

## Physical Efficiency Index (PEI) and injuries after return to play post Covid-19 in Italian Serie A.

MARCO GIOVANNELLI<sup>1</sup>, GAETANO RAIOLA<sup>2</sup>, CEJUDO PALOMO A<sup>3</sup>, SAINZ DE BARANDA P.<sup>4</sup>, RICCARDO IZZO<sup>5</sup>

<sup>1,5</sup>Department of Biomolecular Sciences, School of Health and Sport Science, University of Urbino Carlo Bo, Urbino, ITALY

<sup>2</sup>University of Salerno, ITALY

<sup>3,4,5</sup>Grupo de Investigación Aparato Locomotor y Deporte. Department of Physical Activity and Sport, Faculty of Sports Sciences, Campus of Excellence, Mare Nostrum. University of Murcia, SPAIN

Published online: December 30, 2021

(Accepted for publication December 15, 2021)

DOI:10.7752/jpes.2021.06458

### Abstract

The aim of this study is analyze physical performance in Italian Serie A 2019-2020, after return to play post Covid-19, in the 20 club participants in the championship (n=567 players, age 27.2±1.1, value: 8.12 mln), to understand the causes of injuries that occurred during the last 12 match for the conclusion of the Serie A and variation in high intensity production. The analysis of physical performance is analyzed with SPORTVU OPTICAL TRACKING (STATS PERFORM, CHICAGO, USA) during each football match, from 27 match day (June 2020, after lockdown) to 38 match day (August 2020). Using a semiautomatic video analysis system that has incorporated new parameters able to measure physical efficiency (“Method for game analysis”, patented in 2010, PCT/IB2010/002593, K-SPORT UNIVERSAL, MONTELABBATE, ITALY). At the same time we analyzed players absence from each match day for all teams (n=20), to better understand how many injuries the lockdown (3 and a half months) caused over time. Our research relates with a professional Top Level Championship, physical efficiency index and injuries occurred during a post Covid-19 period. The championship was suspended due to the Covid-19 emergency on matchday 26 and restart from matchday 27a in June 2020. The percentage of absences due to injury by comparing matchday 27 (post lockdown) and matchday 38 (last season) has showed a statistically significant increase 26% (n=20; p<0.05). Negative correlations was found between PEI (Physical Efficiency Index) and number of injuries occurred post lockdown respectively, (n=20, r = -0.25, p > 0.05). For the 2019-20 season there is a total number of absences equal to 2213; compared with the data of the last thirteen seasons, an increase of 6%, statistical meaningfulness, (n=20; p<0.05) is observed compared to the previous season (2018-19). Key performance indicators in this research not predict injuries and they have a low correlation with them. Future studies it's necessary to have more information on absence of injuries and their relation with performance and technical/tactical game intelligence. Of course, PEI (Physical Efficiency Index), it's a good indicator of physical team condition.

**KEY WORDS:** Match Analysis, Injuries, Covid-19, High Intensity, Physical Efficiency Index (PEI).

### Introduction

Soccer is an intermittent sport characterized by about 1200 acyclical and unpredictable changes in activity (each lasting from 3 to 5 s) involving, among others, 30 to 40 sprints, more than 700 turns and 30 to 40 tackles and jumps [1,2]. This team sport involves periods of high-intensity activity, interspersed with lower intensity actions, as well as technical and tactical components (Sparkes et al., 2018). These efforts increase the physical demands of the players and contribute to characterize soccer, as a sport with high metabolic and physiological demands (Iaia et al., 2009; Arslan et al., 2017). Moreover, computerized time motion and video analyses have revealed that top class football players perform 2 to 3 km of high-intensity running (>15 km/h) and about 0.6 km of sprinting (>20 km/h). In addition, the less successful teams exhibit greater decrements in the total speed distance covered during the match, suggesting the importance to perform high intensity activities through football specific exercises (Iaia M. et al., 2009) [3,4]. Soccer is one of the most investigated sports in the world, with its scientific analysis growing continuously. Contemporary match analysis procedures (Barros et al., 2007; Glazier, 2010; Gregson, Drust, Atkinson, & Di Salvo, 2010) have provided insiders a great quantity of information. Thanks to low-cost, high-technology standards, this information is available to an always increasing audience of stakeholders (performance analysts, coaches, team managers, and exercise physiologist) with the ultimate aim to continuously enhance soccer performance. These systems now provide better insight into the physical and technical aspects of the game, with data presented in a more detailed fashion than ever before. In these contests, soccer was considered as a nonlinear dynamical system that required a novel mathematical analysis (such as that provided by Prozone) to investigate the relevance of the main key performance indicators

