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Session RPE and Speed High Intensity Distance in Meters (D_SHI mt): A Valid Method to Analyze Training Load in Soccer Players

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Abstract: The purpose of this study is to verify the physiological effect and describe the intensity of training in response to internal and external loads, through Session Rate of Perceived Exertion and Speed High Intensity Distance in Meters reports, on professional soccer players engaged in weekly training (199 Sessions, 43 weeks) and league games (32 official matches). Twenty-two male professional soccer players (n = 22) of the Italian national championship under-19 are involved in this study during the season 2014-2015. Daily, Weekly and Monthly RPE (perceived exertion) Session (Borg CR-10 Scale) is a good indicator of the amount of work done: training time multiplied by perceived effort (TL = Training Time × RPE). With Arbitrary units (a.u.) produced by the individual and used for team-based data analysis, we analyze the intensity produced by workout depending on the working time. Furthermore, by means of global positioning system technology (K-Sport, Montelabbate PU, Italy 10 Hz), we statistically established the existing relationship with high intensity speed distance (> 16 km/h) and session rate of perceived exertion to describe how the internal (represented by the sum of the stresses that the body undergoes an external load; is strictly subjective) and external loads (the objective quantification of the means used in training km routes, running speed, slope, type of recovery), are correlated (r = 0.87, p <0.01, 95% CI). The statistical analysis highlights how these methods are suitable to quantifying the high-intensity work done by the soccer player during the workout and the game.

Key words: Internal load, external load, session rate of perceived exertion, global positioning system, high intensity distance running in meters (> 16 km/h).

1. Introduction

Soccer is a dynamic sport of which the performances depend on physical fitness, psychological factors, technical skills and team tactics [1-4]. Filetti et al. [2] analyzed the relationship between high intensity run (> 16 and > 20 km/h) and the technical tactical skills of the professional football player during the matches. This study shows scientifically how the physical and tactical aspects are closely linked and in the programming of the practices. It is necessary to create the most functional workouts in all aspects with respect for high workout intensities from the psycho-physical point of view. Consideration should be given to both external and internal loads, on the days of workouts per week.

Gabbett [3] analyzed importance of more detailed external load analysis as prevention injuries risk factor: use external load parameters to calculate the likelihood of injuries, the relationship between acute load (fatigue) and chronic load (fitness). All this highlights how there are different approaches to workload analysis and how it is necessary to draw from the external load of the appropriate responses to get benefits. An example of this new approach is the following: acute training load (i.e. fatigue)/chronic training load (i.e. fitness) ratio. Acute training load is average workload of the last 7 days (e.g. sum of session rate of perceived exertion, distance covered to very high intensity accelerations > 3 m/s^2 or decelerations < -3 m/s^2 or distance covered to

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high intensity >16 km/h and very high intensity run > 20 km/h). Chronic training load = average workload of the last 42 days (or 4 weeks) (e.g. sum of session rate of perceived exertion, distance covered to very high intensity accelerations > 3m/s² or decelerations < -3 m/s²or distance covered to high intensity >16 km/h and very high intensity run > 20 km/h).

Subsequently it will perform the ATL/CTL ratio, this result of which will be a low-injury risk for single player and team will have to be between 0.8-1.3, on the other hand, if > 1.5 the risk of injury will be much higher. What is to be considered is also the difference in workload increase between one week and next week: according to data collected during the training the increase must be between 10%-15%, not higher, so as not to have higher risk of injuries.

The important point to consider is the relationship between internal and external loads and the associated variables of each. What are the most important parameters of external load? In the state of the art, in training science the latter is only a "descriptor" of the work and not a precise and detailed load indicator such as internal load.

Gabbett [3] reported that 40% of muscle injuries are associated with a rapid change in training load (> 10%) compared to the previous week. As the training load (TL) increases by 15% over the previous week, the risk of injury increases between 21% and 49%. To minimize these risks, weekly loads must not exceed 10% of the previous week. The ACL/CTL report is a specific analysis of the condition and individual athlete's preparation; aerobic training is a key basis for injury prevention, in conjunction with other work; training programs must be both physiological and psychological to allow players to cope with workload and play requirements.

