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THE ASSOCIATION BETWEEN PHYSICAL TESTING AND TRAINING OUTPUT ACROSS AN 8-WEEK TRAINING CYCLE AMONGST ELITE CHAMPIONS LEAGUE LEVEL SOCCER PLAYERS.

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Running Head: Association between testing and training data in professional soccer

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ABSTRACT

The aim of the present investigation was to analyse the association between physical fitness profiles, playing positions and the profile relationships between training output amongst elite professional soccer players. Twenty professional players (height: 182.0 ± 3.2 cm, body mass:77.4 ± 6.1 kg, 25.7 ± 3.4 years) competing at UEFA Champions League level were involved in the present investigation. Players assessments included speed (5m and 20m), agility (T-test), jump performance (SJ and CMJ) and aerobic power (VO_{2max}) at the start of pre-season. Players training outputs were recorded with global positioning systems (Statsports, Viper Pod, Newry, Northern Ireland) across 5 micro-cycles at the start of competitive period. Total distance (TDC; m), relative distance ($m.min^{-1}$), high-speed running (HSR; m), explosive distance (m), total accelerations (n), total decelerations (n) and total sprints (n) were measured. No difference between playing positions were found in the physical tests. Jump and 20m-speed tests were significantly correlated with total accelerations (r= 95% CI:), total decelerations (r = 95% CI:), total sprints (r = 95% CI:), HSR (m) (r= 95% CI:) and HSR ($m.min^{-1}$) (r= 95% CI:). 5m-speed test significantly correlated with explosive distance (r= 95% CI:). VO_{2max} correlated with all metrics ($p<0.05$) except total decelerations (r= 95% CI:) and TDC (r= 95% CI:). To conclude, laboratory based testing protocols were shown to positively relate to professional player training outputs. Furthermore, this study additionally highlights the significant difference in positional based training demands and requirements from a physical training output perspective. Coaches and key individuals involved with the physical preparation of elite players should consider the relationships between these tests when attempting to monitor and develop specific physical fitness qualities of the elite soccer player.

Key Words: *soccer, testing, human performance, health, fitness testing*

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INTRODUCTION

Professional soccer players at the elite level are placed under continual domestic, European and international competitive demands. Inadequate conditioning levels combined with limited recovery phases between matches induce significant stress and subsequent injury risk (Carling et al., 2012; Laux et al., 2015). Technical and physical coaching staff involved within the physical preparation of players should understand both the demands required to compete at the elite level, in addition to the global physical profile of the player in order to balance physical capacity improvement and subsequent training loads. As such there is a requirement for effective player management and monitoring strategies across intensified training periods and competitive schedules (Dupont et al., 2010).

Match play demands of soccer involve endurance activities alongside powerful, repeated bouts of high-intensity and high-speed actions interspersed with limited recovery periods, players are required to possess a range of physical qualities in order to best meet these demands (Owen et al., 2014; Stolen et al., 2005). Recently the importance that power and speed actions during soccer matches (e.g. sprints, jumps) have been highlighted (Faude et al., 2012). Interestingly, goals during match play were preceded by at least one powerful action of the scoring or the assisting player. Most actions for the scoring player were straight sprints (45% of analysed goals) followed by jumps (16%), rotations and change-in-direction sprints (6% each). Most sprints were conducted without an opponent ($P< 0.001$) and without the ball ($P< 0.001$). Similarly, for the assisting player the most frequent action was a straight sprint ($P< 0.001$) followed by rotations, jumps, and change-indirection sprints. The straight sprints were mostly conducted with the ball ($P = 0.003$). Currently, there is an ever-growing appreciation for the use of tools to quantify and monitor these actions within the training process, with these tools used to quantify training outputs and training loads (Owen et al., 2014; Buchheit et al., 2014). It is widely accepted that the use of these monitoring systems can provide practitioners with a summary of the induced mechanical and locomotor demands of training (Akenhead et al., 2016; Owen et al., 2017).