(KPIs) that were chosen for the game's final outcome. Our hypothesis, according to previous studies (Carling & Dupont, 2011; Diaz del Campo, Gonzalez Villora, Garcia Lopez, & Mitchell, 2011; Hoppe, Slomka, Baumgart, Weber, & Freiwald, 2015), was that there is a different contribution of these KPIs on matches outcome, such that the technical-tactical domain is of primary importance [5,6]. The COVID-19 pandemic has changed the conditions for competitive football around the globe dramatically. Several competitions and leagues have been cancelled or postponed. Players have firstly been forced to training in solitude. In a second stage, players start training in small groups with strict contact restriction and return to competitive play might occur after only few weeks of normal team training preparation.

Whilst the last economic crisis of 2007-2008, had major consequences for non-sporting and sporting industries across Europe (Parnell et al., 2017), it had a limited negative impact on elite professional football industry [7]. Modern elite football is getting more and more demanding in terms of the numbers of matches played during the season that may add extra physical and mental load to the players. With regard to the match running distance, data from the English Premier League between 2006/2007 and 2012/2013 showed a ~20% elevation (~3% increase per year) in the distance covered at high-intensity and a ~50% increase in the number of high-intensity actions. The total sprint distance increased by 8% in the same period. Assuming a comparable trend for the season 2013/2014 and beyond, one would expect an additional increase of >40% in the distance covered at high-intensity running in 2030 compared with that covered during the 2012/2013 season.

We assume that this trend observed in the English Premier League will be presented in other national football leagues too [8,9]. There are several approaches to quantifying physical load in team sports using positional data. Distances in different speed zones are most commonly used. Recent studies have used acceleration data in addition in order to take short intense actions into account [10]. The aim of this study is analyze physical performance in Italian Serie A 2019-2020, after return to play post Covid-19, in the 20 club participants in the championship (n=567 players, age 27.2±1.1, value: 8.12 mln), to understand the causes of injuries that occurred during the last 12 match for the conclusion of the Serie A and variation in high intensity production.

## Materials and Methods

Twenty football team Italian Serie A 2019-2020 (n=20) and 567 professional football players took part in this study. All athletes are elite football players. In order to be included in the study subjects had to 1) ensure regular participation in all the training sessions, 2) have competed regularly during the previous competitive season, and 3) possess medical clearance. Before entering the study, participants were fully informed about the study aims and procedures, and they provided written informed consent before the testing procedure. Infact in all match day, football players and team have public data analysis in official website. The study protocol was conformed to the code of Ethics of the World Medical Association (Declaration of Helsinki).

## Equipment

Italian Serie A Team was analyzed with SPORTVU OPTICAL TRACKING (STATS PERFORM, CHICAGO, USA) during each football match, from 27 match day (June 2020, after lockdown) to 38 match day (August 2020). Using a semiautomatic video analysis system that has incorporated new parameters able to measure technical tactical and physical efficiency ("Method for game analysis", patented 2010, PCT/IB2010/002593, K-SPORT UNIVERSAL, MONTELABBATE, ITALY).