According to Gabbett [3], one of the values predicting an increased risk of injuries in sports is the average load over the last 7 days, expressed in meters covered in acceleration (> 2 and 3 m/s²). The external load does not describe stress, as perceived exertion does not describe performance [5], it is necessary to collect all the available data, but in compliance with the rule by which you can immediately get practical information and take time to scientifically study the phenomenon in its complexity using necessary statistical techniques. Transform knowledge into knowledge. This is also confirmed from Impellizzeri et al.'s [4] study, which has always offered practical training solutions for TL (training load): schedule the week's workload according to the individual's history, check at the weekend how much it is done actually compared to the programmed and the relationship between the workload done in the last few days and the previous weeks, avoiding sudden swings of TL by observing all available parameters, change training content to avoid monotony, modify individual programs by adding work without ball or strength work and change exercises considered dangerous to players.

2. Methods

2.1 Participants

Twenty-two male professional soccer players (n = 22) of the Italian national championship under-19 are involved in this study during the season 2014-2015 (199 training sessions, 10-12 h/week, 43 weeks, 1-2 years experiences in this competition, 29 Official Matches: Championship and Italy Cup) (mean ± SD: age 20 ± 11.8 years, height 181.0 ± 0.1 cm, weight 73.6 ± 6.6 kg, BMI 23.0 ± 1.1 kg/m², % fat mass 9.3% ± 2.7%, sit and reach 47.0 ± 8.0 cm, IR1 2575 ± 600 m, VO_2max 58.1 ± 0.8 mL/kg/min, HRmax 195 ± 4.7 bpm, high blood pressure 137 ± 10 mmHg, low blood pressure 69 ± 6 mmHg; CMJ 39.5 ± 3.6 cm; CMJb 47.0 ± 3.6 cm; 20 mt Sprint 3.05 ± 0.17 s; C2OD Agility Test 7.59 ± 0.24 s). The aim of this study is to establish the existing relationship with high intensity speed distance (> 16 km/h) and SRPE (session rate of perceived exertion).

2.2 Procedure

Training load was analysed (with global positioning

system, heart rate belt and Borg scale CR-10) throughout the entire season of the Italian Championship U19 2014-2015 (199 sessions, 6 workouts per week, 32 official matches) on 22 professional football players, excluding goalkeepers and injured players who did not complete the training week. For SRPE, we collected data at the end of each training and match (CR-10 Borg Scale) (Fig. 1) for individual and team analysis. SRPE was calculated as: rate of perceived exertion × workout time or game = training load in AUs (arbitrary units). For the external load we are used K-GPS (10 Hz) and K-Fitness software (K-Sport Universal, Italy), from which we detected D_SHI (speed high intensity distance in mt > 16 km/h) covered by individual players and team at the end of each workout and match.

2.3 Statistical Analysis

All data are presented as mean ± SD (standard deviations). Pearson's product moment correlation coefficients were used to examine the relationship between the weekly TL (internal training load and external training load) for each week during the season. The level of significance was set at $p < 0.01$ and CI (95%). All statistical analyses were conducted using the statistical package for the social science (SPSS, version 18.0 SPSS Inc, Chicago, IL, USA).

3. Results

Analysis of the internal load during practice and match shows how the session rating perceived of exertion is an excellent indicator of the work produced: it describes precisely the intensity achieved. This is due to the multiplication between perceived effort (CR-10) and training time. In this regard, our aim was to investigate the relationship between the SRPE and the external workload to better understand how this relationship was related. It is shown that this ratio has a very high correlation coefficient ($r = 0.87$, $p < 0.01$) (Fig. 2), pointing out that as s high intensity distance (> 16 km/h) covered by player increase, perceived exertion (RPE) increases. The D_SHI (mt) (> 16 km/h), produced during training (Figs. 2 and 3), which can be verified using K-GPS and K-Fitness, is an excellent indicator of high intensity produced by player during training and game [6-8].

4. Discussion

In fact, Borg CR-10 might have a limit: for different work time, it may happen that the exercise has a high or low intensity and this does not tell us what the total volume of work is and how it is distributed, so the above mentioned report necessitates the best way to interpret and analyze the entire training session (time) thanks to result in AUs. Regarding to SRPE, the internal workload has different levels based on arbitrary units reached. High: > 700 AUs; Medium-High: 500-700 AUs; Medium: 400-500 AUs; Medium-Low: 300-400 AUs; Low: < 300 AUs [4, 9, 10].

