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Contribution of Speed to Running Anaerobic Sprint Test (RAST) Performance in Professional Greek Soccer Players

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Abstract

The running anaerobic sprint test (RAST) evaluates repeated sprint ability and its relation to maximal speed. However, the association between RAST and other speed parameters has attracted little scientific attention. The purpose of this study was to establish the relationship amongst RAST performance measures to first step quickness (5 m), acceleration (10 m), maximal speed (30 m), 5-10 m and 20-30 m splits in professional soccer players. Nineteen Greek professional soccer players were tested for RAST performance, first step quickness, acceleration and maximal speed during the preseason. Mean time (RASTmean), percent decrement (%dec) and fatigue index (FI) were also calculated. RASTmean had a likely moderate relationship to 10 m (r= 0.33; 90%CL, -0.07 to 0.67), most likely large relationship to 5-10 m (r= 0.60; 90%CL, 0.27 to 0.80), likely moderate relationship to 20 m (r= 0.32; 90%CL, -0.08 to 0.63), very likely large relationship to 30 m (r= 0.60; 90%CL, 0.26 to 0.80) and a most likely large relationship to 20-30 m (r= 0.70; 90%CL, 0.43 to 0.86). %decbest were likely moderately slower in 5 m (r= 0.88; 90%CL, 0.12 to 1.64), 10 m (r= 0.93; 90%CL, 0.19 to 1.68), 20 m (r= 0.68; 90%CL, -0.12 to 1.48) and 30 m (r= 0.70; 90%, 0.09 to 1.49) compared to %decworst. Similarly, FIbest were likely moderately slower in 5 m (r= 0.66; 90%CL, -0.14 to 1.46), 10 m (r= 0.95; 90%CL, 0.22 to 1.69), 5-10 m (r= 0.76; 90%CL, -0.03 to 1.54), 20 m (r= 0.78; 90%CL, -0.01 to 1.57), 30 m (r= 0.92; 90%CL, 0.17 to 1.67) and 20-30 m (r= 0.61; 90%CL, -0.20 to 1.41) compared to FIworst. In conclusion, RASTmean had the strongest association with maximal speed. On the other hand, %dec and FI indices are negatively associated to all speed parameters and slower speed performance.

Keywords: *magnitude-based inferences, repeated sprint ability, field testing, correlation*

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Ερευνητική

Η Συμβολή της Ταχύτητας στην Επίδοση της Δοκιμασίας RAST σε Επαγγελματίες Ποδοσφαιριστές