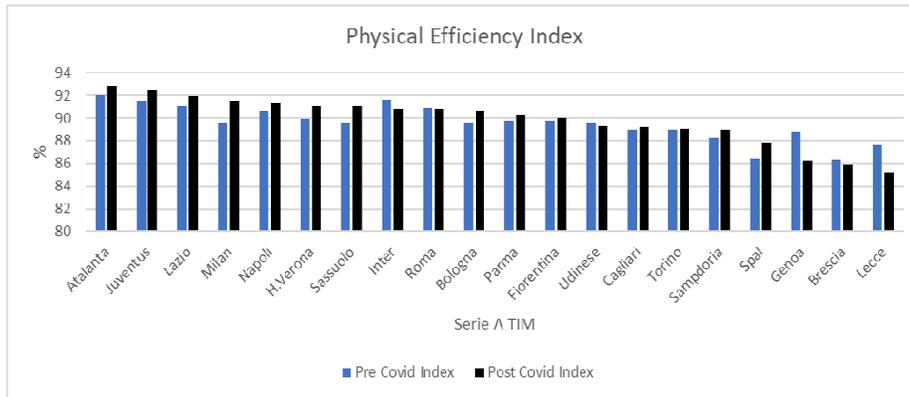
## Data Analysis

Statistical analyses were performed using the STATISTICA for Windows Excel 10 (Microsoft, USA) software package. Data were analyzed using Pearson's Correlation Coefficient to examine the relations between key performance and injuries. An alpha level of  $p < 0.05$  was chosen. Data are presented as means  $\pm$  standard deviation. The 95 % confidence interval (CI) was also computed for each team. Effect size dimension (d-Cohen) is low from 0 to 0.4, moderate from 0.5 to 0.6 and large from 0.7 to 1.0.

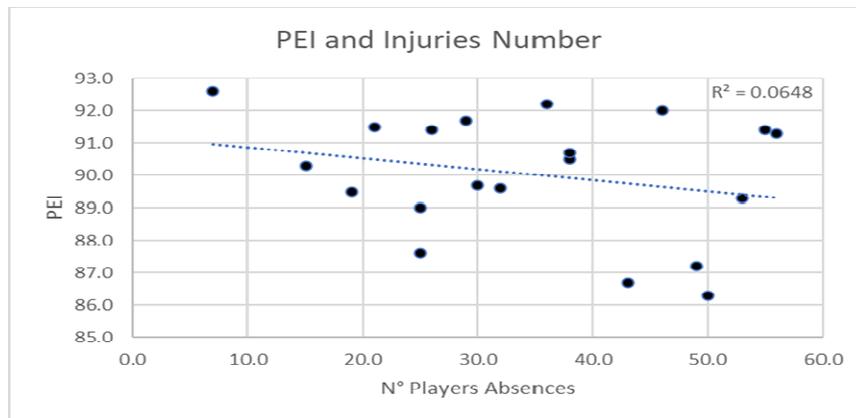
## Results.

PEI is Physical Efficiency Index, indicates the physical efficiency that the athlete has shown in the match. In practice, this index is the most useful for assessing the athlete's state of form; e.g.: there is a fast break and an athlete must reach the ball as soon as possible, thus running at maximum speed. Knowing that the best performance (in the data collected in the match-analysis) is to reach the ball in X seconds, if the athlete takes X seconds his physical efficiency in that counterattack is 100%, if instead it takes more time, depending on the extra time it takes, its physical efficiency will be 100% lower. This index is explained by other more specific efficiency indexes concerning speed, acceleration, deceleration and power. Pre and Post test PEI is analyzed in all serie A team (Fig.1), and revealed a little change statistically meaningfulness in this KPIs (ES:0.19;  $p < 0.05$ ). Probably all team during a lockdown, with fitness training tried to maintain and not totally lose their physical condition, but not improve aerobic and anaerobic fitness, as evidenced from PEI data post Covid. Instead, low

negative correlations was found between PEI and number of injuries occurred post lockdown respectively, (n=20, r = -0.25, p >0.05) (Fig.2).



