

Original Article

Relationship between intermittent endurance capacity and match performance according to the playing position in sub-19 professional male football players: preliminary results

VINCENZO RAGO¹, FEDERICO PIZZUTO², GAETANO RAIOLA³

¹University of Porto, PORTUGAL

²Futebol Clube do Porto, Porto, PORTUGAL

³University of Salerno, ITALY

Published online: June 30, 2017

(Accepted for publication June 15, 2017)

DOI:10.7752/jpes.2017.02103

Abstract:

Problem statement: The association between field-based tests has been predominately conducted in adult male football players. The importance of intermittent endurance performance, as meaningful physical fitness component for football players has been underlined. However, the physical demands imposed by the respective positional role may results on different capacity to perform intermittent exercise. **Approach:** Activity profiles and baseline intermittent endurance capacity were collected from twenty-nine elite sub-19 male Italian football players using global positioning system and yo-yo intermittent endurance test. Movement data were collected during four official matches. **Purpose:** to examine (i) whether playing position affect physical demands during a football game and (ii) whether these demands reflect the capacity to perform intermittent endurance exercise, in sub-19 elite male football players. **Results:** For all match-related parameters, physical performance was higher for defenders and midfielders compared to attackers. ($P < 0.05$). Moreover, the capacity of performing intermittent endurance exercise was greater for defenders compared to other positional roles ($P < 0.05$). Small to large correlations ($P < 0.05$; $r = 0.24$ to 0.65) were observed for defenders and midfielders. **Conclusion:** Physical demands during a youth football game differ per playing position and correlate with the capacity to perform intermittent endurance exercise. Coaches and anyone involved in training prescription for football player should account for these positional variations in distance covered in order to design position-specific physical drills.

Key words: Yo-yo test; Testing; Time motion analysis; Global positioning systems; Acceleration.

Introduction

Adult elite football players cover 8 to 14 km during an official match, of which 1.5 to 3.3 km are performed by high-intensity (Mohr, Krstrup, & Bangsbo, 2003). However, the ability to perform intense exercise is declined towards the end of matches, as well as immediately after the most intense periods of the game (Mohr et al., 2003; Rebelo, Brito, Seabra, Oliveira, & Krstrup, 2014). These data underline the importance of intermittent endurance performance, as meaningful physical fitness component for football players, throughout training sessions and match-play (Stølen, Chamari, Castagna, & Wisløff, 2005). The relationship between match performance and physical capacity has been extensively described (Krstrup et al., 2006). However, less attention has been paid to youth populations (Rebelo et al., 2014). Recent studies with 13-to-18 aged football players have suggested an association between physical fitness and match performance (Buchheit, Mendez-Villanueva, Simpson, & Bourdon, 2010). Under-17 elite football players cover 5 to 7 km during an official match, of which 15% (0.4 to 1.5 km) by high-intensity. In the same study, the ability to perform intermittent efforts was related to the total distance covered, as well as with the distance covered by high-intensity (Castagna, Impellizzeri, Cecchini, Rampinini, & Alvarez, 2009).

The physical profile of football players is highly variable, having implications for the interpretation of high-intensity running (Gregson, Drust, Atkinson, & Salvo, 2010). Variations in physical patterns are given by positional roles. Central defenders seem to cover less total distance and perform less high-intensity running compared to other positions (Bradley et al., 2009; Di Salvo et al., 2007; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007) whereas fullbacks and midfielders perform seem to perform more sprint activity (Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009). Yet, strikers and wings have a greater decline in high-intensity bursts when the own team have ball possession (Di Salvo et al., 2009). It would be of interest to examine the running performance in youth football matches, in relation to the specific positional roles and to correlate the physical match performance to the actual capacity of performing intermittent exercise. Field tests such as the Yo-Yo intermittent tests are very practical and have been considered the most valid approaches to evaluate

endurance of football players (Bangsbo, Iaia, & Krstrup, 2008). Although the effort in football relies on aerobic and anaerobic metabolism, the repeated high-intensity exercise performed during Yo-Yo tests allows a sport-specific evaluation of players' physical capacity (Krstrup et al., 2003). Recent data has also suggested that the Yo-Yo IE2 test is a sensitive tool that relates to match performance, differentiating the intermittent exercise performance of youth players in various standards, stages of the season and playing positions (Bradley et al., 2011). However, it has not yet been investigated in the same cohort of players whether intermittent endurance is an important determinant of the physical match performance in youth football. Thus, the aims of the present study were (1) to analyse the activity profile of youth football players in relation to field position, and (2) to examine the relationship between physical match performance and intermittent endurance capacity.

