal or near maximal sprints of short duration (1 – 7 s) with brief recovery periods [12, 43]. Therefore, the ability to repeat multiple sprints at high speed (i.e., RSA) is important for soccer physical performance [9, 44]. The use of tests consisting of several sprints interspersed with brief recovery periods, instead of a single sprint, ensures physiological responses similar to those occurring during actual matches such as a decrease in muscle pH, phosphocreatine and ATP, and the activation of anaerobic glycol-

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ysis [37, 39, 44]. Therefore, the relevance of RSA tests for soccer is mainly based on their logical validity as these tests require the repetition of soccer-specific high-intensity activities (i.e., repeated sprints with or without direction changes) and similar metabolic requirements [37, 39, 44]. Furthermore, RSA tests have been shown to discriminate players of different competitive levels [39].

Muscular power is an important prerequisite for sprinting and is therefore also commonly assessed in soccer players [6, 39]. In addition, soccer requires players to perform activities such as striding, turning and jumping [12, 17, 38, 43], which may require muscular power. Vertical jump performance (VJP) is a simple measure of lower limb muscular power [4], and has been used to evaluate training-induced changes in soccer players [19, 23, 36]. The use of vertical jump tests in soccer is supported by some, but not all studies on the association between this test and competitive level and ranking [3, 35].

Several studies have shown that a good level of aerobic fitness is required to meet the physiological demands of soccer [8, 10, 33, 38]. In fact, a significant relationship between aerobic power and competitive ranking, team level and total distance covered during a match has been reported [2, 11, 24, 25, 42]. For this reason, the routine monitoring of aerobic fitness in soccer players has been suggested [20, 22, 29, 38]. Incremental continuous and shuttle run field tests have been proposed as practical alternatives to the measurement of aerobic power in the laboratory because of their strong correlations with maximum oxygen uptake [1, 27, 28]. An example of such a test is the Montreal University Track Test [27], which comprises a continuous incremental protocol to exhaustion. The use of peak speed itself, rather than the estimated maximum oxygen uptake, has been suggested as an integrated measure of aerobic performance, concurrently accounting for both running economy and aerobic power [32].

As seen in the above brief review of the literature, the validity of most currently used tests is based predominantly on their intrinsic characteristics (logical validity) or the ability to discriminate players of different levels or role positions. However, test validation requires several studies to gather different types of evidence: e.g., logical validity, construct validity, criterion-related validity. The use of these tests often assumes that they actually measure match-related physical performance (construct validity). However, to the best of our knowledge, the relationship between common performance tests and physical soccer match performance has been verified only for the yo-yo intermittent recovery test [24, 25].

Therefore, the aim of this study was to verify the construct validity of an incremental test for aerobic fitness, VJP and RSA by examining the correlations between these tests and selected measures of physical performance during actual match play. Furthermore, we verified the ability of these tests to differentiate top-level professional soccer players with dissimilar physical match performance (known-group difference technique). We hypothesized that: 1) peak speed reached during the incremental field test would be related to total distance covered in a soccer match; 2) RSA scores (best and mean time, and relative decrement) would be related to the distance covered at high running speeds and while sprinting during a match; and 3) the best RSA and VJP scores would be related to the top speed reached during the match.

Material and Methods

Subjects

Eighteen professional, top-level soccer players (age 26.2 ± 4.5 yrs, mass 80.8 ± 7.8 kg, and height 181.9 ± 3.7 cm) were involved in the study (3 centerbacks, 5 fullbacks, 7 centermidfielders and 3 forwards). All players were playing for the same elite team of one of the most important European leagues, which placed in the top four of the final ranking of its national championship and reached the quarterfinals in the UEFA European Champions League during the study. Fourteen of these athletes were also included in their respective national teams (6 nations), and five of them were among the best in the world (ranked 1 – 8 on the official FIFA list). All subjects signed an informed consent. The study was approved by the Institutional Review Board and conformed to the Helsinki declaration for human experimentation.