Rating	Descriptor
0	Rest
1	Very, very easy
2	Easy
3	Moderate
4	Somewhat hard
5	Hard
6	
7	Very hard
8	
9	
10	Maximal

Fig. 1 CR-10 Borg scale.

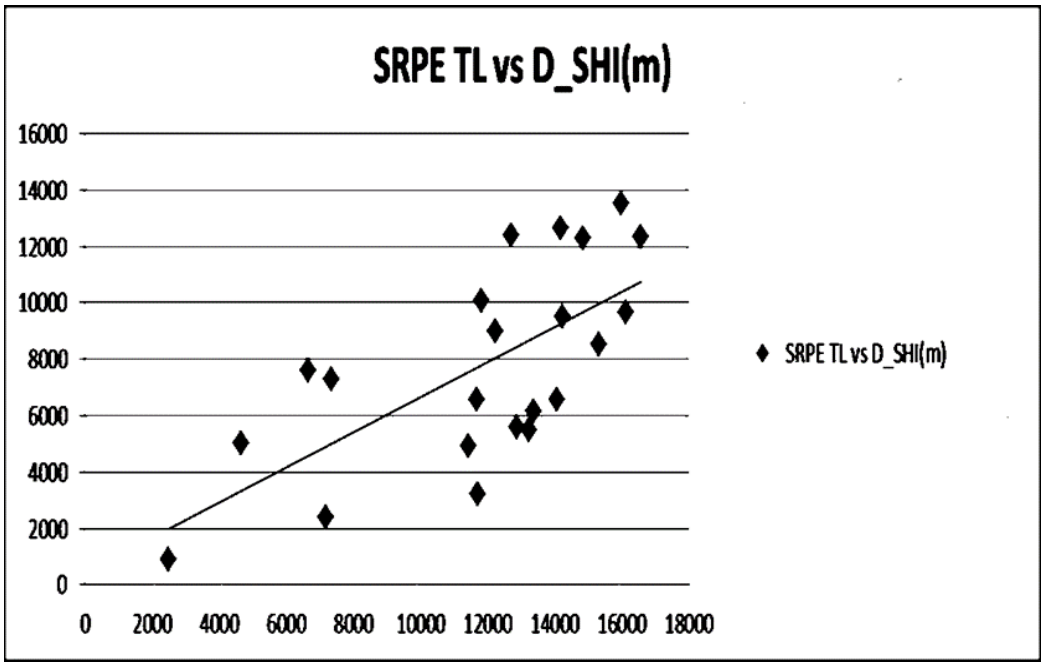

Fig. 2 SRPE relationship with D_SHI(m).

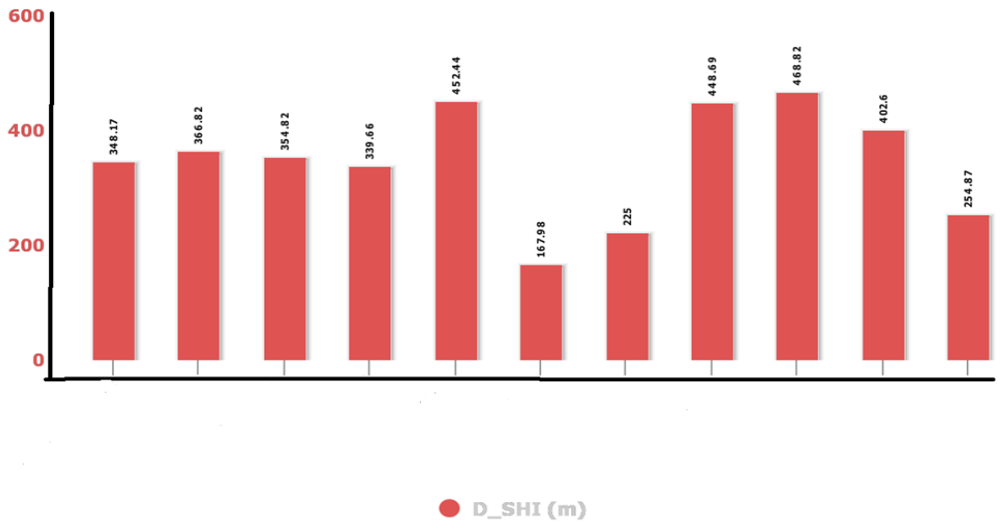

Fig. 3 D_SHI(mt) >16 km/h (near here).