Methods and materials

Subjects

Twenty-nine elite sub-19 male football players (Mean $\pm$ standard deviation; height: 177.15 ± 5.30 ; Body weight: 71.96 ± 5.08) competing at national level were tested. Positional roles were 12 defenders, 10 midfielders and 7 attackers. Substituted players and goalkeepers were not included for analysis. Players and their parents were informed about the purpose of this study and provided verbal consent.

Experimental design

Data were collected during the first 4 matches in the beginning of a 9-month competitive season. Anthropometric measurements and intermittent endurance assessment took place in the first two weeks of the study period. Time-motion analysis was performed for the 10 outfield players playing of the team analysed.

Yo-yo intermittent endurance test. The Yo-Yo IR1 and the Yo-Yo IE2 were performed before the videotaped matches, two weeks apart, in a random order. After a 10-min warm up the players repeated 2 x 20 m runs back and forth between the start and finish line at a progressively increasing speed, controlled by audio bleeps from a CD-ROM according to the guidelines (Bangsbo et al., 2008). The test was terminated when the subjects failed twice to reach the starting line (objective evaluation) or the participant felt unable to complete another shuttle at dictated speed (subjective evaluation). The total distance covered during the Yo-Yo IR1 and the Yo-Yo IE2 was recorded and represented the test result.

Time motion analysis

The players' movement pattern during each game was obtained using unobtrusive portable GPS units (QStarz BT-Q1000XT, Taiwan). Based on signals from at least three Earth-orbiting satellites, the GPS receiver recorded the players' positional data (x-and y-) with a time resolution of 15 Hz (obtained through interpolation of a 5-Hz signal). The system used the GPS doppler data and distances were calculated from changes in position and subject to the manufacturer's proprietary algorithm integrated to reduce measurement error. A particular vest was tightly fitted to each player to place the receiver between the scapulae. According to the drill duration, total distance covered and high-intensity running were calculated using a custom Excel spreadsheet from instantaneous raw data of time. Speed, acceleration and deceleration categories were adopted from Osgnach, Poser, Bernardini, Rinaldo, and di Prampero (2010) as follows: intermediate-speed distance (IS; from 16 to 19 $\text{km}\cdot\text{h}^{-1}$); high-speed distance (HS; from 19 to 22 $\text{km}\cdot\text{h}^{-1}$) and very-high speed distance (VHS; $>22 \text{ km}\cdot\text{h}^{-1}$). In addition, total distance covered (TD), total high-intensity running (HIR, given by the sum of IS, HS and VHS) were calculated.

Statistics

Data were reported as Mean $\pm$ SD. Reliability measures were also reported as coefficient of variation (CV). Difference between playing positions were analysed using one-way analysis of variance. Pearson correlation coefficients were calculated to verify the association between match activity and intermittent endurance. To interpret the magnitude of the correlation coefficients, the following criteria were used: < 0.10 trivial, $0.10 < r < 0.30$ small, $0.30 < r < 0.50$ moderate, $0.50 < r < 0.70$ large, $0.70 < r < 0.90$ very large and $0.90 < r < 1$ almost perfect. The level of statistical significance was set at $P < 0.05$ for all tests. Data analysis was performed using Statistical Package for Social Science statistical software (version 23, IBM SPSS Statistics, Chicago, IL, USA).

Results

Table 1 shows the descriptive values for match performance parameters and intermittent endurance capacity. For all match-related parameters, physical performance was higher for defenders and midfielders compared to attackers. Moreover, the capacity of performing intermittent endurance exercise was greater for defenders compared to other positional roles. The correlations between match performance and intermittent endurance capacity is shown in table 2. Small to large correlations (r ranging from 0.24 to 0.65) were observed for defenders and midfielders.

Table 1. Differences between playing position in match activity and intermittent endurance capacity

	D	M	A	P	Post-hoc test
TD (m)	8910.75 ± 2097.99	9732.30 ± 583.22	7491.50 ± 846.97	< 0.05	D, M > A
HIR (m)	1003.55 ± 235.38	1090.41 ± 119.12	533.76 ± 166.90	< 0.01	D, M > A
IS (m)	537.24 ± 159.11	612.70 ± 108.04	334.25 ± 12.86	< 0.01	D, M > A
HS (m)	295.16 ± 76.77	280.76 ± 68.08	130.04 ± 80.52	< 0.05	D, M > A
VHS (m)	171.16 ± 48.55	196.94 ± 66.52	69.48 ± 73.52	< 0.01	D, M > A
YYIE1 (m)	1586.67 ± 121.47	1435.33 ± 216.79	1456.50 ± 159.66	< 0.05	D > M, A

D= Defenders; M= Midfielders; A= Attackers; ES= Effect sizes; TD= total distance covered; HIR= high-intensity running; IS= intermediate-speed distance; HS= high-speed distance; VHS= Very-high speed distance; YYIE1= Distance covered in the yo-yo intermittent endurance level 1.