Match-related physical performance

Each match was monitored using a video-computerized, semi-automatic, match analysis image recognition system (data published with the permission of ProZone®, Leeds, England). This method uses six cameras, three for each side of the pitch, providing a simultaneous observation of the 22 players involved in the game. From the great amount of data obtained using the ProZone® specific software, total distance covered during a match as well as high-intensity running and sprinting distances were chosen for further analysis as they have been shown to differ between soccer players of dissimilar level [30]. The match analysis system supplies data relative to the following locomotor categories: standing (from 0 to 0.7 $km \cdot h^{-1}$), walking (from 0.7 to 7.2 $km \cdot h^{-1}$), jogging (from 7.2 to 14.4 $km \cdot h^{-1}$), running (from 14.4 to 19.8 $km \cdot h^{-1}$), high-speed running (from 19.8 to 25.2 $km \cdot h^{-1}$), and sprinting (> 25.2 $km \cdot h^{-1}$). From these locomotor categories, total distance (TD), high-intensity running distance (HIR) (running speed > 14.4 $km \cdot h^{-1}$), very high-intensity running (VHIR) (running speed > 19.8 $km \cdot h^{-1}$) and sprinting distance (> 25.2 $km \cdot h^{-1}$) were calculated and used for the analysis. Furthermore, top speed reached during the matches was also selected to assess its relationship with field tests of muscular power (VJP) and speed (RSA best time). The best value for each variable observed during the 2 – 3 matches closest to the tests (within three weeks) was used for the statistical analysis. As per their normal routine, players did not complete intense exercise sessions 48 hours before matches.

Field tests

Field tests were performed on two separate occasions with at least two days between the two testing sessions and during tapering weeks. Vertical jump and incremental tests were completed on the first day, while the repeated sprint test was performed in the second testing session. Tests were completed during days without wind and the air temperature ranged from 17 to 24 °C. Subjects were instructed not to eat for at least three hours before testing, and not to drink coffee or beverages containing caffeine for at least eight hours before testing. All players were familiar with, and had previously performed, all of the tests used in this study.

Vertical jump performance

After a 15-min warm-up consisting of low-intensity running and striding, players performed vertical jumps keeping their hands on the iliac crests, bending the knees to 90°, stopping for 1 – 2 s, and then jumping as high as possible without knee or trunk countermovement. Vertical jump elevation was determined using a photocell mat (1 m × 1 m) (Optojump, Microgate, Bolzano, Italia) connected to a portable personal computer, which estimated jump height from flight time [5]. The best of five trials (with 1-min rest between each jump) was used for the final statistical analysis [41].

Incremental field test

After the vertical jumps test, the subjects performed an additional 10-min warm-up consisting of low-intensity running before starting the incremental test. The incremental field test was a shorter version of the University Montreal Track Test completed on a 300-m circular track marked on a regular soccer pitch [27]. The test-retest reliability index for this test has been reported to be r = 0.96 [27]. A grass surface was chosen instead of the track as soccer players prefer and compete on a grass surface. Every 50 m, a cone was positioned as a reference. Following an acoustic signal, the subjects performed the incremental field test, starting from 8.0 $km \cdot h^{-1}$ with the speed then increasing by 1.0 $km \cdot h^{-1}$ every 1 min (instead of 2 min as in the original version [27]). The end of the test was taken to be when the participant twice failed to reach the next cone in the required time (objective evaluation) or if he felt unable to cover another interval at the dictated speed (subjective evaluation). During the test, athletes were verbally encouraged by the technicians, as well as by their team coach. If the last step was not completed, the peak speed was calculated using the formula of Kuipers et al. [26]:

$$\text{peak speed} = S_f + (t/60 \cdot 0.3)$$

where S_f was the last completed step in $m \cdot s^{-1}$ and t is the time in seconds of the uncompleted step.

Repeated-sprint ability test

To measure the ability to perform work characterized by short duration and high intensity [14], we used a test consisting of six 40 m (20 + 20 m) shuttle sprints separated by 20 s of passive recovery. This test was designed to measure both repeated-sprint and change in direction abilities. The reliability (typical error expressed as a coefficient of variation) for the best shuttle sprint time, the mean time and percent decrement has been reported to be 1.3, 0.8, and 25.0 %, respectively [18]. Despite the low reliability of the percent decrement, it was included in the statistical analysis because the inter-subject variability was higher than for the other variables [18]. The athletes started from a line, sprinted for 20 m, touched a line with a foot, and came back to the starting line as fast as possible. After 20 s of passive recovery, the soccer player started again. Prior to the RSA test, subjects completed a warm-up consisting of 15-min low-intensity running and striding and three sub-maximal shuttle sprints. Immediately after the warm-up, each player completed a preliminary single shuttle sprint test using a photocells system (Microgate, Bolzano, Italia).

Table **1** An example of the methods used to calculate the RSA mean time (RSA_{mean}), RSA best time (RSA_{best}) and the RSA percent decrement (RSA_{dec})

6 × 20 m + 20 m test	
Trials	***Mean time (s)***
1st	6.85
2nd	6.98
3rd	7.09
4th	7.28
5th	7.37
6th	7.49
RSA mean time (RSA_{mean})	7.18
RSA best time (RSA_{best})	= 6.85
RSA percent decrement (RSA_{dec}, %)	= ($[RSA_{mean}]/[RSA_{best}] \times 100$) – 100 = (7.18/6.85 × 100) – 100 = 104.8 – 100 = 4.8 %

This trial was used as the criterion score during the subsequent 6 × 40-m shuttle sprint test. After the first preliminary single shuttle sprint, subjects rested for 5 min before the start of the RSA test. If performance in the first sprint of an RSA test was worse than the criterion score (i.e., an increase in time greater than 2.5 %), the test was terminated immediately and subjects were required to repeat the RSA test with maximum effort after a 5-min rest. Five seconds before the start of each sprint, subjects assumed the ready position and waited for the start signal. Best time in a single trial (RSA_{best}), mean time (RSA_{mean}) and percent decrement (RSA_{dec}) during the RSA test was calculated as explained in Table **1**.

Statistical analysis

Data are presented as the mean ± standard deviation (SD). Assumptions of normality were verified using the Shapiro-Wilk W test. Pearson's product-moment correlations were used to examine the relationships between field test scores and match-related physical performance. To apply the known-group difference technique, participants in the study were divided into two groups using the median split technique based on performance levels in each of the field tests. They were assigned to the best or worst group if the test score was below or above the median value of all participants. Best and worst groups were determined using the median value of peak speed during the incremental test, VJP and the results derived from the RSA test ($RSA_{best,}$ RSA_{mean}, and RSA_{dec}). Then, the selected measures of match-related physical performance (TD, HIR, VHIR, and sprinting) of the best group were compared to those of the worst group using unpaired *t-tests*. The effect sizes (d) for these differences were also determined as (mean value of best group – mean value of worst group)/pooled SD. Effect size values of 0.2, 0.5 and above 0.8 were considered to represent a small, moderate and large difference, respectively [40]. The level of statistical significance was set at $p < 0.05$. Statistical analyses were performed using the software STATISTICA (version 6.0, StatSoft, Tulsa, OK, USA).

Results

Field tests

The mean peak speed reached during the incremental test was 17.7 ± 0.9 km·h^{-1} (range: 16.5 – 19.2 km·h^{-1}). The mean time to reach the peak speed was 10 min 41 s (range 9 min 30 s – 12 min 10 s). The mean VJP was 36.6 ± 3.8 cm (range: 28.7 – 41.3 cm). RSA test results were 7.00 ± 0.19 s (range: 6.62 – 7.29 s) for RSA_{best}, 7.25 ± 0.17 s (range: 6.95 – 7.50 s) for RSA_{mean}, and 3.3 ± 1.6% (range: 1.0 – 8.1%) for RSA_{dec}.