During both training and match-play, positional variance with regard to conditioning levels, training and competition impact the physical output generated by players (DiMascio et al., 2013; Dellal et al., 2011; Owen et al., 2016). Previous research has observed how central midfielders (CM) and full-backs (FB) cover greater distances vs. central defensive players (CD) within match-play scenarios (DiMascio et al., 2013 ; Dellal et al., 2011) based on a tactical need to provide both attacking and defensive support functions (Strudwick et al., 2002). Furthermore, players have shown differing physical qualities and requirements. An example of this is how forward players (FW) reported fastest sprint times from 10 to 40m and produced higher explosive jump scores, when compared to other positions assessed (Sporis et al., 2009; Boone et al., 2012; Haugen et al., 2013).

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Positional testing analysis however, revealed how midfield players had improved aerobic profiles (VO_{2max}) compared to FW and CDs. Recently, within training sessions, variance in positional demands have been shown, with this variance shown with respect to players percentage of match day exposure (Owen et al., 2017).

Association of physical testing and these tests association to players training output activity is a topic of limited research, especially at the elite level, due to the time constraints of the competitive cycle. One such study by Helgerud et al. (2001) revealed significant improvements of aerobic fitness (VO_{2max}) were directly related to an increased total distance covered (TDC) within competitive match-play in addition to increased number of sprints, and ball possession involvement. Furthermore, Rebelo et al., (2014) revealed that the Yo-Yo intermittent endurance test performance of soccer players was significantly correlated to increased match high-speed running activity amongst elite youth soccer players (Rebelo et al., 2014). Moreover, the same authors concluded that acceleration and maximum sprint abilities are distinct for each player from different standard of play (Rebelo et al., 2013). According to recent research in this area linking training outputs with physical developments, authors have reported increased training-duration spent at the higher-intensity zone significantly correlated to the increase in oxygen uptake (VO_2) and lactate threshold at running speeds at 2 and 4 $mmol.L^{-1}$ (Impellizzeri et al., 2005; Castagna et al., 2011). As a result of these studies, it may therefore suggest that enhancing of players physical testing data may directly relate to an increased training output.

To date, no previous or current study has examined the association between elite players physical capacities and their subsequent training outputs. The information gathered could be of a crucial interest since players training activity could directly be related to the teams physical testing protocols. Moreover, individuals involved within the physical preparation of elite soccer players could utilise the information to provide clearance thresholds within the rehabilitation processes, along with targets for performance enhancement. Therefore, the aim of the current investigation was to analyse the association between physical test performance and training output among elite level soccer players. It was hypothesised that players who produced greatest performance on specific laboratory based testing protocols would achieve a greater relative training metric output. It was also hypothesised that training outputs would differentiate between positions due to different demands imposed on positional roles.

METHODS

Subjects

Twenty elite male professional soccer players (Height: 182.0 ± 3.2 cm, body mass: 77.4 ± 6.1 kg, Age: 25.7 ± 3.4 years) participated in this investigation. Players participating within this study

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were at the time competing in their associated Premier League within European in addition with the UEFA Champions League. All participants had been playing soccer for an average of 8 years or more (Range: 3-11 years). Participants were informed that they were free to withdraw their individual data from the study at any time. Procedures were in accordance with the Helsinki Declaration and approved by the local University ethical committee.

Procedures

To examine the association between physical test data and training output of elite soccer players, each player undertook a battery of tests involving speed, power and endurance capacities at the start of the pre-season phase. Training data used for analysis within this study involved a total number of 35 training sessions over eight consecutive weeks of a competitive period (August - September). Any players who failed to complete the full training duration or session, or whose data revealed abnormality upon further investigation was removed from the statistical analysis. Goalkeeper's data was also excluded from the study and the data analysis. During the observational period. all players were allowed to consume isotonic sports drinks ad libitum. Prior to all testing players were instructed to maintain normal daily food and water intake. No additional dietary interventions were undertaken throughout the investigation.