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Περίληψη

Η ικανότητα για επαναλαμβανόμενα σπριντ συσχετίζεται με την μέγιστη ταχύτητα περισσότερο απ' ότι με την αντοχή αλλά η αλληλοσυσχέτισή της με άλλα χαρακτηριστικά της ταχύτητας δεν έχει ξεκαθαριστεί. Ο σκοπός της παρούσας μελέτης ήταν να εξακριβώσει την αλληλοσυσχέτιση μεταξύ της ικανότητας για επαναλαμβανόμενα σπριντ (δοκιμασία RAST) και της ταχύτητας των πρώτων βημάτων (5 m), επιτάχυνσης (10 m) και μέγιστης ταχύτητας (30 m), καθώς και των ενδιάμεσων χρόνων 5-10 m και 20-30 m σε επαγγελματίες ποδοσφαιριστές. Δεκαεννέα ποδοσφαιριστές εκτέλεσαν στην αρχή της περιόδου προετοιμασίας τις δοκιμασίες RAST, ταχύτητας των πρώτων βημάτων (5 m), επιτάχυνσης (10 m) και μέγιστης ταχύτητας (30 m). Υπολογίστηκαν ο μέσος χρόνος (RASTmean), η ποσοστιαία πτώση (%dec) και ο δείκτης κόπωσης (FI). Ο RASTmean είχε μια πιθανή μέτρια συσχέτιση με τα 10 m (r= 0.33; 90%CL, -0.07 to 0.67), πιθανότατα μεγάλη συσχέτιση με 5-10 m (r= 0.60; 90%CL, 0.27 to 0.80), πιθανή μέτρια συσχέτιση με τα 20 m (r= 0.32; 90%CL, -0.08 to 0.63), πολύ πιθανότατα μεγάλη συσχέτιση με τα 30 m (r= 0.60; 90%CL, 0.26 to 0.80) και πολύ πιθανότατα μεγάλη συσχέτιση 20-30 m (r= 0.70; 90%CL, 0.43 to 0.86). Το υποσύνολο %decBEST ήταν πιθανώς μέτρια πιο αργοί στα 5 m (r= 0.88; 90%CL, 0.12 to 1.64), 10 m (r= 0.93; 90%CL, 0.19 to 1.68) , 20 m (r= 0.68; 90%CL, -0.12 to 1.48) και 30 m (r= 0.70; 90%, 0.09 to 1.49) σε σύγκριση με το υποσύνολο %decWORST. Παρομοίως, το υποσύνολο FIBEST ήταν πιθανώς μέτρια πιο αργοί στα 5 m (r= 0.66; 90%CL, -0.14 to 1.46), 10 m (r= 0.95; 90%CL, 0.22 to 1.69), 5-10 m (r= 0.76; 90%CL, -0.03 to 1.54), 20m (r= 0.78; 90%CL, -0.01 to 1.57), 30 m (r= 0.92; 90%CL, 0.17 to 1.67) και 20-30m (r= 0.61; 90%CL, -0.20 to 1.41) σε σύγκριση με το υποσύνολο FIWORST. Συμπεραίνουμε ότι η πιο ισχυρή συσχέτιση του δείκτη RASTmean ήταν με την μέγιστη ταχύτητα. Αντίθετα, οι δείκτες %dec και FI είχαν αρνητική συσχέτιση με όλα τα χαρακτηριστικά ταχύτητας από την στιγμή που οι καλύτερες επιδόσεις στους παραπάνω δείκτες συνοδεύονται από σταθερά πιο αργές επιδόσεις σε όλο το φάσμα της ταχύτητας.

Λέξεις κλειδιά: *συμπεράσματα βάσει μεγέθους, ικανότητα επαναλαμβανόμενου σπριντ, δοκιμές πεδίου, συσχέτιση*

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Introduction

One of the important soccer fitness components is the repeated sprint ability (RSA), a measure of the ability to recover and maintain maximal effort during subsequent sprints (Stølen et al., 2005). Players with high RSA are more likely to perform at a higher level during a game compared to players who have a lower ability to reproduce maximal sprints (Bishop et al., 2001). Evaluation of RSA has formed a basis for the development and evaluation of the effectiveness of training strategies (Svensson & Drust, 2005) and talent identification (Reilly et al., 2000). It is therefore important that coaches and trainers are able to test reliably RSA in order to assess sport-specific fitness and efficacy of training (Pyne et al., 2008). Numerous exercise protocols for testing RSA have been developed but are marked by disparities in sprint duration, sprint frequency, recovery time, and type of recovery. RSA protocols generally involve 5-10 sprints, spanning 10-40 m (or 4-6 s) with 10-25 s of either passive or active recovery between sprint bouts (Psotta et al., 2005; Rampinini et al., 2007; Pyne et al., 2008; da Silva et al., 2010).

Previous research has reported a significant relationship between RSA and maximal speed (Pyne et al., 2008; da Silva et al., 2008) Also, correlations between acceleration and maximum running speed are typically reported to be large to very large ($r > 0.70$) (Harris et al., 2008). However, besides maximal speed, first step quickness and acceleration are also considered important factors during a soccer game (Bangsbo et al., 2006). Furthermore, it has been reported that first step quickness, acceleration and maximal speed are rather distinct qualities (Little & Williams, 2005). Acceleration is thought to be influenced by the development of concentric forces, impulse and knee extensor activity, whereas maximal speed is thought to be related more to the stretch-shortening cycle, lower-limb stiffness, and hip extensor activity (Sleivert & Taingahue, 2004).