Match-related physical performance

The mean distance covered at the different locomotor categories in this group of eighteen top-level professional soccer players recorded during matches was 4030 ± 344 m (range: 3195 – 4700 m) for walking, 4588 ± 697 m (range: 3420 – 6100 m) for jogging, 1847 ± 474 m (range: 1210 – 2730 m) for running, 697 ± 142 m (range: 430 – 947 m) for high-speed running, and 199 ± 62 m (range: 110 – 335 m) for sprinting.

From the locomotor categories, the mean TD, HIR, and VHIR distances calculated were 10864 ± 918 m (range: 9710 – 12750 m), 2530 ± 532 m (range: 1770 – 3910 m), and 802 ± 168 m (range: 560 – 1250 m), respectively. Top speed was 31.7 ± 1.2 km·h^{-1} (range: 29.3 – 33.3 km·h^{-1}).

Relationships between field tests and match physical performance

The correlation coefficients between field-test results and selected physical match performance variables are presented in Fig. **1**. There were significant correlations between peak speed in the incremental test and TD, HIR, and VHIR. A significant correlation was also found between RSA_{mean} and VHIR and sprinting. No other significant correlations were found between field test results and match-related physical performance variables (data not shown). Notably, no correlation was found between peak speed in the incremental test and RSA_{mean} ($r = -0.31$; $p = 0.38$).

Using the median split technique, we found that the group that reached the higher peak speed during the incremental test covered significantly more TD, HIR, and VHIR in comparison with the group that reached the lower peak speed during the same test. The best group in RSA_{mean} (time below the median value) covered more VHIR and sprinting distance compared to players with times above the median value. No significant differences were observed between the best and worst group in VJP, RSA_{best} or RSA_{dec} (Table **2**).

Discussion

Despite the different match analysis systems used, the total and HIR distances covered by top level soccer players in the present investigation were similar to those recently reported in top-level soccer players [30] (10860 m and 2430 m vs. 10864 and 2530 m, respectively). Vertical jump performance was similar to that reported by Arnason et al. [3] using the same protocol and equipment in elite soccer players. The results of the other two tests cannot be compared with previous studies because of the different protocols used to measure RSA and aerobic fitness. Given the top level of the professional athletes involved in this study, we can expect that the results presented here reflect a high level of physical fitness for soccer players.

In agreement with our hypothesis, the peak speed reached during the incremental field test was found to be significantly associated with TD. This association is similar to those found by previous investigators using laboratory incremental treadmill tests of maximum oxygen uptake in junior [21], professional [24] and female soccer players [25]. In contrast, only trends were previously reported for the correlation between time to exhaustion during incremental treadmill tests and TD in both elite male and female soccer players [24,25]. This is probably due to the shorter duration of the tests (about 4 – 5 min) employed by Krustrup et al. [24,25] compared to the duration of our protocol (about 10.5 min). This suggests that longer test duration may be more appropriate to evaluate the ability of soccer players to cover long distances during a match.

Surprisingly, we have also found significant relationships between peak speed during the incremental field test and distance covered at high and very high running speeds. This relationship suggests that the ability to cover greater distances at high running speeds during a match is associated with aerobic fitness. This relationship may be related to the observation that a high aerobic capacity aids recovery during the high-intensity intermittent exercise typical of soccer performance [7]. Furthermore, during repeated, compared to a single sprint, the contribution of the aerobic energy system increases [37]. An even higher correlation between time to exhaustion and HIR was previously reported in female soccer players ($r = 0.82$; $p < 0.001$). The same group, however, found no correlation ($r = 0.26$; $p > 0.05$) between the same variables in male elite soccer players. Gender differences in aerobic and anaerobic contribution to physical soccer match performance have been proposed as a possible explanation of these conflicting results [25]. Specifically, Krustrup et al. [25] suggested that female soccer players may have a greater aerobic contribution during matches and thus aerobic power may be more important for their physical match performance. However, this cannot be reconciled with our findings as the longer duration of our incremental protocol should require a greater aerobic contribution and, consequently, a lower or no correlation between the peak speed during the incremental test and HIR would be expected. Further studies on the energy systems involved during actual soccer matches in male and female players are required to clarify this point. In summary, the results of the present study not only confirmed our hypothesis that peak speed reached during the incremental field test is related to total distance covered in a soccer match, but also suggest that this test measures physical characteristics related to the distances covered at high running speeds.

