

## Evaluation of differences at high intensity threshold and its performance value during the most valuable soccer championships in Europe

IZZO R.<sup>1</sup>, HOSSEINI VARDE'I C.<sup>2</sup>, SOPRANZETTI S.<sup>3</sup>, CEJUDO A.<sup>4</sup>, CRUCIANI A.<sup>5</sup>, GIOVANNELLI M.<sup>6</sup>  
<sup>1,2,3,6</sup>Department of Biomolecular Sciences, School of Sport Science, Exercise and Health, University of Urbino Carlo Bo, Urbino, PU, 61029, ITALY

<sup>1,4</sup>Grupo de Investigación Aparato Locomotor y Deporte. Departamento de Actividad Física y Deporte. Facultad de Ciencias del Deporte. Campus de Excelencia Mare Nostrum. Universidad de Murcia (ESPAÑA).

<sup>5</sup>K-Sport Universal Engineering Research development department.

Performed by ARGES, Advanced Research Group in Sport, School of Health and Sport Science DISB, Urbino University (IT) with K-Sport Universal-STATS PERFORM, ITALY

Published online: May 31, 2021

(Accepted for publication May 15, 2021)

DOI:10.7752/jpes.2021.03177

### Abstract

The sports performance of footballers during games and training has been the subject of research for years. Nowadays thanks to the new technologies applied to the match analysis, is possible to highlight performance using statistical-mathematical criteria. Recent studies support that not only the phase of the match spent at high speeds are determinants, but even each instant in which the acceleration and deceleration values cross above the high intensity thresholds. Our research seeks essentially to add, in the literature, a specific study, concerning quantity and quality of work expressed on these parameters, above the high intensity thresholds, in the various European elite championships. The search raises 26 players for each match (including substitutes), 260 athletes per championship, for a total of 1300 players (average age 28.4 years, height 1.79 meters, weight kg 78) and 9100 parameters data. The high intensity parameters evaluated are: Distance covered at high intensity (> 16 Km/h); Distance covered in Acceleration (> 2m/s<sup>2</sup>); Distance covered in Deceleration (< -2m/s<sup>2</sup>); Distance covered a MP > 20 Watt / Kg; Average AMP; D = Total Distance; Drel = distance/minute. Data shows that the comparison in French league is balanced, that is high intensity activity is equal for winning and losing teams, in German and Italian championship, winning teams work below the high intensity threshold compared with losers, in the English and Spanish league winning teams work upper the high intensity threshold respect to losers. This confirms that the efficiency of sport performance, in case of football the victory of competition or matches, is not directly dependent only on the ability to carry out high-intensity activities and also supports the lack of specific training aimed at promoting the development of such skills. A more specific investigation directed at the analysis of only winning teams and losing teams in all championships showed a no decisive difference in high intensity parameters. In the chart below, it is highlighted that the high intensity activity is greater in the parameters of D\_AccHI and D\_DecHI in the winning teams than the losers (5-6%).

**Keywords:** soccer, performance model, fitness data, high intensity run threshold, European Championship

### Introduction

The sports performance of footballers during games and training has been the subject of research for years. Coaches to properly organize and plan a work schedule needs to know the real stresses imposed by the competitions/matches, of the sport take in to exam (D'Ottavio, Tranquilli 1992, mod. R. Izzo 2010, Ceruso et al., 2019, Esposito et al., 2020) [1,2]. During years the match analysis has undergone significant changes, through the notational analysis (notational analysis, which can be manual or computerized), motion analysis (which analyzes the activity and movements of athletes) and video analysis (Raiola et al., 2016, 2020a, 2020b). Thanks this new technology during years were executed some studies, that took into consideration the distances traveled and the movements of the players in the field (Rampinini et al., 2007 and Di Salvo et al, 2009, Altavilla et al., 2017). All these researches were performed in order to define the Player Performance Model (PPM) of footballers [3,4]. In 2010 (Osgnach et al. 2010) was proposed a new method to analyze the PPM during matches and training, this was a turning point the evolution of performance analysis. The new method analysis was based on the evaluation of training load using the metabolic power (MP), mediating changes in speed activities and acceleration of the individual athlete. Subsequently numerous studies were performed through GPS technology and semi-automatic video tracking system, trying to evaluate the PPM (Bradley et al. 2009, 2010, Whebe et al. 2014). The Global Position System (GPS) is a system that processes position signals, sent from satellites in orbit, providing position and time to a GPS receiver. The GPS provide a kinematic analysis to measure the

movement of the players (volume and intensity) and then quantify the level of physical effort. The accuracy of the detection depends on weather conditions, satellite position, and type of receivers and radio propagation effects of the radio signal. The Video analysis is carried out with the installation of cameras devices that allow to filming matches or trainings, data are analyzed thanks to specific tracking software. The use of video tracking systems are an important tool for identifying players physical efforts during professional official matches played in stadium with big stands (where GPS could be inefficient) and even to let players free from use GPS jacket, thing that could damage the physical and psychological confidence during games. Video tracking systems with multiple cameras tend to overestimate the distance covered at high intensity (> 18 Km/h) compared to GPS; video analysis also slightly overestimates the distances covered at various speeds, overestimates the peak of maximum speed and the average speed, but calculates better the total distances, even if we must consider that often the cameras cannot be installed in optimal locations. GPS are more accurate in measuring accelerations, but tend to underestimate the distances covered (error: 1-3%), are more accurate in calculating linear actions than changes in direction, underestimate the average speed of about 6% and sprints also tend to decrease in precision with increasing distance. Both systems are reliable in measuring the total distance, the peak of maximum speed and the distances greater than 30 meters., while they tend to drop precision with short distances, short sprints and changes of direction (the last parameter is more penalized in GPS). The analysis of the PPM using GPS or video-tracking of a specific championship could provide crucial information to define the level of players and allow the comparisons with other leagues and nations. For these reasons, the internal and external load required by players during competitions and training has become the main subject of research. That the competition is committed with resistance has long been proven by numerous researches, carried out using innovative systems (hardware and software dedicated), which show, for example, that the average walking distance of a player in 90 minutes can vary from 9 to 12 km, reaching also 13km (Bangsbo et al., 1991, D'ottavio 2001, Mhor et al., 2003, Krusturp et al., 2009) [5,6], made in different speed thresholds (walking, jogging, run, fast run, sprinecc..) calculated using GPS, which have enabled specific acceleration and deceleration detection [7,8]. The elements which in our view go to distinguish the performance profile of the player is the high-speed run phases, their metabolic demands, and in this case the acceleration and deceleration value even when the speed is low. The work we have carried out has been devoted to interpreting and eventually diversifying the methodological-didactic applications in competitions of some of the most important European football teams: Italy, Spain, France, England, Germany, establishing with the study some specific Items of high intensity[9,10].

**Means and methods**

The objective was to try to design and carry out this analysis, which is focused on the evaluation of high-intensity activities in athletes participating in the five elite European championships (Italian, French, English, German, Spanish) on a data set of the very last year. Specifically, the analysis carried out assess the presence or absence of significant performance differences in high intensity between the leagues taken into consideration. The search raises 26 players for each match (including substitutes), 260 athletes per championship, for a total of 1300 players (average age 28.4 years, height 1.79 meters, weight kg 78) and 9100 parameters data. The high intensity parameters evaluated are: Distance “D” (meters), Distance/minute “Drel” (m/min), Distance covered at high intensity > 16 Km/h “D\_SHI” (meters), Distance covered in Acceleration > 2m/s<sup>2</sup> “D\_AccHI”; Distance covered in Deceleration < -2m/s<sup>2</sup> “D\_DecHI” (meters), Distance covered at MP > 20 Watt/Kg “D\_MPHI” (meters) and Average Metabolic Power “AMP” (W/Kg).

**Data analysis** Once the data collection was made, the first considerations were made by getting the average and standard deviation for each championship (Table 1, 2).

Tab.1: Average data for each championship taken into account.

	Ligue 1	Bundesliga	Premier	Serie A	Liga		
<b>D (m)</b>	10874	10748	10584	10768	10477		
<b>Drel (m/min)</b>	115	118	111	114	112		
<b>D_SHI (m)</b>	1901	1821	1859	1757	1608		
<b>D_AccHI (m)</b>	689	588	708	649	577		
<b>D_DecHI (m)</b>	673	589	633	645	578		
<b>D_MPHI (m)</b>	2906	2809	2783	2775	2590		
<b>AMP (W/Kg)</b>	11.0	11.0	10.0	11.0	10.0		
	<b>D</b>	<b>Drel</b>	<b>D_SHI</b>	<b>D_AccHI</b>	<b>D_DecHI</b>	<b>D_MPHI</b>	<b>AMP</b>
<b>Ligue 1</b>	279	3	204	112	110	240	0,5
<b>Bundesliga</b>	417	4	246	112	96	286	0,5
<b>Premier</b>	244	3	156	58	55	153	0,3
<b>Serie A</b>	414	5	164	84	72	208	0,4
<b>Liga</b>	321	4	155	46	45	179	0,4

Tab.2: Standard deviation data for each analyzed parameters.

In essence, the aim of our study was to estimate how much each championship actually works over the high intensity thresholds and how much each parameter is correlated with the final outcome. To clarify the concept of "performance efficiency", it was necessary to carry out a characterization of the championships, calculating the average of the European championships. In this sense, was possible to estimate how championships objectively develop a higher, lower or even equal level of performance correlated with the European average (Table 3).

Tab.3: European average for each analysed parameters.

D(m)	Drel(m/min.)	D_SHI(m)	D_AccHI(m)	D_DecHI(m)	D_MPHI(m)	AMP (W/kg)
10690	114	1789	642	623	2772	10.6

The second step was to make a comparison between the winning and losing teams in each championship, in order to determine if there are a significant differences in the considered parameters (Table 4).

Tab.4: Comparison between winning and losing teams.

Parameters	Winning Team	%Avg	Losing Team	%Avg
D(m)	10762	101%	10723	100%
Drel(m/min.)	115	101%	115	101%
D_SHI (m)	1797	100%	1789	100%
D_AccHI(m)	658	102%	620	97%
D_DecHI(m)	636	102%	609	98%
D_MPHI(m)	2793	101%	2770	100%
AMP(W/Kg)	11	101%	11	100%

Then it was very useful to evaluate the performance of the winning and losing teams (taking into account the draws in each championship) to further confirm or disable the reliability of high-intensity work over threshold as a performance index, with particular attention to the acceleration, deceleration and metabolic power determinants of the competition.

**Results**

From the first consideration of standard averages and deviations it can be stated that:

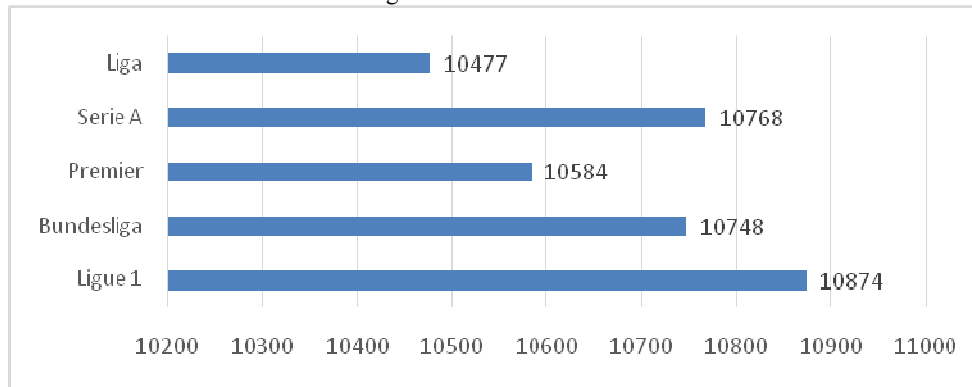


Chart 1: Average of total distance covered (m)

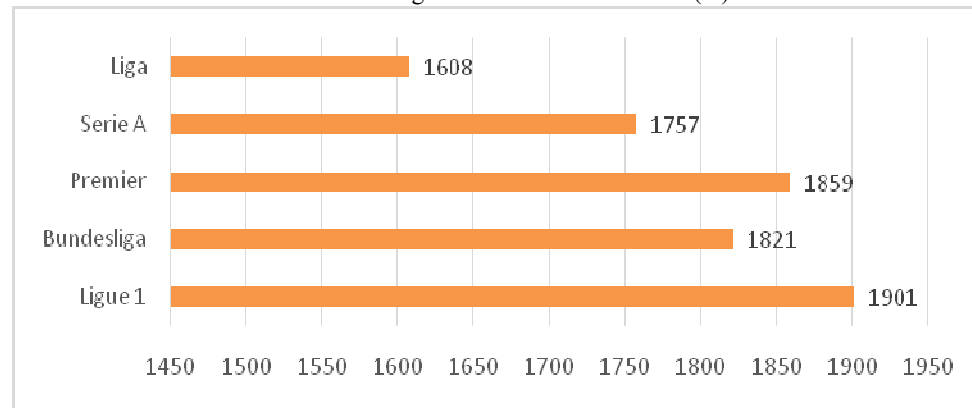


Chart 3: Average distance covered at high intensity(>16 Km/h)

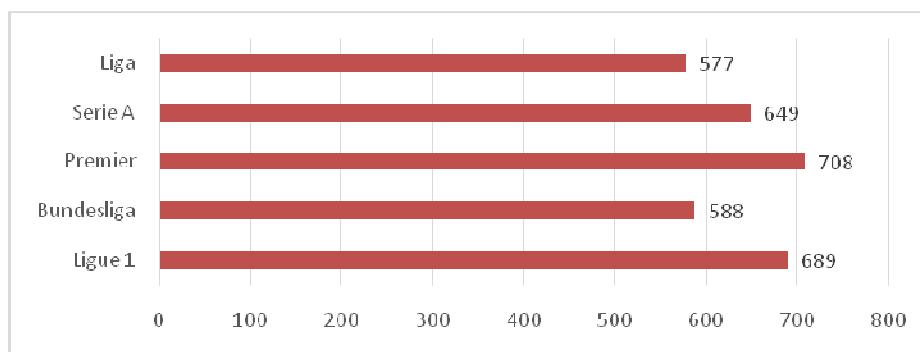


Chart 4: Average distance covered at high intensity acceleration. (> 2m/s<sup>2</sup>)

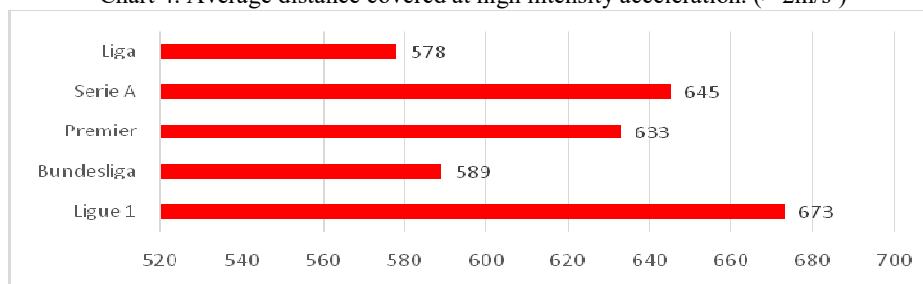


Chart 5: Average distance covered at high intensity deceleration. (< -2m/s<sup>2</sup>)

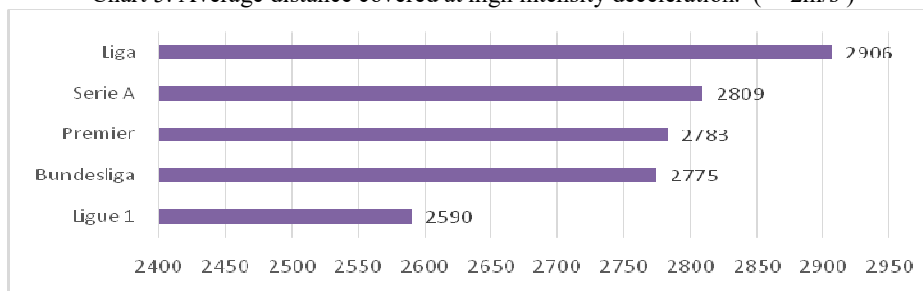


Chart 6: Average distance covered at high metabolic power (W/Kg)

The second step of analysis was focused on the comparison at the activities carried out over the high intensity thresholds of winning and losing teams in each championship. Firstly, it was considered appropriate to evaluate if the performance of the competition was positive (above threshold) or negative (below threshold), subtracting from the parameters of the winning teams those of the losing teams, obviously in this evaluation were not taken into account the draws (Tab.5).

Tab.5: Correlation between Winning and Losing teams

CORRELATION WINNING AND LOSING TEAM SAME CHAMPIONSHIP	
<b>Ligue 1</b>	<b>Balanced correlation; in threshold</b>
<b>Bundesliga</b>	<b>Negative correlation; not above threshold</b>
<b>Premier</b>	<b>Positive correlation; above threshold</b>
<b>Serie A</b>	<b>Negative correlation; not above threshold</b>
<b>Liga</b>	<b>Positive correlation; above threshold</b>

At least, it was considered appropriate to evaluate the performance of winning and losing teams of all championships, by averaging and standard deviation, in order to evaluate the efficiency of high intensity.

Tab.6: Average and Standard Forwarding Winning Teams

Parameters	WINNING TEAMS				
	Ligue 1	Bundesliga	Premier	Seria A	Liga
	<i>Avg ± sd</i>	<i>Avg ± sd</i>	<i>Avg ± sd</i>	<i>Avg ± sd</i>	<i>Avg ± sd</i>
<b>D(m)</b>	10920±295	10661±377	10704±377	10979±392	10548±159
<b>Drel(m/min)</b>	116±3	117±4	112±4	118±5	113±2
<b>D_SHI (m)</b>	1927±227	1806±179	1866±179	1737±210	1649±99
<b>D_AcCHI (m)</b>	698±133	636±86	732±86	641±91	582±36
<b>D_DecHI (m)</b>	685±129	617±84	654±84	640±78	586±37
<b>D_MPHI(m)</b>	2934±282	2786±222	2829±222	2785±214	2630±106
<b>AMP(W/kg)</b>	11±1	11±0	11±0	11±0	10±0

Tab.7: Average and Standard Forwarding Losing Teams

Parameters	LOSING TEAMS				
	Ligue 1	Bundesliga	Premier	Seria A	Liga
	<i>Avg ± sd</i>	<i>Avg ± sd</i>	<i>Avg ± sd</i>	<i>Avg ± sd</i>	<i>Avg ± sd</i>
D(m)	10899±302	10835±455	10622±312	10883±236	10377±444
Drel(m/min.)	116±3	110±4	111±4	117±2	111±5
D_SHI (m)	1924±228	1836±309	1886±166	1765±91	1533±180
D_AccHI (m)	708±117	540±119	687±73	599±152	568±58
D_DecHI (m)	691±115	562±104	618±70	606±130	565±56
D_MPHI(m)	2934±248	2832±350	2788±184	2777±135	2518±229
AMP(W/kg)	11±0	11±1	10±0	11±0	10±1

**Discussion**

The main purpose of this research work was to analyze seven performance parameters (external load) in European elite football; in specific the aim was to investigate the work done above the high intensity thresholds. As a first analysis we tested the performative efficiency of each championship in relation to the total average. For a more objective understanding, we highlight high intensity performance with a percentage rating.

Tab.8: Percentage value form analysed parameters calculated on European average

CHAMPIONSHIP CHARACTERIZATION %							
	D	Drel	D_SHI	D_AccHI	D_DecHI	D_MPHI	AMP
Ligue 1	2%	1%	6%	7%	8%	5%	2%
Bundesliga	1%	3%	2%	-8%	-6%	1%	2%
Premier	-1%	-3%	4%	10%	2%	0%	-2%
Serie A	1%	0%	-2%	1%	3%	0%	0%
Liga	-2%	-2%	-10%	-10%	-7%	-7%	-3%

From Tab.8 it is possible to see how not all competition determinants (R. Izzo 2010) are balanced. With regard to distance and distance per minute parameters, we can notice that for each championship there are no values that deviate much from the average value. However, our study shows that the ability to perform activities above the high intensity thresholds of Speed, Acceleration and Deceleration is not expressed as a determinant of the competition, at least not in a significant way. In fact, only the French championship expresses the activity above the high intensity threshold in the parameters mentioned above for 6% D\_SHI (speed threshold), 7% D\_AccHI (acceleration threshold), 8% D\_DecHI (deceleration threshold). MP index is concerned, as it allows to understand the energy demands of competition, the distribution of work during play and the energy demands that have to be reproduced in training it is performative. In our study, only in the French championship are above the average for 5% while in the other championships it is not expressing significant positive metabolic power activities in relation to the level of elite performance analysed. In the second phase, we correlate the values with the winning and losing teams, it turned out that winning teams not always work over the high intensity thresholds considered, stating the opposite of what the literature argues, namely that the sole activity of high intensity are not essential determinants in achieving positive results (Tab 9).

Tab.9: Correlation between losing and winning teams

CORRELATION WINNING AND LOSING TEAM SAME CHAMPIONSHIP	
Ligue 1	Balanced correlation; in threshold
Bundesliga	Negative correlation; not above threshold
Premier	Positive correlation; above threshold
Serie A	Negative correlation; not above threshold
Liga	Positive correlation; above threshold

Data shows that the comparison in French league is balanced, that is high intensity activity is equal for winning and losing teams, in German and Italian championship, winning teams work below the high intensity threshold compared with losers, in the English and Spanish league winning teams work upper the high intensity threshold respect to losers. This confirms that the efficiency of sport performance, in case of football the victory of competition or matches, is not directly dependent only on the ability to carry out high-intensity activities and also supports the lack of specific training aimed at promoting the development of such skills.

A more specific investigation directed at the analysis of only winning teams and losing teams in all championships showed a no decisive difference in high intensity parameters. In the chart below (Chart 8), it is highlighted that the high intensity activity is greater in the parameters of D\_AccHI and D\_DecHI in the winning teams than the losers (5-6%).

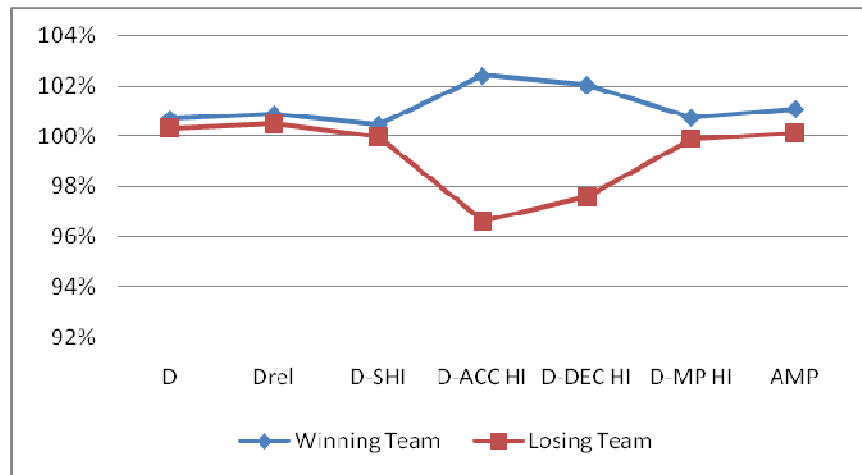


Chart 8: Performance of high intensity activity in winning and losing teams.

### Conclusions

Starting from the considerations emerging following the results of our research, it seems appropriate to point out how the variables that are being investigated are crucial. As attested by scientific literature these performance parameters influence the performance and if they are not well expressed, this can really make the difference on results. It is true that the five most prestigious European championships were obviously not foreseeable to find a high level of difference between them. Only in French championship, had a sufficiently positive intensity activity (D\_SHI 6%, D\_AccHI 7%, D\_DecHI 8%, D\_MPHI 5%), which means that if not trained and supported by good technical-tactical preparation, it can not be a predictive for success. Effective competitive behaviour also presupposes a good tactical arrangement by the players; but a tactical construct can only be achieved if there are adequate technical bases that necessarily are correlated with a specific sports physical training. Football performance is distinct from aerobic activity that cover almost the 70% of the total load, the anaerobic phases are only 30% but they are crucial and critical for the final results. It is clear that the goal is not to develop a resistance capability (which minimizes the effects of fatigue) to the highest level, but a direct resistance to specific football requirements (maintaining a constant speed throughout the duration of the competition), which is inseparably tied to a great anaerobic potential as a basis for a good sprint run ability. For these reasons, the traditional concept of football training must be extended to all those factors that affect the performance of the player and at the same time increase the performance of the player.

### Author Contributions:

Conceptualization: Sopranzetti S., Izzo R., Cruciani A.  
 Methodology: Izzo R., Cejudo A., Giovannelli M.  
 Validation: Izzo R., Hosseini C.  
 Formal analysis: Giovannelli M., Cruciani A., Hosseini C.  
 Investigation: Cejudo A., Giovannelli M., Hosseini C., Sopranzetti S.  
 Resources: Cruciani A., Giovannelli M.  
 Data curation: Izzo R., Cejudo A., Hosseini C.  
 Writing, original draft preparation: Izzo R., Hosseini C.  
 Writing, review and editing: Izzo R., Hosseini C.  
 All authors have read and agreed to the published version of the manuscript.

### Acknowledgements

For this study, we especially thank K-Sport Universal, Stats Perform, Italy for making available the most advanced technologies, database and overall the engineering expertise for filtering the data collected in the study. This study did not receive any financial support or other assistance.  
 Conflicts of Interest: The authors declare no conflict of interest.

### Citation Index

1. Izzo, R., Giovannelli, M. (2018) Ergonomics for the game: internal and external load analysis for problem solving in training soccer", Ph.d in Science of physical exercise and healthcare, Urbino University Library
2. Izzo, R., Giovannelli, M. (2017) Edwards TL Method and D\_SHI(m): Intensity descriptors, Sport Science, Vol.10, Supplement 1, Croatia, ISSN (online) 1840-3670, ISSN (Print) 1840-3662.
3. Izzo, R., Cejudo, A., Hosseini Varde'I (2017) Comparison between under 20 and Over 20 amateur football players with the use of hi-tech Gps (K-Gps 20Hz), International Journal of Physical Education, Sport and Health, Vol.4, Issue 3, IF 5.38 Tirupati J. Serv. Rohini, New Delhi, India, ISSN (online) 23941693, ISSN (Print) 2394-1685,

4. Izzo, R., Giovannelli, M. (2018) Session RPE and Speed High Intensity Distance in Meters (D\_SHI mt): A valid method to analyze training load in soccer players, *Journal of Sports Science*, Vol. 6, number 3, May - June
5. Izzo, R., Giovannelli, M., Raiola G. (2019) Tracking on adequate profile for a more targeted template methodology in youth elite level footballers using GPS technology: a comparison between seasonal data of U-17 vs U-19, highlights and shadows. (Epub ahead of print)
6. Izzo, R., Giovannelli, M., Raiola, G. (2019) Training Load in elite Goalkeepers with K-Track for monitoring performance. *Journal of physical education and sport (JPES)*, pp 1890 – 1896, Vol 19 Supplement issue 5 October ISSN:online ISSN: 2247 - 806X, p-ISSN: 2247 - 8051, ISSN - L = 2247 – 8051 SJR Category: Physical Therapy Sports Therapy and Rehabilitation, SJR 2018: 0.32. Q3
7. Rago, V., Pizzuto, F., Raiola, G. (2017) Relationship between intermittent endurance capacity and match performance according to the playing position in sub-19 professional male football players: Preliminary results. *Journal of Physical Education and Sport*, 17 (2), 688-691.
8. Raiola, G., D'isanto, T. (2016) Assessment of periodization training in soccer. *Journal of Human Sport and Exercise*, 11 267-278.
9. Gaetano, R., Rago, V. (2014) Preliminary study on effects of hiit-high intensity intermittent training in youth soccer players, *Journal of Physical Education and Sport*, 14 (2), 148-150.
10. Raiola, G. (2017) Motor learning and teaching method, *Journal of Physical Education and Sport*, 17, 2239-2243.

## References

- Akenhead, R., Hayes, P.R., Thompson, K.G., French, D. (2012). Diminutions of acceleration and deceleration output during professional football match play”, *Journal of Science and Medicine in Sport*.
- Almeida, C. H., Ferreira, A. P., Volossovitch, A. (2014). Effects of Match Location, Match Status and Quality of Opposition on Regaining Possession in UEFA Champions League, *Journal of Human Kinetics* vol. 41, 203-214.
- Altavilla, G., RIELA, L., Di Tore, A.P., Raiola, G. (2017) The physical effort required from professional football players in different playing positions. *Journal of Physical Education and Sport*, 17 (3), art. no. 200, pp. 2007-2012.
- Barnes, C., Archer, D. T., Hogg, B., Bush, M., Bradley, P. S. (2014). The Evolution of Physical and Technical Performance Parameters in the English Premier League”, *International Journal of Sports Medicine*, 35(13), 1095-1100.
- Bernardini, R., Osgnach, C., Poser, S., Rinaldo, R., Di Prampero, P.E. (2010). Energy cost and metabolic power in elite soccer: a new match analysis approach”; *Med. Sci. Sports Exerc*, Vol. 42, No. 1, pp. 170-178.
- Bradley P.S., Di Mascio M., Peart D., Olsen P., Sheldon B., “High-intensity activity profiles of elite soccer players at different performance levels.” *J Strength Cond Res*. 2010 Sep;24(9):2343-51. doi: 10.1519/JSC.0b013e3181aeb1b3.
- Bradley P.S., Sheldon W., Wooster B., Olsen P., Boanas P., Krstrup P., “High-intensity running in English FA Premier League soccer matches.” *J Sports Sci*. 2009 Jan 15;27(2):159-68. doi: 10.1080/02640410802512775.
- Carling, C., Nelson, L.J., Bradley, P.S. (2014). Comment on performance analysis in football: A critical review and implications for future research”, *Journal of Sport Science*, 32:1, 2-7.
- Carling, et. al. (2008). The role of motion analysis in elite soccer”; *Sport Med*, 38(10):841.
- Castagna, C. (2003). Activity Profile of Young Soccer Players During Actual Match”, *Journal of Strength and Conditioning Research*, 17 (4):629-831.
- Castagna, C., Lo Castro, L., D'Ottavio, S. (2015). Intensità di gioco nelle leghe europee, *Articolo, Settore Tecnico FIGC, Notiziario 4/2015*, 45-48.
- Castellano, J., Pastor, D.A., Bradley, D.S. (2014). Evaluation of research using computerized tracking system (Amisco and Prozone) to analyze Physical Performance in elite soccer: A systematic review”, *Sport Medicine*, 44:701.
- Ceruso, R., Esposito, G., D'elia, F. (2019) Coordination attached to the qualitative aspects of football, *Journal of Physical Education and Sport*, 19, art. no. 260, pp. 1773-1776.
- Ciuffarella, A., Russo, L., Masedu, F., Valenti, M., Izzo, R., De Angelis, M. (2013). Notational Analysis of the Volleyball Serve”, *Timișoara Physical Education and Rehabilitation Journal*, no.16, vol.6, Timisoara, Romania.
- Clemente, F. M. (2012). Study of successful soccer teams on FIFA World Cup 2010”, *Pamukkale Journal of Sport Sciences*, 3(3), 90-103.
- Collet, C., (2013). The possession game? A comparative analysis of ball retention and team success in European and International football 2007-2010”, *Journal of Sports Sciences*, 31(2), 123-36.
- Dalen, T., Ingebrigtsen, J., Hjelde, G.H., Wislof, f U. (2016) Player load., acceleration and deceleration during 45 competitive matches of elite soccer”, *Journal of Strength and Conditioning Research*, 30(2): 351-9.

- Dellal, A., Chamari, K., Wong, D.P., Ahmaidi, S., Keller, D., Barros, R., et al. (2011). Comparison of physical and technical performance in European soccer match-play: FA Premier League and La Liga”, *European Journal of Sport Science*, 11(1), 51-59.
- Di Prampero, P.E, Fusi, S., Sepulcri, L., Morin, J.B, Belli,, A., Antonutto, G. (2005). Sprint running: a new energetic approach, *J Exp Biol*, 208 (Pt 14):2809–16.
- Di Salvo V, Collins A, McNeill B, et al. Validation of Prozone: A new video-based performance analysis system. *Int J Perf Anal Sport* 2006 Jun; 6 (1), 108-119
- Di Salvo, V., et al., (2009) Analysis of High Intensity Activity”. *Int J Sports Med*, 30: 205 – 212.
- Esposito, G., Raiola, G. (2020) Monitoring the performance and technique consolidation in youth football players, *Trends in Sport Sciences*, 27 (2), pp. 93-100.
- Gaudino, P., Alberti, G. (2014) Estimated metabolic and mechanical demands during different small side games in elite soccer players”, *human movement science*.
- Gonzalez-Rodenas, J., Lopez-Bondia, I., Calabuig ,F., James, N., Aranda, R. (2015). Association between playing tactics and creating scoring opportunities in elite football. A case study in Spanish Football National Team”, *Journal of Human Sport and Exercise*, ISSN 1988-5202.
- Iaia, M. F., Rampinini, E., Bangsbo, J. (2009) High-Intensity Training in Football”, *International Journal of Sports Physiology and Performance*, *Human Kinetics*, 4, 291-306.
- Izzo, R., (2010) Performance Analysis negli sport di squadra, dispensa a cura di centro copie Urbino.
- Izzo, R., Carozzo, M. (2015) Analysis of significance of physical parameters in football through GPS detection in a comparison with amateur athlete”, *International Journal of Physical Education, Sport and Health*, Vol.2, Issue 2, IF 4.69, Tirupati J. Serv. Rohini, New Delhi, India; Nov./Dec. 2015. ISSN (online) 2394-1693, ISSN (Print) 2394-1685.
- Izzo, R., Lo Castro, L., (2015) The study of acceleration and deceleration capacity decrease in repeated sprints in soccer”, *International Journal of Physical Education, Sport and Health*, Vol.2, Issue 2, IF 4.69, Tirupati J. Serv. Rohini, New Delhi, India; Nov./Dec. 2015. ISSN (online) 2394-1693, ISSN (Print) 2394-1685.
- Izzo, R., Morello, Zenatello V. (2016) The study of acceleration capacity decrease in repeated 30 mt sprints”, *International Journal of Physical Education, Sport and Health*, Vol.3, Issue 1, IF 4.69, Tirupati J. Serv. Rohini, New Delhi, India; Jan. 2016. ISSN (online) 2394-1693, ISSN (Print) 2394-1685.
- Izzo, R., Sopranzetti, S. (2016) Speed, acceleration, deceleration and metabolic power in the work to roles for a workout more targeted in elite football”, *International Journal of Physical Education, Sport and Health*, Vol.2, Issue 2, Tirupati J. Serv. Rohini, New Delhi, India, ISSN (online) 2394-1693, ISSN (Print) 2394-1685.
- Jones, Rhys M., et al. (2013) Relationship between Repeated sprint ability and aerobic capacity in professional soccer players, *The Scientific World Journal*, 2013: 1-5
- Keiner, M., Sander, A., Wirth, K., Schmidtbleicher, D., (2014) Long-term strength training effects on change-of-direction sprint performance, *J. Strength Cond.Res.*, 28(1):223-31.
- Lago-Peñas, C., Lago-Ballesteros, J., Rey, E. (2011) Differences in performance indicators between winning and losing teams in the UEFA Champions League, *Journal of Human Kinetics* vol.27.
- Liu H., Gómez M., (2014) Relationships between Match Performance Indicators and Match Outcome in 2014 Brazil FIFA World Cup”, *Conference Paper; Sport Department, Shenzhen University, China*.
- Marcolini, M., (2010) La Match Analysis: un nuovo approccio scientifico; Urbino, 5° Convegno sul calcio giovanile: “Prima del risultato”.
- Osgnach, C., Di Prampero, E.P., at al., (2010) Energy Cost and Metabolic Power in Elite Soccer: A New Match Analysis Approach”, *Med. Sci. Sports Exerc*, 42 (1) 170–178.
- Raiola, G., Altavilla, G. (2020a) Testing motor skills, general and special coordinative, in young soccer, *Journal of Human Sport and Exercise*, 15 (Proc2), pp. S206-S212.
- Raiola, G., D'isanto, T. (2016) Assessment of periodization training in soccer, *Journal of Human Sport and Exercise*, 11 (Proc1), pp. S267-S278.
- Raiola, G., Esposito, G., Sgrò, F. (2020b) The formative value of soccer rules, *Journal of Human Sport and Exercise*, 15, pp. S656-S663.
- Rampinini, E., Coutts, A., Castagna, C., Sassi, R., & Impellizzeri, F., “Variation in top level soccer match performance.” *International Journal of Sports Medicine*, 2007, 28(12), 1018–1024.
- Rampinini, E., Impellizzeri, F., Castagna, C., Coutts, A.J., Wisløff, U., (2009) Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level”, *Journal of Science and Medicine in Sport* 12, 227-233.
- Whebe G. M., Hartwig T. B., and Duncan C. S., “Movement Analysis of Australian National League Soccer Players Using Global Positioning System Technology.” *J. Strength Cond. Res.* 28 (3): 834-42, 2014.