Table 2. Correlation between match activity and intermittent endurance for each positional role.

	TD	HIR	VHS
Defenders	0.47 (moderate)	0.60 (large)	0.31 (small)
Midfielders	0.57 (moderate)	0.65 (large)	0.24 (Small)
Attackers	0.06 (unclear)	0.13 (unclear)	0.11 (unclear)

TD= total distance covered; HIR= high-intensity running; VHS= Very-high speed distance.

Discussion

The present study shows that match-related physical demands differs between playing position. Specifically, the physical demands imposed by positional roles were higher for defenders and midfielders compared to attackers. These physical demands may also explain a greater capacity to perform intermittent exercise for defenders, than other positional roles.

The results of the present study show that the average total match distance for elite sub-19 players, amounted to ~8910 for defenders, ~9732 for midfielders and ~7941 for attackers. Our data are in accordance to that already published in literature in senior football players (Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2010; Di Salvo et al., 2007) and young players (Rebelo et al., 2014). In addition, distance covered per positional role seems supported by the capacity to perform intermittent exercise, assessed through the YYIR1. Indeed, this hypothesis is also supported by results of an intermittent endurance test in elite male football players showing a correlation between the distances covered in this test and the positional role of the players (Bangsbo, Mohr, & Krstrup, 2006).

Despite the multifactorial nature of performance, it has been well-documented that football players need optimal fitness to cope with the demands of either single games or entire season. Initial methods of activity profiling consisted of hand annotation and time-motion analysis video tracking. Contemporary technologies such as semi-automatic cameras and global positioning systems have introduced a more sophisticated and time-saving measurement of players' locomotor activity. Therefore, caution is necessary when comparing our data with reported results from literature (Bangsbo et al., 2006; Bradley et al., 2010; Rebelo et al., 2014) because different technologies and categorisations were employed. Indeed, is not possible to compare video-cameras data to global positioning system due to a high error of estimates. During a match, football players perform different types of behaviour, ranging from standing still to maximum speed runs, the intensity of which may change at any given time.

It is important to consider that the physical profile of football players is highly variable, having implications for the interpretation of high-intensity running (Gregson et al., 2010). In support of our results, variations in physical patterns are given by positional roles. Previous studies showed central defenders covering less total distance and perform less high-intensity running compared to other positions (Bradley et al., 2009; Di Salvo et al., 2007; Rampinini et al., 2007) whereas fullbacks and midfielders perform seem to perform more sprint activity (Di Salvo et al., 2009). Yet, strikers and wings had a greater decline in high-intensity bursts when the own team have ball possession (Di Salvo et al., 2009). Indeed, a limitation of this study was to have not analysed fatigue. In addition, central midfielders shown higher distance covered for both distance covered by acceleration and deceleration (Akenhead, Harley, & Tweddle, 2016). Whereas exist some differences in terms of distance covered between positional roles, these differences seem to widen when focusing recovery time between high-intensity bursts. Specifically, wide and central midfielders recover less time between intense actions (Bradley et al., 2009). As a consequence of the variation that is likely to be mediated throughout both the inherent demands of the game and the individual's ability to regulate their own activity, the variability in high-speed running seems very large (Gregson et al., 2010). Contextual variables such as match location, result of the previous match and opponent's rank also can influence match-activity patterns. Indeed, speed intensities and total distance covered were higher when the reference team played house games, when losing and when played against higher standard teams (Castellano, Blanco-Villasenor, & Alvarez, 2011; Folgado, Duarte, Fernandes, & Sampaio, 2014). Our results provide the basis to conduct further research on physical profile of young football players.

Conclusions

Physical demands during a youth football game differ per playing position and correlate with the capacity to perform intermittent endurance exercise. Coaches and anyone involved in training prescription for football player should account for these positional variations in distance covered in order to design position-specific physical drills. However, our data should be interpreted with caution given the reduced sample size. Further studies should account for further variables such as recovery times, accelerations and decelerations per positional role.