The running anaerobic sprint test (RAST) is an RSA protocol that has been developed to test anaerobic power (Draper & Whyte, 1997) and it is considered to be analogous to the Wingate anaerobic test (Zacharogiannis et al., 2004). The RAST is a reliable (Zagatto et al., 2009) and simple field test that can be easily performed and adequately mimics the parameters of RSA during field-based team sports (Keir et al., 2013). The RAST involves 6 x 35 m sprints separated by 10 s of passive recovery and is perceived as an ideal test to evaluate RSA in soccer players (Spencer et al., 2005). Furthermore, RAST has been validated in soccer players (Keir et al., 2013) and it is reliable, even when performed on grass and the players are wearing soccer cleats (De Andrade et al., 2016). However, the interrelationship between the various speed parameters and RAST has not been established yet. Therefore, the purpose of the present study was to establish the interrelationship between RAST and first step quickness (5 m), acceleration (10 m) and maximal speed (30 m) in professional Greek soccer players.

Methods

Professional Greek soccer players from a team participating in the second national league participated in the study. At the end of the season the team finished at the top 3 of the league and successfully promoted to the first national league. Players performed the following tests at the beginning of the preparation period (early July): a) sprint tests to determine 5 m (first step quickness), 10 m (acceleration) and 30 m (maximal speed) performance, as well as the 5-10 m split and the 20-30 m split, b) RAST test consisting of 6 X 35 m with 10 s passive recovery. Testing took place in the same week but on 2 different days separated by 48 hours. Speed testing was performed first, followed by RSA testing.

Subjects

Nineteen professional well-trained Greek soccer players (26.2 ± 5.6 years; 180 ± 6cm; 76.4 ± 6.0 kg; and 10.8 ± 2.5% body fat) volunteered. The players had been playing professionally for at least 2 years (range: 2-14 years). Written informed consent was received from all participants after explanation of the aims, benefits, and risks of the study. Participants were free to withdraw from the study at any time. All procedures were approved by the University Ethics Committee.

Anthropometric assessments

Height and weight were measured using calibrated stadiometer and scale (Seca, Hamburg, Germany). Percent fat was assessed using a skinfold calliper (Lange, Beta Technology, Santa Cruz, USA) and was calculated based on the 7-site Jackson and Pollock formula (Jackson & Pollock, 1985).

Speed testing

Testing took place in a natural turf soccer pitch with players wearing soccer shoes with cleats. Prior to testing all players completed a standardised warm up of low-intensity running, static and dynamic stretching exercises and short acceleration efforts. Sprint times for 5 m, 10 m, 5-10 m, 20 m, 30 m and 20-30 m were recorded to the nearest 0.001 s using electronic timing lights (Newtest PowerTimer, Newtest Oy, Oulu, Finland).

The 0-5 m, 5-10 m, and 0-10 m intervals measured acceleration; the 0-30 m time afforded a measure of maximum speed specific to soccer. The players performed all sprints starting from a split stance position, with their front foot placed ~30 cm behind the first photocell, and started their effort upon hearing an audio signal. Every player completed 3 attempts and the fastest was used in the subsequent analysis.

RSA testing

The RAST was administered according to the guidelines developed by the University of Wolverhampton, United Kingdom (Draper & Whyte, 1997). In summary, the RAST consists of 6 x 35 m maximal sprint efforts separated by 10 s of recovery (including deceleration). Participants started their sprint upon hearing an audio signal. Upon finishing, they were allowed a short deceleration phase in order to prepare for the next sprint. The time for each run was measured by two photocells placed 35 m apart and the start for each sprint (10 s interval) occurred with an audio signal from the photocell equipment. The power in each sprint was calculated with the formula Power = (Body Mass x Distance2)/Time3. Mean time (RSAmean) was calculated as the average of the 6 sprints, percent decrement (%dec) was determined as RSAmean/RSAbest (Rampinini et al., 2007) and expressed as percent, and fatigue index (FI) was calculated as (Powermax-Powermin/Powermax)*100 (Zagatto et al., 2009).