**Fig.1. PEI pre Covid and post Covid in serie A 2019-2020 (mean ± st.dev) (ES: 0.19; p<0.05) (Data Gazzetta Sport)**



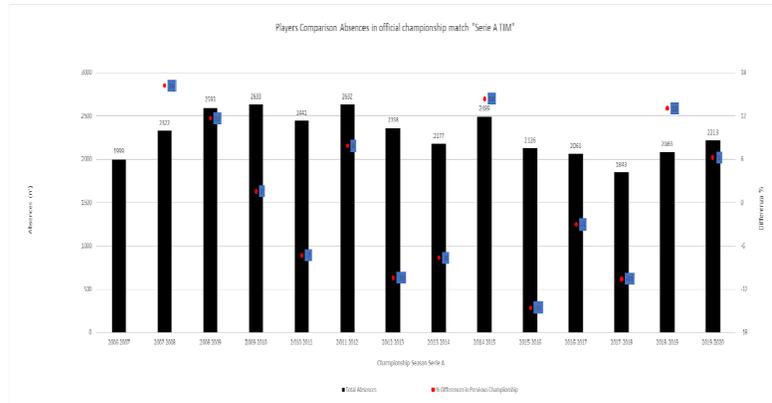
**Fig.2. Correlation Numbers of Players Absences for injuries and PEI between 20 Italian Serie A Team 2019-2020 (mean ± st.dev) after Covid-19 (Lockdown) (r = - 0.25; p>0.05)**

The championship was suspended due to the Covid-19 emergency on matchday 26 and restart from matchday 27a in June 2020. The percentage of absences due to injury by comparing matchday 27 (post lockdown) and matchday 38 (last season) has showed a statistically significant increase 26% (n=20; p<0.05). Negative correlations was found between PEI (Physical Efficiency Index) and number of injuries occurred post lockdown respectively, (n=20, r = -0.25, p > 0.05). For the 2019-20 season there is a total number of absences equal to 2213; compared with the data of the last thirteen seasons , an increase of 6%, statistical meaningfulness, (n=20; p<0.05) is observed compared to the previous season (2018-19) (Fig.3). The 2019-20 season is the fifth of the fourteen seasons monitored for the total number of absences of players from official matches due to injuries in the Championship. In the 2019-20 season there is an average absence per day of 58, with a maximum of 71 on the 13th and 20th and a minimum of 39 on the 1st match day; in the first leg the average absences were 57, in the second leg 59, with the respective maximum and minimum values of 71-39 and 71-48. Key performance indicators in this research not predict injuries and they have a low correlation with them. Future studies it's necessary to have more information on absence of injuires and their relation with performance and technical/tactical game intelligence (Tab.1.).

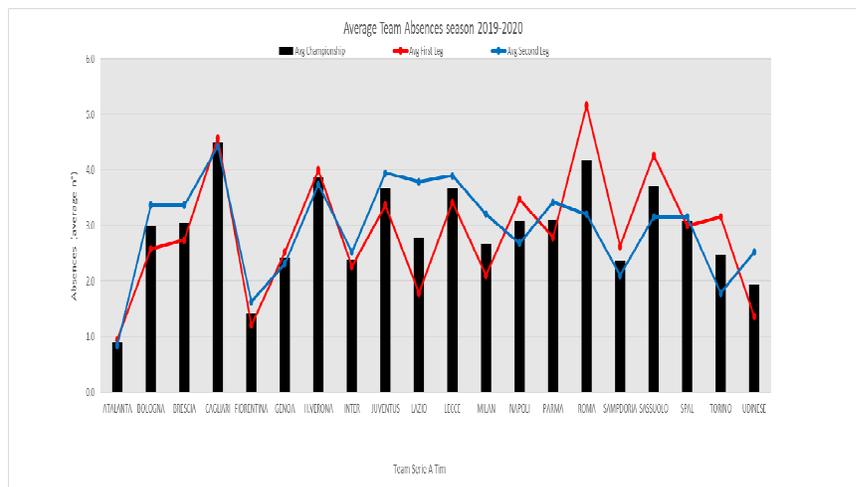
**Tab.1. PEI and Injuries (mean ± sd) %CV; IC 95%**

	Mean	SD	%CV	95%IC
PEI (%)	90.0	1.9	0.02	1.0
Avg Total Injuries (1st + 2nd leg)	58.0	8.5	0.15	4.0
Avg Injuries First Leg	57.0	10.5	0.18	4.6
Avg Injuries Second Leg	59.0	6.2	0.11	2.7

Of course, PEI (Physical Efficiency Index), it's a good indicator of physical team condition. Average team absences comparing first leg and second leg not statistically meaningfulness (ES:0.21; p>0.05), probably due at lockdown and a long period stop that not change average first leg respect second leg (Fig.4.).