As hypothesized, RSA_{mean} was significantly correlated with both very high-speed running and sprinting distance during actual match play. This is the first study to report the relationship between RSA and actual match performance. This association could be mediated by the metabolic characteristics of RSA tests (reduction of pH, phosphocreatine, ATP and purine nucleotides, and activation of anaerobic glycolysis) [37], which are similar to those occurring during the most intense phases of a soccer match

Table 2 Distance covered (mean ± SD) in different motions in two groups of top level professional soccer players (best [n = 9] and worst [n = 9]) according to the median value of peak speed during an incremental test, vertical jump performance, and best, mean and relative decrement during repeated sprint test (RSA_{best}, RSA_{mean}, and RSA_{dec}, respectively). Effect sizes (*d*) are also present

	TD (m)	*HIR (m)*	*VHIR (m)*	*Sprinting (m)*	*Top speed ($km \cdot h^{-1}$)*
Peak speed ($km \cdot h^{-1}$)					
Best	12011 ± 747	3192 ± 482	1014 ± 120	213 ± 76	31.4 ± 1.4
Worst	10712 ± 669*	2314 ± 347*	779 ± 122*	185 ± 45	32.0 ± 0.9
Difference	1299	878	235	28	– 0.6
Difference (CI 95%)	544; 2054	422; 1334	105; 365	– 32; 88	– 1.7; 0.5
d	1.35	1.44	1.39	0.45	0.52
RSA_{best} (s)					
Best	11373 ± 826	2760 ± 529	964 ± 159	223 ± 52	31.9 ± 1.0
Worst	11350 ± 1128	2746 ± 711	828 ± 157	175 ± 66	31.6 ± 1.4
Difference	23	14	136	48	0.3
Difference (CI 95%)	– 949; 995	– 611; 639	– 26; 298	– 11; 107	– 1.0; 1.6
d	0.02	0.02	0.79	0.76	0.23
RSA_{mean} (s)					
Best	11327 ± 848	2758 ± 517	974 ± 162	235 ± 56	32.2 ± 1.0
Worst	11396 ± 1111	2748 ± 720	819 ± 144*	164 ± 58*	31.3 ± 1.2
Difference	– 69	10	155	71	0.8
Difference (CI 95%)	– 1021; 883	– 625; 645	2; 308	17; 125	– 0.3; 1.9
d	0.07	0.02	0.92	1.14	0.71
RSA_{dec} (%)					
Best	11196 ± 1056	2665 ± 664	858 ± 180	183 ± 62	31.6 ± 1.4
Worst	11527 ± 883	2841 ± 572	935 ± 157	213 ± 62	31.9 ± 1.0
Difference	– 331	– 176	– 77	– 32	– 0.3
Difference (CI 95%)	– 1272; 610	– 775; 423	– 242; 88	– 93; 29	– 1.7; 1.1
d	0.35	0.29	0.46	0.51	0.22
Vertical jump performance (cm)					
Best	11474 ± 750	2805 ± 462	930 ± 143	212 ± 74	31.9 ± 1.1
Worst	11249 ± 1168	2701 ± 753	862 ± 194	186 ± 49	31.5 ± 130
Difference	226	105	68	26	0.4
Difference (CI 95%)	– 725; 1177	– 498; 708	– 98; 234	– 35; 87	– 0.7; 1.5
d	0.24	0.17	0.4	0.41	0.36