Statistical analyses

Data in the text and figures are presented as mean ± SD unless stated otherwise. Pearson's correlation coefficients were calculated to establish the respective relationships between RAST performance measures and the various speed variables. The magnitude of the correlations (r; 90% confidence limits) was assessed with the following thresholds: ≤0.1, trivial; >0.1-0.3, small; >0.3-0.5, moderate; >0.5-0.7, large; >0.7-0.9, very large; and >0.9-1.0, almost perfect. If the 90% confidence intervals overlapped small positive and negative values, the magnitude was deemed unclear; otherwise, the magnitude was deemed as observed (Hopkins et al., 2009). Essentially, players were split to BEST and WORST groups, using the median split technique (Rampinini et al., 2007), depending on whether their test score was below or above the median value of peak speed of all participants during RAST. Subsequently, data were log transformed to reduce bias arising from non-uniformity error and then analyzed for practical significance using magnitude-based inferences (Hopkins et al., 2009; Batterham & Hopkins, 2006). Between group standardized differences or Cohen Effect Sizes (d) (90% confidence limits, CL) in the selected performance variables were calculated using pooled standard deviations. Threshold values for d statistics were >0.2 (small), >0.6 (moderate), and >1.2 (large) (Hopkins et al., 2009). Probabilities were also calculated to establish whether the true (unknown) differences were lower, similar or higher than the smallest worthwhile difference or change (0.2 multiplied by the pooled between-subject standard deviation, based on Cohen's Effect Size). Quantitative chances of higher or lower differences were evaluated qualitatively as follows: <1%, almost certainly not; 1-5%, very unlikely; 5-25%, unlikely; 25-75%, possible; 75-95%, likely; 95-99%, very likely; >99%, almost certain. If the chance of both higher and lower values was >5%, the true difference was assessed as unclear (Hopkins et al., 2009). Otherwise, the change was interpreted as the observed chance.

Results

Speed and RAST variables are presented in Table 1. Interrelationships between the various speed attributes are presented in Table 2. The largest interrelationships between the various speed attributes were observed between 5 m and 10 m, and between 20 m and 30 m. The relationships between RAST performance measures (RASTmean, %dec and FI) and the various speed attributes (5 m, 10 m, 5-10 m, 20 m, 30 m and 20-30 m) are summarised in Table 3. With the exception of 5 m, RASTmean correlated with all other speed attributes with the magnitude of the relationships ranging from likely moderate positive to most likely large positive. Correlations of %dec with speed attributes were either unclear or trivial. Finally, FI had a likely moderate negative relationship to 10 m with all other correlations being unclear. %decbest were likely slower in 5 m, 10 m, 20 m and 30 m compared to %decWORST (Table 4). Similarly, FIBEST were likely slower in 5 m, 10 m, 5-10 m, 20 m, 30 m and 20-30 m compared to FIworst (Table 5).

Table 1. Speed and RAST variables (n=19). Values are presented as mean ± SD.

5 m	**10 m**	**5-10 m**	**20 m**	**30 m**	**20-30 m**	**RAST$_{mean}$**	**%dec**	**FI**
s	**s**	**S**	**s**	**s**	**s**	**S**		
1.038 ± 0.074	1.778 ± 0.087	0.740 ± 0.044	3.064 ± 0.101	4.241 ± 0.122	1.176 ± 0.058	5.997 ± 0.150	5.3 ± 2.2	3.8 ± 1.3

Table 2. Interrelationships between the various speed variables. Correlation coefficient (90%CL), p value and observed magnitude of the relationship.