The weekly SRPE sum is 2,000-3,000 AUs (including game) [4, 9, 10]. In fact, one game per week represents about 25% of the total weekly load; instead, two games a week account for about 65% of total weekly load. This is important to have a correct workload post-match, especially for players who played entire game. Indeed, it can be seen from Borg's scale (CR-10) and relative sessions-RPE as the efforts perceived during match are important and require a suitable one recovery from player as a result of permanent fatigue phenomenon that occurs at the end of the game and glycogen store not yet restored before 48-72 h. On average at the age taken into account, it is also important to remember the player's ability to restart training, usually taking a day off, but at times not enough to recover due to above mentioned phenomena.

In some cases there are players who can recover better than others and this performs regular training. There are different approaches to workload analysis, literature has always put a lot of emphasis on the analysis of what is happening in the field, technological evolution has brought important improvements to guarantee more and more insights and better results. What can hardly be changed is about physiological analysis and compliance with the laws regulating this matter. Filetti et al. [2] and Impellizzeri [4] considered to be one of the world's leading scientists and experts on the topic of training exercise monitoring, the author of the rating of perceived exertion (RPE), has repeatedly emphasized in his studies the importance of the amount and quality of the athlete's training. He has identified some goals independent of technological development (global positioning system, match analysis) for the coming years: Improving the ability to make day-to-day management of load management based on what is monitored; minimize the time between the data collection and the information given to the trainer to minimize the interference of training methods with training, training and its monitoring as the interface between the athlete and the trainer. A very detailed analysis was carried out by Refs. [2, 5], which reiterated importance of using RPE in high intensity metabolic sessions. By properly utilizing perception of effort, possibility of simplifying a complex system has been supported such as the human brain. The studies he conducted using the CR-10 Borg Scale enabled him to identify 3 training intensity zones: the first from 0.5 to 4, the second from 4.1 to 6.5, and the third from 6.6 to 10. He proposed 6 bouts for 4 minutes, interrupted by 1-2 or 4 rest minutes, depending on group that showed how RPE after each repetition was the same in all three experimental groups, while SRPE was greater in group with longer recoveries. According to Refs. [3, 11], the important thing is to improve performance by minimizing injuries, among situations that cause an increase in the incidence of injuries which are reported high running speeds at high intensity (> 16 km/h and > 20 km/h), repeated high intensity efforts, the loads are constantly high or inadequate (both in terms of internal load, RPE and Edwards method both external load TD (mt), D_SHI (mt). Sudden burst loads (acute and chronic load ratio: ratio between last week and average of the last four) and the history of previous injuries are other triggering factors, so it is necessary to hold load variations between 10%-15% between a week and the next training calculation of the difference between SRPE, Edwards Method (AUs), D_SHI (mt), D_ACCHI (mt), D_DECHI (mt) to reduce likelihood of injuries [3, 12-14]. In all of this, not only TL itself causes an injury, but also training contents with its aims. Internal load is the main descriptor of what happens, this is largely evidenced by the studies of scientific literature. The external load is greatly affected by the size and play spaces. The proposal for team sports and in this case for football is not to train for match average request, as this would not allow you to prepare for the decisive moments with greater run intensity (> 16 km/h, > 20 km/h) [15]. What becomes very important is to analyze the perceived effort in terms of working time (SRPE), calculate the daily, weekly and monthly load and establish the correct arbitrary units that we are reaching with proposed workout. Very large correlation ($r = 0.87$; $p < 0.01$) between SRPE and average heart rate and high intensity distance (> 16 km/h) makes us understand the importance of the relationship between the two internal and external components of workload. On equal terms (depending on the role) players that produce greater intensity of running in a workout and match have better performance than others who do so less. As the D_SHI (mt) (> 16 km/h) increases as the perceived effort (RPE value), SRPE is based on training time (TL = RPE × training time) and is expressed as arbitrary units. Refer to a proper daily, weekly, and monthly SRPE analysis to understand the "ideal" weekly individual load for the player. Be careful not to exceed 10%-15% of the load between one week and the next, as the risk of injury increases by 4 times. Establish a target RPE to achieve

according to the proposed training, to ensure an adequate D_SHI (mt) that can ensure physiological adaptation over time.

