Journal of Physical Education and Sport ® (JPES), Vol. 21 (4), Art 211, pp. 1669 - 1675, June 2021
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Weekly training load distribution and relationships between external and internal load indicators in professional soccer players

ŁUKASZ RADZIMIŃSKI
Department of Health and Natural Sciences, Gdansk University of Physical Education and Sport, Gdansk, POLAND

Published online: June 30, 2021
(Accepted for publication June 15, 2021)
DOI:10.7752/jpes.2021.04211

Abstract
The distribution of the weekly training load is an important factor that determines the match performance in soccer players. The main purpose of this study was to present the weekly training load of professional soccer players during the competitive season and to investigate which external load variables may affect the rating of perceived exertion. The external and internal training loads applied to 31 professional soccer players (age: 26.7 ± 4.85 years; height: 181.2 ± 6.64 cm; mass: 76.4 ± 6.87 kg) during the competitive period of the 2018/2019 season were investigated. The largest training volume was performed on Matchday-5 (M-5) and Matchday-3 (M-3), while the longest average distance in high-speed running (HSR) and sprinting was covered on Matchday-4 (M-4). The data on RPE provided by the players suggested that M-4 was the most intensive day of the training week. The values for the most external and internal load indicators for Matchday-2 (M-2) and Matchday-1 (M-1) were significantly lower than during other days of the microcycle. Significant correlations were found between RPE and total distance (TD; $r = 0.58$, $p < 0.001$), HSR ($r = 0.51$, $p < 0.001$), sprinting ($r = 0.25$, $p < 001$), number of accelerations ($r = 0.49$, $p < 0.001$), number of decelerations ($r = 0.56$, $p < 0.001$), energy expenditure ($r = 0.59$, $p < 0.001$), average heart rate (HR avg) ($r = 0.38$, $p < 0.001$) and session duration ($r = 0.37$, $p < 0.001$). A progressive decrease in training loads from the middle of the week was observed in this study. Thus, variables, such as energy expenditure, TD, HSR distance and number of accelerations and decelerations determine the subjective fatigue of professional soccer players.
Key words: periodization, RPE, training monitoring, football.

Introduction

The physical demands of professional soccer have been previously described by numerous authors (Stølen et al., 2005; Di Salvo et al., 2009). Longitudinal analysis of soccer match performance indicates evolution in both physical (Barnes et al., 2014), and technical (Konefał et al., 2019) requirements for elite players. However, most of the published studies refer to data from official competitions, while training loads are investigated less frequently. A properly planned and performed training is essential for allowing players to meet the match requirements at the elite level. Thus, systematic monitoring of the training loads is one of the crucial responsibilities for coaches (Impellizzeri et al., 2005). The typical classification of training loads typically includes external load and internal load. External load refers to training prescribed by the coaches and can be characterized by time–motion variables (Malone et al., 2015). The internal training load is defined as the physiological response of the athlete to the applied effort, which is determined by volume and intensity of the exercise (Enes et al., 2020). Accurate training load control should involve data from both of these components. Due to differences in actual physical fitness, player mentality or training history, a similar external load can result in a different internal load (Jaspers et al., 2018).

The external and internal training loads can be accurately monitored using different methods. Video tracking and GPS systems are most commonly used for external load control. These instruments provide numerous data, including total distance (TD), distance covered in different speed zones, number of high-intensity efforts (high-speed runs, sprints) or number of accelerations and decelerations. Proper interpretation of the data delivered by GPS systems can reduce the injury risk and control the external load for the team and for individual players (Rave et al., 2020). The physiological response to the applied training load can be assessed with the use of heart rate (HR) monitors, which are usually compatible with GPS devices. The average HR data of the session or time spent in individual HR zones (% of maximal HR) provide useful information about the work of the cardiovascular system. Moreover, coaches and sport scientists can analyse selected blood parameters to evaluate the internal load in professional soccer (Radzimiński et al. 2020). Furthermore, Foster et al. (2001) proposed a method based on the rating of perceived exertion (RPE), which is a simple tool that allows evaluation of the load regarding the intensity and volume of the training session. The RPE TL is calculated by multiplying the session RPE (mark given by the player from the CR-10 scale) and the duration of the session expressed in minutes

Corresponding Author: ŁUKASZ RADZIMIŃSKI, E-mail: lukaszradziminski@wp.pl

(Haddad, et al., 2017). The simplicity of this method makes it very popular for both amateur and professional athletes.