TD: total distance; HIR: high-intensity running (speed > 14.4 $km \cdot h^{-1}$); VHIR: very high-intensity running (speed > 19.8 $km \cdot h^{-1}$); sprinting: (> 25.2 $km \cdot h^{-1}$); * $p < 0.05$

[31]. That is, the physiological attributes required to perform the RSA tests may be similar to those required to maintain high-speed and sprinting performance throughout a soccer match. In fact, the high-to-low intensity exercise ratio and the mean total duration of the RSA test used in the present study was 1:2.8 and 143.5 s, respectively, which is similar to the values reported by Withers et al. [43] for the most physiologically demanding phases during a soccer match (ratio of 1:3.1 and duration of 178.2 s) [44]. While the correlation between RSA_{mean} and actual match performance was only moderate, this may be explained by the observation that sprinting during a match occurs over a longer period (i.e., 90 min), is interspersed by variable activities (i.e., walking, jogging, etc.) and has larger intra-match distance variability when compared to the RSA test.

Other parameters of the RSA test were not associated with any of the physical match performance variables investigated in this study. Unfortunately, we did not collect data relative to the decrement during the match in sprinting or VHIR performance. Consequently, we cannot exclude that RSA_{dec} might be related to the decrement of high-intensity physical soccer performance as reported in a field hockey simulation [13]. The lack of a significant relationship between RSA_{best} and physical performance justifies the use of a repeated-sprint test rather than a single sprint test to assess soccer players. Furthermore, this could indicate that soccer players do not use their maximum running speed ability during the match. Consequently, tests of maximum running speed such as RSA_{best} may not be relevant for the assessment of soccer players' physical performance. However, we cannot exclude that RSA_{best} may be related to other match variables not selected in the present study. In summary, in agreement with our hypothesis, the mean time during the RSA test was related to the distances covered at high-speed running during a match, but contrary to our expectation, other parameters of the RSA test