References

[1] Fanchini, M., Ghielmetti, R., Coutts, A. J., Schena, F., and 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.

[2] Filetti, C., D'Ottavio, S., Ruscello, B., Manzi, V., and 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] 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.

[4] Impellizzeri, F. M., Rampinini, E., Couutts, A. J., Sassi, A., and Marcora, S. 2004. "Use of RPE-Based Training Load in Soccer." *Med. Sci. Sports Exerc.* 36 (6): 1042-7.

[5] Mujika, I., Foster, C., and Coutts, A. 2016. "Monitoring Athlete Training Loads: The Hows and Whys." Presented at the 2nd Science Conference Aspire.

[6] Izzo, R., and Morello Zenatello, V. 2016. "The Study of Acceleration Capacity Decrease in Repeated 30 mt Sprints." *International Journal of Physical Education, Sport and Health* 3 (1): 200-8.

[7] Izzo, R., and 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* 2 (2): 260-6.

[8] Izzo, R., and 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* 3 (5): 525-9.

[9] Manzi, V., Bovenzi, A., Impellizzeri, F. M., Carminati, I., and Castagna, C. 2013. "Individual Training-Load and Aerobic-Fitness Variables in Premiership Soccer Players during the Pre-competitive Season." *J. Strenght Cond. Res.* 27 (3): 631-6

[10] Manzi, V., Impellizzeri, F. M., and Castagna, C. 2014. "Aerobic Fitness Ecological Validity in Elite soccer players: A metabolic power approach." *J. Strength Cond Res.* 28 (4): 914-9.

[11] Izzo, R. 2010. "Performance Analysis negli sport di squadra." dispensa a cura di centro copie Urbino.

[12] Izzo, R., and 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* 2 (2): 250-9.

[13] Izzo, R., and Ciro 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* 4 (3): 263-7.

[14] Izzo, R., and Giovannelli, M. 2017. "Edwards TL Method and D_SHI(m): Intensity Descriptors." *Sport Science* 10 (1): 104-10.

[15] Osgnach, C., Poser, S., Bernardini, R., Rinaldo, R., and Di Prampero, P. E. 2010. "Energy Cost and Metabolic Power in Elite Soccer: A New Match Analysis Approach." *Med. Sci. Sports Exerc.* 42 (1): 170-8.

[16] Castagna, C., Impellizzeri, F. M., Cecchini, E., and Rampinini, E., and Alvarez, J. C. 2009. "Effects of Intermittent-Endurance Fitness on Match Performance in Young Male Soccer Players." *J. Strength Cond. Res.* 23 (7): 1954-9.

[17] Castagna, C., Impellizzeri, F. M., Chaouachi, A., Bordon, C., and Manzi, V. 2011. "Effect of Training Intensity Distribution on Aerobic Fitness Variables in Elite Soccer Players: A Case Study." *J. Strength Cond. Res.* 25 (1): 66-71.

[18] Castagna, C., Impellizzeri, F. M., Chaouachi, A., and Manzi. V. 2013. "Preseason Variations in Aerobic Fitness and Performance in Elite-Standard Soccer Players: A Team Study." *J. Strength Cond. Res.* 27 (11): 2959-65.

[19] Castagna, C., Giovannelli, M., and Manzi, V. 2014. "Physiologicals Responses and Reliability in Super Small-Sided Games: 5v5." *Notiziario del Settore Tecnico FIGC* 4: 28-32.

[20] Castellano, J., Puente, A., Echeazarra, I., and Casamichana, D. 2015. "Influence of the Number of Players and the Relative Pitch Area Per Player on Heart Rate and Physical Demands in Youth Soccer." *J. Strength Cond. Res*. 29 (6): 1683-91.

[21] Chamari, K., and Padulo, J. 2015. "'Aerobic' and 'Anaerobic' Terms Used in Exercise Physiology: A Critical Terminology Reflection." *Sport Medicine* 1 (1): 1-9.

[22] Di Prampero, P. E., Botter, A., and 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.