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Sprint Performance (5 and 20m)

Straight-line sprint speed at 5-m (Sp-5) and 20-m (Sp-20) were measured to assess sprint performance. The straight-line sprint test was conducted outdoors on a track. Prior to the sprint assessment, players completed a 7-minute low intensity warm up followed by a 3-minute joint mobilization period focusing on ankles, knees, hips and shoulders. This was preceded by 3 x 30m sprints progressively increasing in intensity from 60 to 95% of perceived maximum speed. During the test, running speed of the subjects was evaluated on a 5-m and 20-m using electronic timing gates (Swift Performance Speed Light Pro4 Bundle equipment). These were positioned at 5-m and 20-m from the starting point. Subjects began each sprint from a standing position with their front foot beside a cone, 1 m behind the first gate. Subjects were then instructed to run as quickly with 100% effort along the tested distance. Time was measured to the nearest 0.01 second and the best value obtained from the 2 trials was used for later analysis.

Agility Performance (T-test)

Players performed a T-test to evaluate agility performance as described by Hoffman (2006). T-test is formatted as a T-figure represented by four cones placed on the ground. Players were instructed to start at the first cone and sprint 10 m forward to the second cone, shuffle laterally 5 m to the third cone to the right, shuffle 10 m in the opposite direction to the fourth cone, shuffle 5 m back to the middle cone, and then run backward 10 m to the starting cone. Players were asked to touch each cone with their hand. They had three attempts separated by one minute of passive recovery and the fastest one was kept for analysis. The same electronic system as used for sprint performance was used for agility assessment.

Jumping Performance (CMJ, SJ)

Players performed a vertical jump (CMJ) and squat jump (SJ), each jump was assessed through the use of a portable optical timing system (Optojump Next, Microgate, Bolzano, Italy). The system is valid and reliable in the assessment of jump performance variables (Glatthorn et al., 2011). The Optojump Next system consists of 2 bars (i.e., transmitting and receiving units) placed 1 m apart and parallel to each other that were equipped with 33 optical LEDs. The Optojump Next features 2 cameras (i.e., 30 Hz) that enable front and lateral caption of video footages of each performed jumps (Castagna et al., 2013; Glatthorn et al., 2011). When performing the SJ assessment, subjects started from the upright standing position, they were then instructed to flex their knees and hold a predetermined position (approximately 90º) as used during their normal training routines. Subjects were required to hold that position for 3 seconds before being instructed to jump as high as possible. Three trials were performed with 1-minute rest between them. If any counter-movement was observed, the trial was discarded and an additional trial was performed after 1 minute of rest. With respect to the CMJ, subjects started from upright standing position, with knees fully extended, and then were instructed to flex their knees (approximately 90º) as quickly as possible and then jump as high as possible in the ensuing concentric phase. Three trials were performed with 1-minute rest between them. All jumps were performed with hands on the hips to eliminate the effect of arm swing during the performance of each jump. Only the highest of the three jumps performed for each test was considered for the statistical analysis (Domire et al., 2007; Glatthorn et al., 2011).

Aerobic Performance Assessment (VO_{2max} Protocol)

Prior to the commencement of the VO_{2max} treadmill assessment, each player performed a 5-min jogging warm up on a motorized treadmill (Technogym, Run 500 model, Italy) at a velocity that elicited ~60% of player's maximum heart rate ($HR_{max)}$ which was obtained from the players previous VO_{2max} treadmill test. Following the warm up, each player performed a maximal incremental running test sustained at 5.5% gradient for the totality of the test. The treadmill was set at 9 $km \cdot h^{-1}$ for the first 5-min before the velocity of the treadmill increased by 1 $km \cdot h^{-1} \cdot min^{-1}$ until volitional exhaustion. VO_{2max} was recorded as the highest mean VO_2 obtained for a 1 min period with the following criterion met: (1) a plateau in VO_2 despite increasing treadmill speed (2) a respiratory ratio above 1.10 (3) attainment of the age predicted heart rate (HR). The HR was recorded using HR belts (Polar Team System, Polar Electro, OY, Finland).

Training Output analysis.