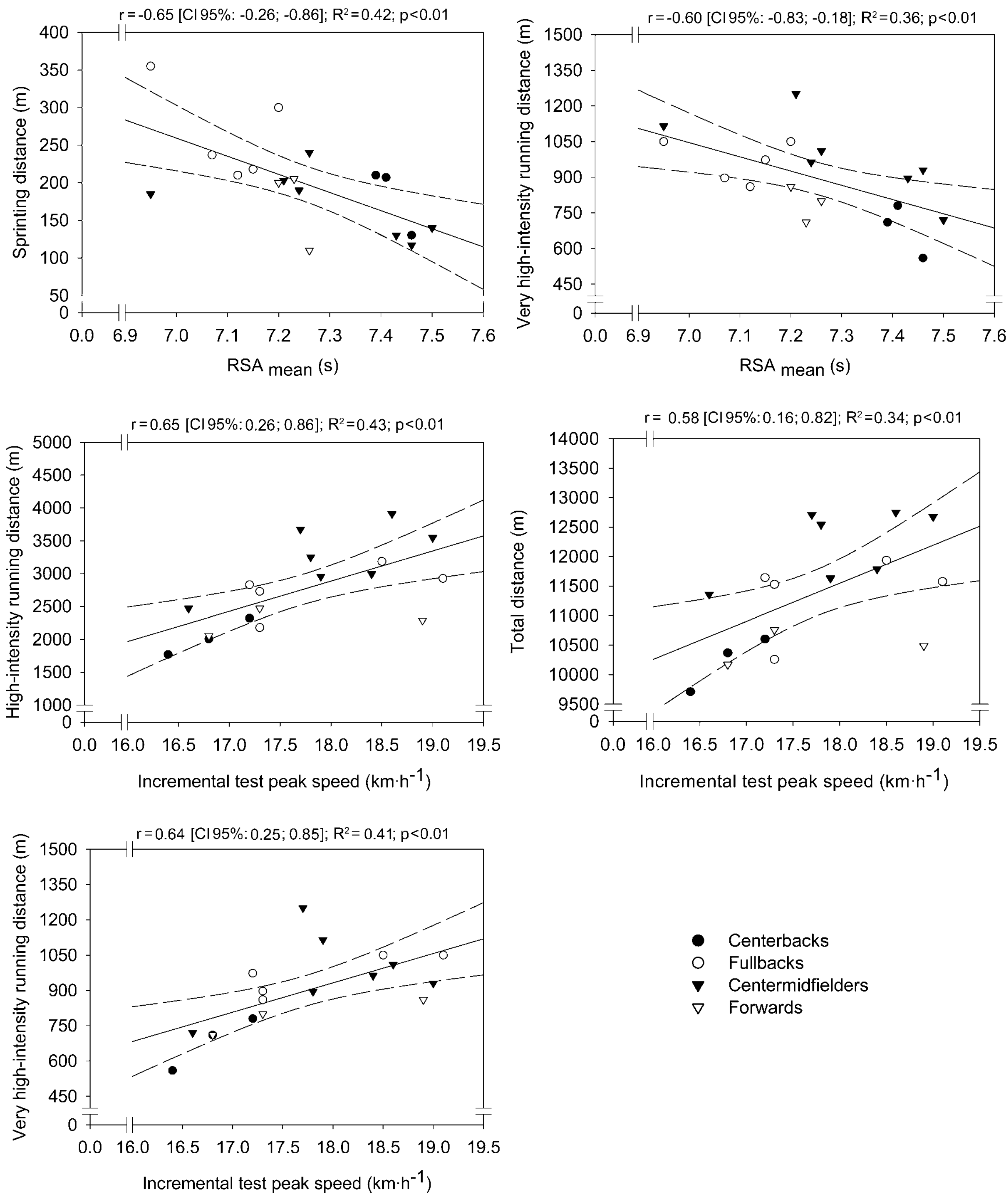

Fig. 1 Scatterplots of the significant correlations between field tests and match-related physical performance (n = 18).

(RSA_{best}, RSA_{dec}) were not associated with HIR or sprinting performance.

Contrary to our hypothesis, the present study failed to show a significant correlation between VJP and the selected soccer match variables. Similarly, VJP did not discriminate players with different physical match performance abilities. In contrast, Arnason et al. [3] reported that VJP was related to ranking in Icelandic elite soccer players. However, Cometti et al. [16] observed higher VJP in amateur compared to sub-elite French soccer players while Rosh et al. [35] reported lower VJP in amateur players compared to top-level and third division players. However, they also found similar VJP between top-level and third division players compared to local team players. Wisloff et al. [42] also found no difference in VJP between the first and last team in the Norwegian National Championship. Thus, to date, there appears to be little clear evidence that VJP is able to discriminate players with different match performance. It should be acknowledged that muscular power may be an important component of other soccer activities such as tackles and headers not analyzed in the present study. However, as headers and tackles do not discriminate players of different competitive levels [30], the utility of assessing VJP in soccer players seems to be doubtful. Further, studies are, therefore, needed to establish the relevance of vertical jump assessment for soccer players.

In conclusion, this study gives empirical support to the construct validity of RSA and incremental running tests as indicators of match-related physical performance in top level professional soccer players. Nevertheless, the moderate correlations found do not allow their use for predictive purposes (predictive validity). However, this was beyond the aim of the present study. In fact, according to Svensson and Drust [39], field tests as well as laboratory assessments should never be used to predict on-field actual match performance because of the complex and multifactorial nature of soccer performance itself. On the other hand, field tests such as the ones validated in this study can be used to assess specific physiological components of soccer performance and to prescribe individualized physical training for soccer players [22, 39]. Interestingly, peak speed during the incremental test and mean time during the RSA test seemed to measure somewhat different match-related physical performance. In fact, although both tests were associated with HIR, peak speed during the incremental test and RSA test were not correlated to each other. This suggests that both of these tests are useful for the physical assessment of soccer players as they reflect different components of HIR (e.g., aerobic vs. anaerobic power and capacity). Future studies using a larger sample size are needed to confirm our findings.

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