	5 m	**10 m**	**5-10 m**	**20 m**	**30 m**
10 m	*r*= 0.86 (0.71 to 0.94) *p*< 0.001 most likely very large+				
5-10 m	*r*= 0.02 *p*= 0.919 trivial	*r*= 0.52 (0.71 to 0.94) *p*= 0.021 very likely large+			
20 m	*r*= 0.49 (0.12 to 0.74) *p*= 0.032 very likely moderate+	*r*= 0.64 (0.33 to 0.82) *p*= 0.003 most likely large+	*r*= 0.44 (0.06 to 0.71) *p*= 0.063 likely moderate+		
30 m	*r*= 0.40 (0.01 to 0.68) *p*= 0.089 likely moderate+	*r*= 0.68 (0.33 to 0.82) *p*= 0.001 most likely large+	*r*= 0.67 (0.38 to 0.84) *p*= 0.002 most likely large+	*r*= 0.88 (0.75 to 0.95) *p*< 0.001 most likely very large+	
20-30m	*r*= 0.49 (0.12 to 0.74) *p*= 0.032 very likely moderate+	*r*= 0.32 (-0.08 to 0.63) *p*= 0.183 likely moderate+	*r*= 0.65 (0.35 to 0.83) *p*= 0.002 most likely large+	*r*= 0.13 (-0.27 to 0.49) *p*= 0.598 unclear	*r*= 0.58 (0.25 to 0.79) *p*= 0.01 very likely large+

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Table 3. Interrelationships between RAST performance measures and speed variables. Correlation coefficient (90%CL), p value and observed magnitude of the relationship.

	5 m	10 m	5-10 m	20 m	30 m	20-30 m
$RAST_{mean}$	*r*= 0.03 *p*= 0.929 trivial	*r*= 0.33 (-0.07 to 0.67) *p*= 0.172 likely moderate+	*r*= 0.60 (0.27 to 0.80) *p*= 0.06 most likely large+	*r*= 0.32 (-0.53 to 0.23) *p*= 0.181 likely moderate+	*r*= 0.59 (0.26 to 0.80) *p*= 0.007 very likely large+	*r*= 0.70 (0.43 to 0.86) *p*= 0.001 most likely large+
%dec	*r*= -0.23 (-0.57 to 0.18) *p*= 0.334 unclear	*r*= -0.18 (-0.53 to 0.23) *p*= 0.415 unclear	*r*= 0.02 *p*= 0.865 trivial	*r*= -0.03 *p*= 0.895 trivial	*r*= -0.08 *p*= 0.747 trivial	*r*= -0.11 (-0.48 to 0.29) *p*= 0.651 unclear
FI	*r*= -0.29 (-0.61 to 0.11) *p*= 0.222 unclear	*r*= -0.37 (-0.53 to 0.23) *p*= 0.115 likely moderate-	*r*= -0.25 (-0.58 to 0.15) *p*= 0.312 unclear	*r*= -0.21 (-0.55 to 0.20) *p*= 0.398 unclear	*r*= -0.29 (-0.61 to 0.11) *p*= 0.232 unclear	*r*= -0.25 (-0.58 to 0.11) *p*= 0.303 unclear

Table 4. Speed attributes of % decBEST and % decWORST groups. Values are mean ± SD for 5 m, 10 m, 5-10 m, 20 m, 30 m, 20-30 m. Between-group differences are quantified based on a clear decision (i. e., at least possible difference) together with a standardized difference ≥0.2.

	% dec_{BEST}	**% dec_{WORST}**	**Standardized differences for % dec_{BEST} vs. % dec_{WORST}**	**Chances for greater/similar/smaller value for % dec_{BEST} vs. % dec_{WORST}**	**Qualitative outcome**
5 m	1.066±0.067	1.001±0.068	0.88 (0.12;1.64)	93/6/1	% dec_{BEST} likely slower
10 m	1.806±0.064	1.732±0.080	0.93 (0.19;1.68)	95/4/1	% dec_{BEST} likely slower
5-10 m	0.740±0.033	0.731±0.049	0.25 (-0.61;1.10)	54/28/19	unclear
20 m	3.085±0.103	3.022±0.072	0.68 (-0.12;1.48)	85/12/3	% dec_{BEST} likely slower
30 m	4.255±0.094	4.189±0.087	0.70 (-0.09;1.49)	86/11/3	% dec_{BEST} likely slower
20-30 m	1.170±0.047	1.167±0.050	0.05 (-0.80;0.90)	38/31/30	unclear

Table 5. Speed attributes of % FIBEST and % FIWORST groups. Values are mean ± SD for 5 m, 10 m, 5-10 m, 20 m, 30 m, 20-30 m. Between-group differences are quantified based on a clear decision (i. e., at least possible difference) together with a standardized difference ≥0.2.