References

- Akenhead, R., Harley, J., & Twedde, S. (2016). Examining the external training load of an English Premier League football team with special reference to acceleration. *J Strength Cond Res*. doi:10.1519/jsc.0000000000001343
- Bangsbo, J., Iaia, F. M., & Krstrup, P. (2008). The Yo-Yo intermittent recovery test : a useful tool for evaluation of physical performance in intermittent sports. *Sports Med*, 38(1), 37-51.
- Bangsbo, J., Mohr, M., & Krstrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *J Sports Sci*, 24(7), 665-674. doi:10.1080/02640410500482529
- Bradley, P. S., Di Mascio, M., Peart, D., Olsen, P., & Sheldon, B. (2010). High-intensity activity profiles of elite soccer players at different performance levels. *J Strength Cond Res*, 24(9), 2343-2351. doi:10.1519/JSC.0b013e3181aeb1b3
- Bradley, P. S., Mohr, M., Bendiksen, M., Randers, M. B., Flindt, M., Barnes, C., . . . Krstrup, P. (2011). Sub-maximal and maximal Yo-Yo intermittent endurance test level 2: heart rate response, reproducibility and application to elite soccer. *Eur J Appl Physiol*, 111(6), 969-978. doi:10.1007/s00421-010-1721-2
- Bradley, P. S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P., & Krstrup, P. (2009). High-intensity running in English FA Premier League soccer matches. *J Sports Sci*, 27(2), 159-168. doi:10.1080/02640410802512775
- Buchheit, M., Mendez-Villanueva, A., Simpson, B. M., & Bourdon, P. C. (2010). Match running performance and fitness in youth soccer. *International Journal of Sports Medicine*, 31(11), 818-825. doi:10.1055/s-0030-1262838
- Castagna, C., Impellizzeri, F., Cecchini, E., Rampinini, E., & Alvarez, J. C. (2009). Effects of intermittent-endurance fitness on match performance in young male soccer players. *J Strength Cond Res*, 23(7), 1954-1959. doi:10.1519/JSC.0b013e3181b7f743
- Castellano, J., Blanco-Villasenor, A., & Alvarez, D. (2011). Contextual variables and time-motion analysis in soccer. *Int J Sports Med*, 32(6), 415-421. doi:10.1055/s-0031-1271771
- Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, 28(3), 222-227. doi:10.1055/s-2006-924294
- Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in Premier League soccer. *International Journal of Sports Medicine*, 30(3), 205-212. doi:10.1055/s-0028-1105950
- Folgado, H., Duarte, R., Fernandes, O., & Sampaio, J. (2014). Competing with Lower Level Opponents Decreases Intra-Team Movement Synchronization and Time-Motion Demands during Pre-Season Soccer Matches. *PLoS One*, 9(5), e97145. doi:10.1371/journal.pone.0097145
- Gregson, W., Drust, B., Atkinson, G., & Salvo, V. D. (2010). Match-to-match variability of high-speed activities in premier league soccer. *Int J Sports Med*, 31(4), 237-242. doi:10.1055/s-0030-1247546
- Krstrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., . . . Bangsbo, J. (2003). The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Med Sci Sports Exerc*, 35(4), 697-705. doi:10.1249/01.mss.0000058441.94520.32
- Krstrup, P., Mohr, M., Steensberg, A., Bencke, J., Kjaer, M., & Bangsbo, J. (2006). Muscle and blood metabolites during a soccer game: implications for sprint performance. *Med Sci Sports Exerc*, 38, 1165-1174. doi:10.1249/01.mss.0000222845.89262.cd
- Mohr, M., Krstrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *J Sports Sci*, 21(7), 519-528. doi:10.1080/0264041031000071182
- Osgnach, C., Poser, S., Bernardini, R., Rinaldo, R., & di Prampero, P. E. (2010). Energy cost and metabolic power in elite soccer: a new match analysis approach. *Medicine & Science in Sports & Exercise*, 42(1), 170-178. doi:10.1249/MSS.0b013e3181ae5cfd
- Rampinini, E., Coutts, A. J., Castagna, C., Sassi, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance. *Int J Sports Med*, 28(12), 1018-1024. doi:10.1055/s-2007-965158
- Rebelo, A., Brito, J., Seabra, A., Oliveira, J., & Krstrup, P. (2014). Physical match performance of youth football players in relation to physical capacity. *European Journal of Sport Sciences*, 14 Suppl 1, S148-156. doi:10.1080/17461391.2012.664171
- Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of Soccer: an Update. *Sports Medicine*, 35(6), 501-536. doi:10.112-1642/05/0006-0501