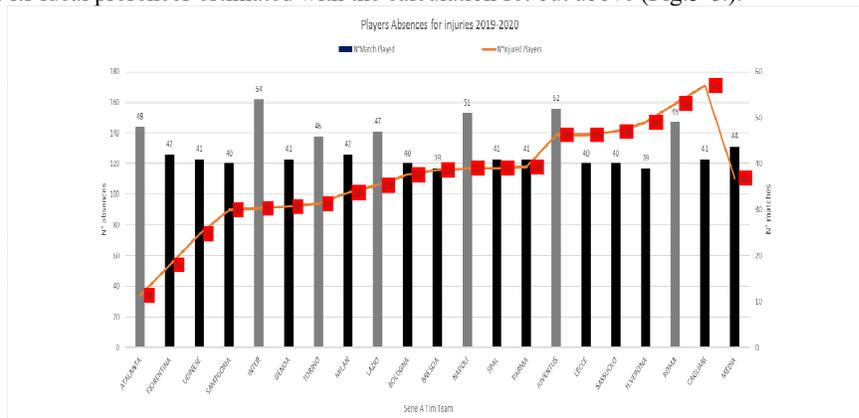


**Fig.3. Players Comparison Absences in official championship match Serie A TIM (13 seasons); statistically meaningfulness (ES:0.32; p<0.05)**



**Fig.4. Average Team Absences in Serie A TIM 2019-2020 first leg vs second leg (ES:0.21; p<0.05)**

To better analyze the situation of absences due to injury, it's important it is important to understand the difference between ideal presences and real presences. By ideal appearances we mean the total of possible appearances of players in the official competitions that each team has played. For this calculation, the number of players in the squad is considered, multiplied by the total of official matches (squad x total official competitions). By real attendance, on the other hand, we mean the total of the real appearances of players in the official competitions played by each team which is calculated by subtracting the total absences due to injury that each team had in the 2019-20 season (ideal appearances - absences x total injuries). Finally, the percentage of availability is calculated, which represents the difference, expressed as a percentage, between ideal and real presences. Therefore, the higher the percentage of availability, the more the number of real appearances of a team approaches its ideal presences estimated with the calculation set out above (Fig.5-6.).