During each training session (n = 35) and across the 8-weekly microcycles of the investigation, each individual player's training outputs were monitored using 10 Hz GPS technology (STATSports Viper Pod, Newry, Northern Ireland). The system has been shown to be a valid and reliable marker of assessment for monitoring team sport movement demands (Beato et al., 2016). For the purposes of the current investigation, the following variables were assessed: TDC (m), relative TDC ($m \cdot min^{-1}$), high-speed running distance (HSR; m; >5.5 $m \cdot s^{-1}$), relative HSD ($m \cdot min^{-1}$). Additionally, explosive distance (m; >2 $m \cdot s^{-2}$), total numbers of accelerations (n), decelerations (n) (n; >3 $m \cdot s^{-2}$), total number of sprints (n > 7 $m \cdot s^{-1}$). Following each training session, GPS data were downloaded using the respective software package (Viper software, STATSports, Newry, Northern Ireland) and were analysed to include all movements within the "main" organised training session (i.e. the beginning of the warm up to the end of the last organized drill for each player).

Statistical analyses

All data is reported as mean ± standard deviation unless stated otherwise. Prior to analysis all variables were assessed for normality via a Shapiro-Wilk test. A univariate analysis of variance (ANOVA) along with a bonferroni post hoc test was performed to determine if there was variation across position (dependent variable) within all of the variables analysed, with statistical significance was set at $p < 0.05$. Finally, Pearson's product-moment correlation tests were assessed between the physical-test variables and the GPS metrics. Significant correlations ($p<0.05$) with values of 0-0.19, 0.20-0.39, 0.40-0.59, 0.60-0.79 and 0.8-1.00 were respectively interpreted as very weak, weak, moderate, strong and very strong (Evans, 1980). All statistical analysis was performed using the Statistical Package for Social Sciences software (SPSS Version 23.0, Chicago, IL).

RESULTS

$$$ Table 1 & 2 near here $$$

All the variables were found to have a normal distribution ($p<0.05$). All means are detailed in **Table 1** and **Table 2**. No differences were found in physical tests according to the playing positions. All jump tests and Sp-20 were significantly correlated with the number of accelerations (|0.15| to |0.31|), decelerations (|0.16| to |0.29|), sprints (|0.10| to |0.29|), HSR (|0.10| to |0.31|) and $HSR.min^{-1}$ (|0.10| to |0.31|) distances ($p<0.05$), but not with TDC and $TDC.min^{-1}$. Only Sp-5 test was correlated with explosive distances (0.11 to 0.17; $p<0.05$).

VO_{2max} was significantly correlated with the number of accelerations (0.16), the number of sprints (0.20), explosive distances (0.12), TDC.min^{-1} (0.11), HSR (0.19), HSR.min^{-1} (0.20) ($p<0.05$). Every correlation can be found in **Table 3**.

$$$ Table 3 near here $$$

DISCUSSION

The aim of the current investigation was to analyse the relationship between physical-test performances and physical-output during soccer training sessions amongst elite level soccer players. The main findings were that the majority of the sprint and jump tests performance were correlated to the number of accelerations, decelerations, sprints, HSR and HSR.min^{-1}. Furthermore, that VO_{2max} test performance was positively correlated to the number of sprints, accelerations, HSR, HSR.min^{-1}, TDC.min^{-1} and explosive distance. The investigation did not find any levels of significance within the physical-test performance according to playing positions even though the physical activity during training sessions was positional dependant for most of the training outputs.