	FI_{BEST}	FI_{WORST}	Standardized differences for FI_{BEST} vs. FI_{WORST}	Chances for greater/similar/smaller value for FI_{BEST} vs. FI_{WORST}	Qualitative outcome
5 m	1.063±0.081	1.011±0.065	0.66 (-0.14;1.46)	84/12/3	FI_{BEST} likely slower
10 m	1.820±0.087	1.734±0.074	0.95 (0.22;1.69)	95/4/1	FI_{BEST} likely slower
5-10 m	0.757±0.037	0.723±0.048	0.76 (-0.03;1.54)	89/9/2	FI_{BEST} likely slower
20 m	3.110±0.115	3.032±0.065	0.78 (-0.01;1.57)	90/8/2	FI_{BEST} likely slower
30 m	4.302±0.133	4.189±0.088	0.92 (0.17;1.67)	94/5/1	FI_{BEST} likely slower
20-30 m	1.192±0.059	1.157±0.056	0.61 (-0.20;1.41)	81/14/5	FI_{BEST} likely slower

Discussion

This study examined the associations between different speed and RAST parameters and found that RAST had the strongest association with maximal speed. This finding is in agreement with previous reports of significant relationship between sprint tests and RSA (da Silva et al., 2010; Ingebrigtsen et al., 2014; Lockie et al 2019). Both 0-10 m and 0-30 m sprint intervals correlated with RASTmean, in agreement with previous findings on elite male soccer players, where 0-34.2 m (da Silva et al., 2010) and 0-10 m, 0-20 m, and 0-35 m (Ingebrigtsen et al., 2014) sprint times correlated with RSA in tests featuring 7 x 34.2 m sprints and 7 x 35 m sprints, respectively.

Pyne et al. (2008) reported that total time in an RSA test was highly correlated (r= 0.66) with single-sprint (20 m) performance and concluded that RSA (6 x 30 m) was more related to short sprint than endurance capacity. In comparison, the 20 m sprint time in the present study was only moderately correlated (r=0.32) to RASTmean (6 x 35 m). However, the correlation increased to r= 0.70 when the flying 20-30 m sprint time (a measure of established maximal speed) was considered, supporting the relationship of RSA to sprint capacity. However, considering that other studies reported larger correlations between tests of aerobic capacity and RSA than sprint capacity (Aziz et al., 2000; Spencer et al., 2005; Volianitis et al., 2019), it should be acknowledged that this relationship depends largely on the individual variables of the protocol used in the different studies, i.e., sprint number, sprint duration, recovery duration, and recovery intensity (Spencer et al., 2005). A more endurance-oriented RSA protocol involving a greater number of efforts, a longer sprint distance, and/or a shorter recovery period would be expected to reduce the anaerobic energy production (Balsom et al., 1992; Gaitanos et al., 1993) and thus shift the relative energy contribution towards aerobic metabolism. The mechanisms for this shift in energy contribution are poorly understood, however, increased vasodilation in the working muscles, increased pH-mediated response leading to a Bohr shift of the oxygen-haemoglobin dissociation curve, and increased activity of pyruvate dehydrogenase have been suggested (Glaister, 2005).

Considering that during the first phase of preparatory phase the main training objective is the development of aerobic fitness with great training volumes that can affect negatively sprint performance, information on the training schedule would have been helpful in the interpretation of the present results. However, since such information is not available, it has to be considered a limitation of the study.

In conclusion, the present results suggest that the ability to sprint at a faster speed could positively influence RSA in soccer players. Maximal sprint training could potentially benefit not only acceleration and top speed sprinting, but RSA as well.

Implications for Competitive Sports

From a training perspective, protocols such as plyometrics and free sprint training, which have been shown to improve speed in athletes (Lockie et al., 2014), could be adopted to enhance RSA in soccer players.

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