**Fig.5. Players Absences for injuries in Serie A TIM 2019-2020**



### Citation Index

- [1] Bangsbo J., Mohr M., Individual training in football , (2014). © Bangsbosport ePub produktion: Rosendahls – BookPartnerMedia ISBN: 978-87-994880-2-5.
- [2] Filetti C., D’Ottavio S., Ruscello B., Manzi V., Moalla W.(2016). Relationship between high intensity running and outcome of technical-tactical skills in professional soccer players during match play, *American Journal of Sports Science* 4(1): 1-9.
- [3] Raiola G., D’Isanto T., Assessment of periodization training in soccer (2016). *Journal of Human Sport and Exercise*, 11 267-278.
- [4] Izzo R., Carrozzo M., Analysis of significance of physical parameters in football through GPS detection in a comparison with amateur athlete (2015). *International Journal of Physical Education, Sport and Health*, Vol.2, Issue 2, IF 4.69, Tirupati J. Serv. Rohini, New Delhi, India; ISSN (online) 2394-1693, ISSN (Print) 2394-1685.
- [5] Filetti C., et al., A Study of Relationships among Technical, Tactical, Physical Parameters and Final Outcomes in Elite Soccer Matches as Analyzed by a Semiautomatic Video Tracking System (2017). *Perceptual and Motor Skills* Vol. 124(3) 601–620.
- [6] Izzo R., Sopranzetti S., Speed, acceleration, deceleration and metabolic power in the work to roles for a workout more targeted in elite football (2016). *International Journal of Physical Education, Sport and Health*, Vol.2, Issue 2, Tirupati J. Serv. Rohini, New Delhi, India, ISSN (online) 23941693, ISSN (Print) 2394-1685.
- [7] Mohr M., et al., Return to elite football after the COVID-19 lockdown , *Managing Sport and Leisure* (2020). <https://doi.org/10.1080/23750472.2020.1768635>. ISSN: 2375-0472 (Print) 2375-0480 (Online) Journal homepage: <https://www.tandfonline.com/loi/rmlc21>.
- [8] Nassis G.P., et al., 2020 Elite football of 2030 will not be the same as that of 2020, (2020). *Scand J Med Sci Sports*. 2020;30:962–964.
- [9] Gualtieri A. et al., Workload Monitoring in Top-level Soccer Players During Congested Fixture Periods (2020), *Int J Sports Med* DOI <https://doi.org/10.1055/a-1171-1865>.
- [10] Sonderegger K. et al., The Challenge of Evaluating the intensity of short actions in soccer: A new methodological approach using percentage acceleration,(2016) *PLoS ONE* 11(11): e0166534. Doi:10.1371/journal.pone.0166534.

### References

- 1.Anderson, L., Close, G.L., Morgans, R., Hambly, C., Speakman, J.R., Drust, B., Morton, J.P., (2019). *Assessment of Energy Expenditure of a Professional Goalkeeper From the English Premier League Using the Doubly Labeled Water Method*”. *Int J Sports Physiol Perform.*;14(5):681-684. Doi: 10.1123/ijspp.2018-0520. Epub 2019 Apr 16.
2. Bangsbo,J., Mohr, M. (2019). *Fitness testing in football*, © Bangsbosport ePub produktion: Rosendahls – BookPartnerMedia ISBN 978-87-994880-0-1.
- 3.Bengtsson, H., Ekstrand, J., H’aggglund, M. (2013). *Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study*. *Br J Sports Med.*;47:743–747.2013
- 4.Coelho, L. (2010) *Mézières’ method and muscular chains’ theory: from postural re-education’s physiotherapy to anti-fitness concept*. *Acta Reumatol Port*. Jul-Sep; 35(3): 406-7.
- 5.Dauty,M., Collon, S. (2011) *Incidence of injuries in French professional soccer players*. *Int J Sports Med*. 2011;32:965–969.
- 6.Donmez,G., Kudas, S., Yorubulut, M., Yildirim, M., Babayeva, N.,Torgutalp, SS., (2018), *Evaluation of Muscle Injuries in Professional Football Players: Does Coach Replacement Affect the Injury Rate?.*” *Sport Med*. Aug 15.
- 7.Donmez, G., Korkusuz, F., Ozçakar, L., et al. (2018). *Injuries among recreational football players: results of a prospective cohort study*. *Clin J Sport Med*. 2018;28:249–254.
- 8.Di Prampero, PE., Botter, A., Osgnach, C. (2015) *The energy cost of sprint running and the role of metabolic power in setting top performances*”. *Eur J Appl Physiol* Mar 115(3) 451-69.
- 9.Ekstrand, J., Haggglund, M., Walden, M. (2011). *Injury incidence and injury patterns in professional football: the UEFA injury study*”. *Br J SportsMed*. 2011;45:553–558.
- 10.Ekstrand, J., Haggglund, M., Kristenson, K. (2013). *Fewer ligament injuries but no preventive effect on muscle injuries and severe injuries: an 11-year follow-up of the UEFA Champions League injury study*”.*Br J SportsMed*. 2013;47:732–737.
- 11.Ekstrand, J., Lee, J.C., Healy, J.C.(2016). *MRI findings and return to play in football:a prospective analysis of 255 hamstring injuries in the UEFA Elite Club Injury Study*. *Br J Sports Med*. 2016;50:738–743.
- 12.Fanchini, M., Ghielmetti, R., Coutts, A.J., Schena, F., Impellizzeri, F.M. (2015). *Effect of training session intensity distribution on Session-RPE in soccer players*”. *Int J Sports Physiol Perform*. 10(4): 426-30.