Designing short- and long-term training programs to induce training adaptations and maximize the match performance is one of the biggest challenges for coaches in different sports (Mujika et al., 2018). The distribution of the weekly training load is an important factor that influences the match performance in soccer players (Modrić et al., 2021). Typical registration should involve locomotion, HR and RPE data from each day of the microcycle. Few studies have reported on the training load in such a complex manner (Malone et al. 2015). Accurate presentation of the weekly load could provide numerous practical applications for coaches working with players representing different levels and different age groups. Moreover, analysing the data in comparison with match performance (or result) can suggest which training load distribution is optimal for successful competition (Oliviera et al., 2020).

Potential relations between the external training load and rating of perceived exertion could provide practical information for coaches during session preparation when they want to avoid the effect of subjective fatigue. Clemente (2018) found that physical performance during different formats of small-sided games is dependent on the wellness status of players. Furthermore, large correlations between RPE and time–motion variables (e.g. total distance, sprint distance or number of accelerations) were indicated in that study. Moreover, Gaudino et al. (2015) investigated the training load from 1892 individual observations. They reported that variables, such as high-speed running, number of impacts and accelerations, allows for prediction of the RPE training load in elite soccer players. Most recently, Dios-Alvarez et al. (2021) demonstrated significant correlations between the external load and RPE values. Interestingly, these associations were higher during the training sessions then during matches. Marynowicz et al. (2021) highlighted the importance of high-speed running per minute as the strongest predictor of RPE. Thus, careful management of high-speed running volume and intensity should be taken into account by coaches when preparing their teams for a game.

Proper planning of the training process and anticipation of the players' reactions to applied loads is a basic task for coaches. Determining associations between the external load and RPE provides useful suggestions for effective distribution of the training load. Therefore, the main purpose of this study was to present the weekly training load during the competitive season and to investigate which external load variables may affect the subjective fatigue assessment (rating of perceived exertion).

Methods

Experimental approach

Training data was collected for thirty-one professional soccer players during the competitive period of the 2018/2019 soccer season. The time–motion data were recorded using 18-Hz GPS devices (GPEXE, Exelio srl, Udine, Italy) with appropriate software (GPEXE Bridge, version 7.6.7). The devices were compatible with wearable heart rate receivers (Polar Electro, Oy, Kempele, Finland). Moreover, individual RPE marks were collected after each training session. A total of 85 training sessions were analysed. Correlations between the GPS data, HR values and RPE were calculated to identify which variables could potentially influence subjective fatigue of players. Additionally, the training loads were presented with reference to the day of the microcycle.

Participants

Thirty-one professional soccer players from the top division took part in the study (age: 26.7 ± 4.85 years; height: 181.2 ± 6.64 cm; mass: 76.4 ± 6.87 kg). Playing positions of the participants included central defenders (n = 4), external defenders (n = 7), central midfielders (n = 7), external midfielders (n = 8) and forwards (n = 5). Data arose as a condition of players' employment; therefore, no written consent was required. Full approval was received from the ethical board at the institution where the research was conducted. Procedures for the study were in accordance with the Declaration of Helsinki.

Training load monitoring

The external training load was measured using GPS devices. Variables, including total distance (TD), distance covered in walking (0–7.19 $km \cdot h^{-1}$), jogging (7.2–14.39 $km \cdot h^{-1}$), running (14.4–19.79 $km \cdot h^{-1}$), high-speed running (HSR; 19.8–25.2 $km \cdot h^{-1}$), sprinting (>25.2 $km \cdot h^{-1}$), accelerations (>2 m/s^2), decelerations ($\leq$-2 m/s^2), maximal running velocity and energy expenditure ($J \cdot kg^{-1}$) were analysed. Moreover, the average heart rate (HR_{avg}, bpm^{-1}), and maximal heart rate (HR_{max}, bpm^{-1}) of each training session were recorded to evaluate the internal load. The duration of the training session was counted from the moment of the beginning of the warm-up to the moment of the finishing whistle of the head coach. The CR-10 point scale (Borg, 1998), where 1 represents "very light activity" and 10 means "maximal effort", was used to classify the fatigue after each session. Immediately after the training sessions, the RPEs were collected from each player separately. Only data from the players who participated in the full training session where analysed. Moreover, data from recovery training sessions (Matchday + 1) and from training sessions performed on the second day after the game (Matchday + 2) were excluded to prevent match fatigue from influencing the RPE marks. Similarly, sessions performed in the gym were not analysed due to lack of data from the GPS system.

Statistical analysis

All statistical analyses were performed using Statistica 13.0 (TIBCO Software Inc., 2017) in accordance with Hazra and Gogtay (2016). The data sets were analysed using the Shapiro–Wilk test for normal distributions. Possible relations between test results, body composition and match performance were calculated using Pearson's correlation. The level of correlation was fixed in the following categories: very strong ($r \geq 0.80$), moderately strong ($r = 0.60–0.79$), fair ($r = 0.30–0.59$) and poor ($r \leq 0.29$) (Chan, 2003). Additionally, repeated ANOVA was performed to assess the differences between training loads applied to the players on different days of the microcycle. The Tukey post-hoc test was conducted for pairwise comparisons. For variables with uncertain data distribution, the nonparametric Friedmans' ANOVA with the appropriate post hoc test were applied. The significance level was set at $p < 0.05$.

Results

The distribution of the weekly external and internal training loads applied to the players are presented in Table 1. Training sessions with the largest volume were performed on M-5 and M-3 (average TD: 6032 m and 5923 m, respectively), while the longest average distance in HSR and sprinting was covered on M-4 (133 m and 19 m, respectively). The RPE data provided by the players suggested that M-4 was the most intensive day of the training week. The values of the most external and internal load indicators in M-2 and M-1 were significantly lower than during other days of the microcycle (table 1).

Moreover, the distribution of HSR, accelerations, decelerations and RPE are presented in Figures 1 and 2. Significant correlations were found between RPE and different variables, including TD ($r = 0.58$, $p < 0.001$), HSR ($r = 0.51$, $p < 0.001$), sprinting ($r = 0.25$, $p < 001$), number of accelerations ($r = 0.49$, $p < 0.001$), number of decelerations ($r = 0.56$, $p < 0.001$), energy expenditure ($r = 0.59$, $p < 0.001$), average HR ($r = 0.38$, $p < 0.001$) and session duration ($r = 0.37$, $p < 0.001$, Table 2).

Table 1. External and internal training loads on different days of the microcycle

	M-5 (n = 152)	**M-4 (n = 281)**	**M-3 (n = 392)**	**M-2 (n = 328)**	**M-1 (n = 241)**
Total distance [m]	6031.7 ± 1159.75	5198.2 ± 973.30*	5922.6 ± 1361.82$^{\#}$	3690.1 ± 612.58*$^{\#\$}$	3947.7 ± 1002.32*$^{\#\$}$
Relative distance [m·min^{-1}]	71.2 ± 10.62	70.2 ± 9.96	68.1 ± 11.06	52.5 ± 6.70*$^{\#\$}$	58.5 ± 10.35*$^{\#\$\dagger}$
HSR [m]	74.5 ± 119.00	133.3 ± 124.49*	113.0 ± 92.81*	43.0 ± 38.31$^{\#}$	50.4 ± 39.97$^{\#\$}$
Sprint [m]	1.2 ± 3.88	18.5 ± 33.16*	17.7 ± 36.20*	4.0 ± 7.70*$^{\#}$	6.9 ± 11.25*$^{\#}$
Accelerations	38.7 ± 15.82	37.5 ± 15.09	41.7 ± 14.04	27.6 ± 11.68*$^{\#\$}$	25.8 ± 12.36*$^{\#\$}$
Decelerations	32.9 ± 12.95	31.8 ± 14.88	39.1 ± 14.63*$^{\#}$	19.7 ± 10.76*$^{\#\$}$	19.4 ± 10.19*$^{\#\$}$
Vmax [m·s^{-1}]	6.42 ± 0.60	6.98 ± 0.99*	7.11 ± 0.74*	6.59 ± 0.86$^{\#\$}$	6.91 ± 0.91*$^{\$\dagger}$
HRavg [bpm^{-1}]	128.8 ± 12.71	129.7 ± 12.95	128.3 ± 13.99	116.9 ± 14.13*$^{\#\$}$	120.3 ± 14.07*$^{\#\$}$
HRmax [bpm^{-1}]	174.9 ± 20.17	177.1 ± 11.27	176.7 ± 11.97	163.4 ± 15.26*$^{\#\$}$	166.6 ± 14.79*$^{\#\$}$
Energy [J·kg^{-1}]	25787 ± 5531	21857 ± 4676*	24588 ± 6549$^{\#}$	14313 ± 2909*$^{\#\$}$	15418 ± 4395*$^{\#\$}$
Time [min]	84.4 ± 9.86	74.2 ± 10.05*	86.7 ± 11.34$^{\#}$	70.4 ± 8.24*$^{\#\$}$	68.3 ± 15.60*$^{\#\$}$
RPE [AU]	4.5 ± 0.98	5.8 ± 1.82*	5.2 ± 1.13*$^{\#}$	3.3 ± 0.83*$^{\#\$}$	2.9 ± 0.78*$^{\#\$\dagger}$
sRPE [AU]	383.5 ± 103.68	426.3 ± 135.4*	456.0 ± 123.13*$^{\#}$	236.1 ± 71.87*$^{\#\$}$	204.7 ± 78.32*$^{\#\$\dagger}$

*significantly different from M-5; $^{\#}$significantly different from M-4; $^{\$}$significantly different from M-3; †significantly different from M-2; M-5 – 5 days before the game; HSR – high-speed running; Vmax – maximal velocity; HRavg – average heart rate; HRmax – maximal heart rate; RPE – rating of perceived exertion

Table 2. Relations between RPE scores and external and internal load variables in professional soccer players

	TD	**Dist/min**	**HSR**	**Sprint**	**ACC**	**DEC**	**Energy**	**avHR**	**Time**
RPE	r = 0.58 p = 0.00	r = 0.50 p = 0.00	r = 0.51 p = 0.00	r = 0.25 p = 0.00	r = 0.49 p = 0.00	r = 0.56 p = 0.00	r = 0.59 p = 0.00	r = 0.38 p = 0.00	r = 0.37 p = 0.00

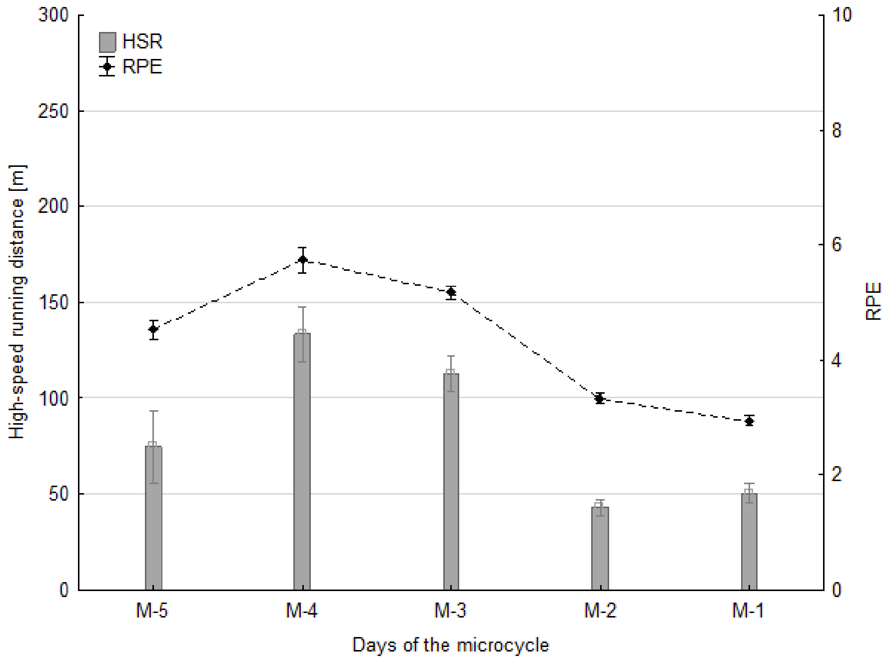

Figure 1. Weekly distribution of high-speed running and RPE values in professional soccer players

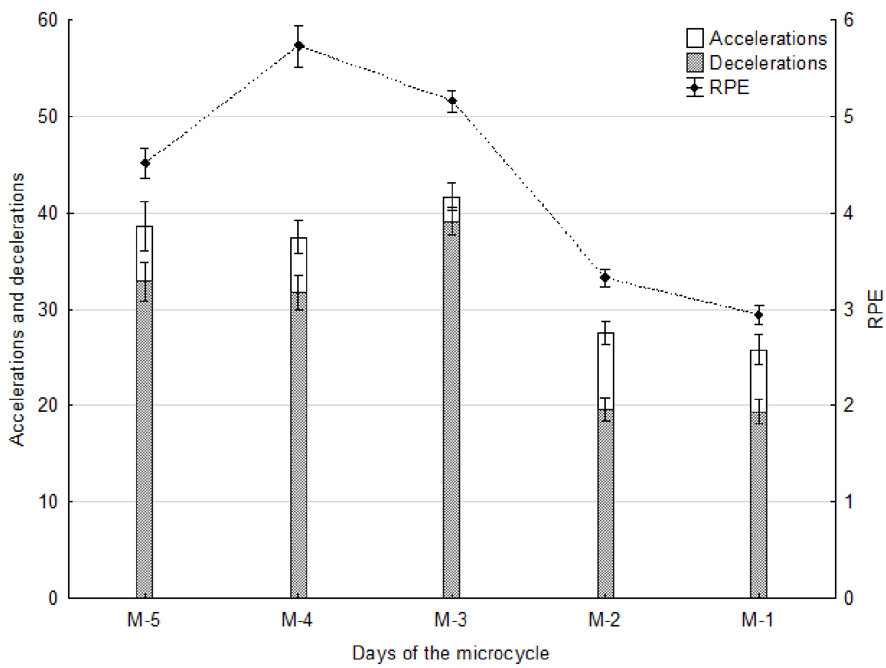

Figure 2. Weekly distribution of accelerations, decelerations and RPE values in professional soccer players

Discussion

The main purpose of this research was to present the weekly training loads of professional soccer players and to identify potential relations between external load variables and RPE. The presented data suggest that the high-volume training sessions were applied on M-5 and M-3. The longest distance in HSR and sprinting was covered by players on M-3. The lowest training load was registered on the last two days before the match. Moreover, significant correlations were found between RPE and external load variables, such as energy expenditure, TD, relative total distance, HSR, sprint distance, number of accelerations and decelerations, HR avg and session duration.

Proper training load periodization is crucial for preparing players for a match during the competitive season. Therefore, the most common practice is to apply intensive sessions at the beginning of the week, whereas the last two days before the game typically involve efforts with lower volume and intensity. In general, a progressive decrease in training loads from the middle of the week was observed, which is in line with previous studies (Clemente et al., 2019; Stevens et al., 2017). Training load distribution in current paper is comparable with the data presented by Oliviera et al. (2019), where the longest distance covered by players was reported on M-5 and M-3. Similarly, Clemente et al. (2019), who compared external load of Portuguese and Dutch teams, noted the greatest distances and intensities on M-5 and M-3. The longest distance covered by the players in speed above 20 km/h (what corresponds to HSR) was observed in their study on M-5, M-3 and M-2. In contrast, the data presented in current study show that the greatest HSR distance was covered by the players on M-4.

Previous studies (Stevens et al., 2017) have highlighted the importance of including accelerations and decelerations when describing external load in professional soccer. These variables are considered to be even more sensitive to fatigue than distance covered in any of the speed zones (Akenhead, et al., 2013). Therefore, a large number of these activities during pre-match training sessions is not recommended. However, many coaches practice set pieces on M-1, where players perform numerous accelerations (e.g. when attacking the ball centred from the corner). Hence, limiting the number of repetitions during these exercises is advisable. Stevens et al. (2017) found that the greatest acceleration load on the most intensive training day (M-4) was close to the match load. In the current study, the highest number of both accelerations and decelerations was noted on M-3. On this training session, a large (11 vs. 11) game was usually applied. On following days (M-2 and M-1), the number of these external load indicators was the lowest (less than 30 accelerations and less than 20 decelerations).

The highest values of internal load, expressed as RPE, was noted on M-4 (5.7 ± 1.85). Although the durations of the sessions on M-5 and M-3 were longer, the RPE values for these days were lower in comparison with that of M-4. These differences might be explained by applying intensive training drills on M-4. Usually, that is the day when players perform high-intensity interval training in the form of small-sided games. Abbott et al. (2018) analysed the internal and external load during different training games. They found that TD covered during small-sided games was lower than in large games. However, the RPE values after small-sided games were higher. Hence, the highest RPE values of the training session involving small-sided games was expected.

The relationships between RPE and external load measures have been previously investigated by several researchers (Marynowicz et al., 2020; Jaspers et al., 2018; Casamichana et al., 2013; McLaren et al., 2018). Gaudino et al. (2015) indicated that a combination of different external load factors can predict RPE training load more precisely than any other parameter alone. In the current study, the largest significant correlations were calculated between RPE and energy expenditure and TD ($r = 0.59$ and $r = 0.58$, respectively). This finding is in line with those of McLaren et al. (2018) and Geurkink et al. (2018), who highlighted a strong association between TD and session RPE. Therefore, these results confirm that the volume of running during training sessions in professional soccer players is one of the most important factors influencing the internal load. Furthermore, significant positive relations between RPE and distance covered in HSR ($r = 0.51$), number of accelerations ($r = 0.49$) and decelerations ($r = 0.56$) were found. Gaudino et al. (2015) reported similarly that high-speed running and number of accelerations are best predictors of RPE training load in elite soccer players. Additionally, Jaspers et al. (2018) emphasized that decelerating efforts result in eccentric contractions, which induce muscle damage. Consequently, these activities may relevantly affect the RPE given by the players.

Lack of an external and internal match load is undoubtedly a limitation of this current study. Analysing the data according to match demands could provide interesting conclusions. Unfortunately, full external load measurements from official games were not available. Moreover, analysing the RPE of individual training drills should be performed in future research. Such information would help coaches to select suitable exercises when they want to avoid the effect of subjective fatigue of their players.

Conclusion

In the current study, an in-season weekly external and internal training load distribution was presented. The longest total distance was covered by the players on M-5 and M-3, while the highest internal load (RPE and HR) was reported on M-3. The lowest training volume and intensity were applied during the last two days before the official matches. Moreover, significant relationships between RPE and several external load indicators were found. Variables, such as energy expenditure, TD, HSR distance and the number of accelerations and decelerations, determine the subjective fatigue of professional soccer players. Therefore, coaches who want to avoid the effect of subjective fatigue should carefully distribute these components of the training load. Such a routine would be helpful to ensure players have optimal preparation for matches.

References

Abbott, W., Brickley, G., Smeeton, N.J. (2018). Positional Differences in GPS Outputs and Perceived Exertion During Soccer Training Games and Competition. *The Journal of Strength and Conditioning Research,* 32(11), 3222-3231.

Akenhead, R., Hayes, P.R., Thompson, K.G., French, D. (2013). Diminutions of acceleration and deceleration output during professional football match play. *Journal of Science and Medicine in Sport,* 16, 556-561.

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, 1095-100.

Borg, G. (1998). Perceived Exertion and Pain Scales., Champaign IL, USA, Human Kinetics.

Casamichana, D., Castellano, J., Calleja-Gonzalez, J., San Roman, J., Castagna, C. (2013). Relationships between indicators of training load in soccer players. *The Journal of Strength and Conditioning Research,* 27(2), 369-374.

Chan, Y.H. (2003). Biostatistics 104: Correlational analysis. *Singapore Medical Journal,* 44(12), 614-19.

Clemente, F.M. (2018). Associations between wellness and internal and external training load variables in two intermittent small-sided games. *Physiology & Behaviour,* 197, 9-14.

Clemente, F.M., Owen, A., Serra-Olivares, J., Nikolaidis, P.T., Van der Linden, C.M.I., Mendes, B. (2019). Characterization of the Weekly External Load Profile of Professional Soccer Teams from Portugal and the Netherlands. *Journal of Human Kinetics,* 66, 155-164.

Dios-Alvarez, V., Suarez-Iglesias, D., Bouzas-Rico, S., Alkain, P., Gonzalez-Conde, A., Ayan-Perez, Carlos. (2021). Relationships between RPE-derived internal training load parameters and GPS-based external training load variables in elite young soccer players. *Research in Sports Medicine,* online ahead of publish, doi: 10.1080/15438627.2021.1937165.

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, 205-212.

Foster, C., Florhaug, J.A., Franklin, J., Gottschall, L., Hrovatin, L.A., Parker, S., Doleshal, P., Dodge, C. (2001). A new approach to monitoring exercise training. *The Journal of Strength and Conditioning Research,* 15, 109-115.

Gaudino, P., Iaia, M.F., Strudwick, A.J., Hawkins, R.D., Alberti, G., Atkinson, G., Gregson, W. (2015). Factors Influencing Perception of Effort (Session Rating of Perceived Exertion) Curing Elite Soccer Training. *International Journal of Physiology and Performance,* 10, 810-864.

Geurkink, Y., Vandewiele, G., Lievens, M., de Turck, F., Ongenae, F., Matthys, S.P.J., Boone, J., Bourgois, J.G. (2019). Modelling the Prediction of the Session Rating of Perceived Exertion in Soccer: Unravelling the Puzzle of Predictive Indicators. *International Journal of Sports Physiology and Performance,* 14(6), 841-846.

Haddad, M., Stylianides, G., Djaoui, L., Dellal, A., Chamari, K. (2017). Session-RPE Method for Training Load Monitoring: Validity, Ecological Usefulness, and Influencing Factors. *Frontiers in Neuroscience,* 11, 612.

Hazra, A., Gogtay, N. (2016). Biostatistics series Module 3: Comparing Groups: Numerical Variables. *Indian Journal of Dermatology*, 61(3), 251-260.

Impellizzeri F.M., Rampinini, E., Marcora, S.M. (2005). Physiological assessment of aerobic training in soccer. *Journal of Sports Sciences,* 23, 583-592.

Ispyrlidis, I., Gourgoulis, V., Mantzouranis, N., Gioftsidou, A., Athanailidis, I. (2020). Match and training loads of professional soccer players in relation to their tactical position. *Journal of Physical Education and Sport,* 305, 2269-2276.

Jaspers, A., Op De Beeck, T., Brink, M.S., Frencken, W.G.P., Staes, F., Davis, J.J., Helsen, W.F. (2018). Relationships Between the External and Internal Training Load in Professional Soccer: What Can We Learn From Machine Learning? *International Journal of Sports Physiology and Performance,* 13, 625-630.

Konefał, M., Chmura, P., Zając, T., Chmura, J., Kowalczuk, E., Andrzejewski M. (2019). Evolution of technical activity in various playing positions, in relation to match outcomes in professional soccer. *Biology o Sport,* 36, 181-189.

Malone, J.J., Di Michele, R., Morgans, R., Burgess, D., Morton, J.P., Drusy. B. (2015). Seasonal Training-Load Quantification in Elite English Premier League Soccer Players. *International Journal of Sports Physiology and Performance,* 10, 489-497.

Marynowicz, J., Kikut, K., Lango, M., Horna, D., Andrzejewski, M. (2020). Relationship Between the Session-RPE and External Measures of Training Load in Youth Soccer Players. *The Journal of Strength and Conditioning Research,* 34(10), 2800-2804.

Marynowicz, J., Lango, M., Hona, D., Kikut, K., Andrzejewski, M. (2021). Predicting rating of perceived exertion in youth soccer players using decision tree models. *Biology of Sport,* 39(2), 245-252.

McLaren, S.J., Macpherson, T.W., Coutts, A.J., Hurst, C., Spears, I.R., Weston, M. (2018). The Relationships Between Internal and External Measures of Training Load and Intensity in Team Sports: A Meta-Analysis. *Sports Medicine,* 48(3), 641-658.

Mujika, I., Halson, S., Louise, M.B., Balague, G., Farrow, D. (2018). An Integrated, Multifactorial Approach to Periodisation for Optimal Performance in Individual and Team Sports. *International Journal of Sports Physiology and Performance,* 13, 538-561.

Modrić, T., Versić, S., Sekulić, D. (2021). Relations of the Weekly External Load Indicators and Running Performances in Professional Soccer Matches. *Sport Mont,* 19, 31-37.

Oliveira, R., Brito, J.P., Martins, A., Mendes, B., Marinho, D.A., Ferraz, R., Marques, M.C. (2019). In-season internal and external training load quantification of an elite European soccer team. *PLoS ONE*, 14(4), e0209393.

Oliviera, R., Brito, J.P., Loureirio, N., Padinha, V., Ferreira, B., Mendes, B. (2020). Does the distribution of the training load account for the match results of elite professional soccer player? *Physiology & Behaviour,* 225, 113118.

Radzimiński, Ł., Jastrzębski, Z., López-Sanchez, G.F., Szwarc, A., Duda, H., Stuła, A., Paszulewicz, J., Dragos, P. (2020). Relationships between Training Loads and Selceted Blood Parameters in Professional Soccer Players during a 12-Day Sport Camp. *International Journal of Environmental Research and Public Health,* 17, 8580.

Rave, G., Granacher, U., Boullosa, D., Hackney, A.C., Zouhal, H. (2020). How to Use Global Positioning Systems (GPS) Data for Monitor Training Load in the "Real World" of Elite Soccer. *Frontiers in Physiology,* 11, 944.

Stevens, T.G.A., de Ruiter, C.J., Twisk, J.W.R., Savelsbergh, G.J.P., Beek, P.J. (2017). Quantification of in-season training load relative to match load in professional Dutch Eredivisie football players. *Science and Medicine in Football,* 1, 117-125.

Stølen, T., Chamari, K., Castagna, C., Wisløff, U. (2005). Physiology of Soccer An Update. *Sports Medicine,* 35(6), 501 – 536.