Testing analysis

Assessments of physical-tests were realised over Portuguese top-elite professional soccer players. They were tested on sprinting-speed, agility-speed, jumping and on a VO_{2max} tests to measure their fitness at the beginning of the pre-season period. Our hypothesis was not confirmed as no differences were found between playing positions in all these physical-tests. A part of the present results were not in accordance with the literature on this topic. Indeed, over speed and jump tests, elite Belgium FW and FB were faster when compared across other positions, and FW and CB jumped higher than other positions when performing

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both SJ and CMJ (Boone et al., 2012). Elite Croatian FW were faster and performed better in the SJ when compared to other positions (Sporis et al., 2009), and elite Norwegian FW and defenders (no differentiations in the study) were faster, with midfielders presenting lower jumping profiles compared across other positions (Haugen et al., 2013). One of the explanation about differences between these studies and the present one could be the size of the sample: 289, 270 and 939 players in theirs, respectively, against 20 in the present study. However, results from another large investigation reported no differences between playing positions in different sprint-tests within 243 elite Turkish players (Taskin, 2008), and an investigation with a similar sample size, across 17 top-level Norwegian soccer teams also observed no differences among playing positions (Wisloff et al., 2004). Sporis et al., (2009) confirmed in accordance with findings in this study that no differences among the playing positions were found in CMJ tests across 270 elite Croatian players. Concerning the endurance capacities of various positions and more concisely VO_{2max}, the current investigation observed how FBs revealed higher values when compared across other positions, although recent reports observed different outcomes with midfielders having greater VO_{2max} values vs. defenders and forward positions (Sporis et al., 2009; Tonnessen et al., 2013). As a result, the findings observed in this study was generally in line with recent the literature (Boone et al., 2012, Rebelo et al., 2013), however the main difference between all studies compared was the testing period, which may influence the outcome. The Belgian players were tested during pre-season (Boone et al., 2012), Croatian players at the end of pre-season (Sporis et al., 2009), Norwegian players at different moment during the season (Haugen et al., 2013), and Turkish players during the competitive period (Taskin, 2008). Therefore, the differences in the physical profiles to cross comparison with data obtained within the current literature may be difficult and taken with caution.

As soccer is a high-intensity-intermittent sport, the ability to sustain high work rates

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during training sessions and match play is an essential component to achieve performance (Owen et al., 2015). As the ability to repeat high intensity actions is well related to performance (Rampinini et al., 2007) and recovery, the efficiency of the process depends on the power of the aerobic metabolism (Sahlin et al., 1979; Spencer et al., 2005). Elite-level soccer players have been reported to have attained VO_{2max} measures up to the equivalent of 75ml.min^{-1}.kg^{-1} (Stolen et al., 2005). In the present investigation, VO_{2max} values (range 52.66 – 59.92 ml.min^{-1}.kg^{-1}) were largely below this maximal observed maybe as a result of the timing of the season tested.

Training analysis

Within the current study, training output highlighted no differences among playing positions in terms of absolute TDC and relative TDC.min^{-1} as presented in **Table 2**. Although TDC is known to significantly differ during soccer matches according to playing positions (Dellal et al., 2011), it is well known that high-intensity actions are more important in the decisive moments of competitive matches (Mohr et al., 2003). In this context, levels of significance were detected among playing positions in high intensity and speed metrics. FB, WM and FW listed greater number of accelerations vs. CB, and more sprints, HSR distance and subsequent intensity drawn through HSR.min^{-1} distance when compared with CB and CM ($p<0.005$). Also WM and FB reported significantly greater levels of explosive distance vs. CB ($p<0.005$). These findings concur with previous literature concerning observations within Champions League-level matches that suggested positional output similarities with respect to number of total, explosive and leading sprints (Di Salvo et al., 2010) showing similarities with training and match activity.

Link between training and testing

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In agreement with our hypothesis, significant correlations were found between Sp-20, SJ, CMJ and the GPS metrics related to speed and explosive power such as A, D, number of sprints, HSR and HSR.min^{-1}. Therefore, taking the current study into context with elite UEFA Champions' League level soccer players, it can be suggested that the quicker and more explosive players assumed from the pre-season physical laboratory tests, the higher the values accumulated in the functionality of training, related to those physical qualities (**Table 3**). Nevertheless, the present investigation is unique in its concept to assess the relationship between physical performance testing, and its transferable capacity to physical activity generated across the training microcycle on the pitch in an elite soccer team. Additional results from the current investigation highlighted Sp-5 and its correlation with number of sprints and explosive distance capacity, which highlight the fact that the most explosive players in a testing scenario generally reproduce this physical quality within the training session. Repeatedly performing intense running actions have shown to impose high mechanical strain and induce possible risk of injury (Raastad et al., 2010), however the fact that increasing player's capacity to produce explosive, fast actions when tested will positively improve that performance aspect in the training session. Subsequently, the risk of injury vs. improvement in performance must be managed safely, but this study highlights the need to overload players for a developmental response.

Furthermore, lab based tests SJ and CMJ revealed significant correlations with speed- and power-related in-session training GPS metrics. From the findings, it is interesting to observe (**Table 3**) how CMJ was similarly correlated to the same training metric response as SJ performance. Even though SJ and CMJ performance are both relative markers of power, SJ has previously being related to maximal sprinting capability (Chelly et al., 2010) and CMJ with repeated sprint capacity (Baldi et al., 2016). However, in this particular context, CMJ has been shown as more relevant relating its performance to speed- and power-related training outputs. This is in-line with previous research suggesting that the most-explosive players in terms of jumping capacity generally posted the faster speed scores in a testing environment but again this is the first study to report the link between testing capacity and in-session training outputs of jump and sprint tests vs. GPS metrics.

In partial agreement with our hypothesis, correlations were observed between VO_{2max} and A, sprints, explosive distance, $TDC.min^{-1}$, HSR, $HSR.min^{-1}$ ($p<0.005$). Only D and TDC were not associated to VO_{2max}. Therefore, in our particular context, the fitter the players were at the start of pre-season, the greater high-intensity activity they performed during training-sessions, after the beginning of the competitive period. The weak and very weak correlations observed in the present study are probably related to the high inter-individual variability represented by the coefficient of variability varying from 18% to 131% in the training-outputs. It is possible that realising a similar analyse over a larger sample would permit to get stronger correlations and therefore strengthen the observation of the present investigation.

It would have been interesting if the laboratory-tests could have been made a second time after pre-season to re-assess the fitness profiles. However, the particular context of a professional team did not allow re-testing the players because major preoccupation at the end of pre-season was to have an optimal training program to perform as the competitive period started. Further investigation might be needed to make relevant conclusions, as the present study analysed one soccer team and results could not be generalized. Sprints in soccer are rarely longer than 20m (Reilly & Thomas, 1976; Bangsbo et al., 1991) but it would have been interesting to test speed over a longer distance (e.g. 40m) in order to have a speed-data closer to the maximal sprinting speed and observe eventual stronger correlations with some of the

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training outputs, although it has been showed that maximal sprinting speed reached during training sessions are quiet lower than the one reached during official matches (Djaoui et al., 2016).

CONCLUSION

The purpose of this investigation was to analyse the relationship between physical-test performance and physical-output during soccer training sessions amongst elite level soccer players. Results of the present study support the suggested hypothesis in revealing an association between players who performed well on specific laboratory based testing protocols achieving greater relative training outputs within the training sessions. The study highlighted how players with well developed explosive and sprint based capacities shown through laboratory testing protocols, corresponded well with similar power based pitch assessment GPS metrics with relationships found between SJ, CMJ, 20m sprint-tests, number of accelerations, decelerations, sprints, explosive distance, absolute HSR and relative HSR.min^{-1}. It can be concluded from this investigation that players who perform well in specific laboratory based testing protocols transfer this capability into the training output response in football related activities. Regarding this finding, coaches and physical development personnel may therefore take notice and subsequent confidence that the continual monitoring and developing of key physical attributes involved within the elite level of professional soccer may enhance the player’s capability to increase physical performance output in training & games. Furthermore, this study additionally highlights the significant difference in positional based training demands and requirements from a physical training output perspective.

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Table 1. Physical test data of elite professional soccer players.

Position	(n)		CMJ (cm)	SJ (cm)	One-leg J (cm)	Sp-5m (s)	Sp-20m (s)	Agility (s)	VO_{2max} ($mL \cdot kg^{-1} \cdot min^{-1}$)
Central Backs	4	m	43.78	43.63	23.34	0.86	2.81	2.86	54.02
		SD	5.20	4.52	4.71	0.10	0.08	0.09	2.40
Full backs	4	m	43.63	43.05	23.50	0.91	2.78	2.90	58.92
		SD	6.68	5.82	5.95	0.02	0.06	0.08	1.37
Central Midfielders	4	m	45.93	46.58	25.18	0.92	2.81	2.89	55.80
		SD	5.72	6.73	5.00	0.04	0.10	0.07	4.09
Wide midfielders	5	m	41.34	40.58	22.30	0.90	2.78	2.92	55.40
		SD	3.81	4.41	4.07	0.05	0.08	0.06	1.77
Forwards	3	m	41.50	39.27	22.73	0.90	2.81	2.92	52.66
		SD	2.96	1.10	3.60	0.03	0.01	0.08	3.64
All players	20	m	43.23	42.69	23.39	0.90	2.80	2.90	55.50
		SD	4.85	5.13	4.35	0.06	0.07	0.07	3.24

CMJ: countermovement jump; SJ: squat jump; One-leg J: one-leg jumps; Sp-5: sprint over 5m;

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Table 2. Training outputs in top-elite professional soccer players.

Positions	(n)		Accelerations (n)	Decelerations (n)	Sprints (n)	Explosive Distance (m)	TDC (m)	Relative TDC ($m \cdot min^{-1}$)	HSR (m)	Relative HSR ($m \cdot min^{-1}$)
Central Backs	86	m	33.16	34.48	1.66	559.88	5247.30	65.85	18.49	0.23
		SD	10.30	14.73	1.91	218.62	1461.70	18.96	22.63	0.29
Full Backs	89	m	47.48*£	44.10*£	5.57*£	697.60*	5396.68	68.68	69.66*£	0.87*£
		SD	19.30	20.64	4.12	299.22	1588.38	19.55	52.55	0.66
Central Midfielders	29	m	32.52	27.38	1.41	616.49	5428.27	69.35	17.32	0.20
		SD	15.24	17.16	1.66	330.89	1901.45	22.51	22.74	0.25
Wide Midfielders	132	m	41.20*	39.00£	4.36*£	741.76*	5478.73	69.11	51.06*£	0.63*£
		SD	14.02	18.25	3.87	305.36	1599.49	20.89	50.29	0.64
Forwards	49	m	40.35*	39.53£	3.69*£	625.41	5065.97	63.24	46.29*£	0.59*£
		SD	13.80	15.06	3.72	256.46	1535.12	20.66	57.30	0.78
All players	385	m	40.10	38.36	3.73	666.68	5351.73	67.55	44.94	0.56
		SD	15.64	18.15	3.74	290.23	1581.59	20.26	49.26	0.63

* Significantly greater than Central Backs (p<0.005); $ Significantly greater than Full Backs (p<0.005); £ Significantly greater than Central Midfielders (p<0.005); #Significantly greater than Forwards (p<0.005)

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Table 3. Correlations coefficient between physical tests and GPS metrics in professional soccer players. Data presented as r^2 (95% CI)

	Accelerations (n)	Decelerations (n)	Sprints (n)	Explosive Distance (m)	TDC (m)	Relative TDC ($m \cdot min^{-1}$)	HSR (m)	Relative HSR ($m \cdot min^{-1}$)
Sp-5	.	.	0.12	0.11	.	.	.	.
Sp-20	-0.31	-0.21	-0.29	.	.	.	-0.31	-0.31
Agility	-0.16	.	.	.	.	.	.	.
SJ	0.15	0.19	0.1	.	.	.	0.10	0.10
CMJ	0.22	0.16	0.15	.	.	.	0.14	0.14
VO2max	0.16	.	0.20	0.12	.	0.11	0.19	0.20

CMJ: countermovement jump; SJ: squat jump; Sp-5 and Sp-20: sprint test over 5 and 20m respectively.

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