13. Filetti, C., D'Ottavio, S., Ruscello, B., Manzi, V., Moalla, W. (2016). *Relationship between high intensity running and outcome of technical-tactical skills in professional soccer players during match play*". American Journal of Sports Science 4(1): 1-9.
14. Gabbett, T.J. (2016). *The training-injury prevention paradox: should athletes be training smarter and harder?*". Br J Sports Medicine Mar; 50(5): 273-80.
15. Gaetano, R., Rago, V., (2014). *Preliminary study on effects of 3385it-high intensity intermittent training in youth soccer players*". Journal of Physical Education and Sport, 14 (2), 148-150.
16. Impellizzeri, F.M., Rampinini, E., Couutts, A.J., Sassi, A., et Marcora, S. (2004). *Use of RPE-Based Training Load in Soccer*". Med Sci. Sports Exerc., 36 (6): 1042-1047.
17. 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; ISSN (online) 2394-1693, ISSN (Print) 2394-1685. 2016
18. Izzo, R., Carrozzo, 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; ISSN (online) 2394-1693, ISSN (Print) 2394-1685.
19. 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; ISSN (online) 23941693, ISSN (Print) 2394-1685.
20. 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) 23941693, ISSN (Print) 2394-1685.
21. 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
22. 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.
23. 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.
24. Izzo R., Hosseini Vardei'i C., Sopranzetti S., Cejudo A., Cruciani A., Giovannelli M. (2021), Evaluation of differences at high intensity threshold and its performance value during the most valuable soccer championships in Europe Journal of Physical Education and Sport ® (JPES), Vol. 21 (3), Art 177, pp. 1387 - 1394, May 2021 online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES
25. Malone, J.J., Jaspers, A., Helsen, W., Merks, B., Frencken, W.G.P., Brink, M.S. (2018), *Seasonal Training Load and Wellness Monitoring in a Professional Soccer Goalkeeper*. Int J Sports Physiol Perform. 2018 May 1;13(5):672-675. Doi: 10.1123/ijsp.2017-0472. Epub 2018 May 26.
26. Maffulli, N., Oliva, F., Nanni, G., et al. (2014). *Ismult guidelines for muscle injuries*", Muscles Ligaments Tendons J. 2014 Feb 24;3(4):241-9. eCollection 2013 Oct. 2014
27. Melegati, G., Tornese, D., Gevi, M., et al. (2014). *Reducing muscle injuries and reinjuries in one Italian professional male soccer team*". Muscles Ligaments Tendons J. 2014;3:324–330.
28. Mujika, I. Foster, C., Coutts, A. (2106). *Monitoring Athlete Training Loads: The Hows and Whys*", 2<sup>nd</sup> Science Conference Aspire.
29. Rago, V., Pizzuto, F., Raiola, G. (2016). *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.
30. Raiola, G., D'Isanto, T. (2016), *Assessment of periodization training in soccer*. Journal of Human Sport and Exercise, 11 267-278.
31. Raiola, G. (2017), *Motor learning and teaching method*. Journal of Physical Education and Sport, 17, 2239-2243.
32. Stubbe, J.H., Van Beijsterveldt, A.M., Van Der Knaap, S. (2015) et al. *Injuries in professional male soccer players in the Netherlands: a prospective cohort study*. J Athl Train. 2015;50:211–216.
33. Wesam Saleh A. et al. (2021), *Implementation of the FIFA 11+ referees injury prevention program among soccer referees* Journal of Physical Education and Sport ® (JPES), Vol. 21 (3), Art 174, pp. 1367 - 1375, May 2021 online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES