Relation Between Total Body Load and Session Rating of Perceived Exertion in Professional Soccer Players

Pedro T. Gomez-Piriz, Pedro Jiménez-Reyes, and Carlos Ruiz-Ruiz

Department of Physical Education and Sport, University of Seville, Seville, Spain

Abstract

Gomez-Piriz, PT, Jiménez-Reyes, P, and Ruiz-Ruiz, C. Relation between total body load and Session-RPE in professional soccer players. *J Strength Cond Res* 25(8): 2100–2103, 2011–The aims of this study were to assess (a) the validity of total body load (TBL)–obtained from the global position system (GPS) devices–to quantify soccer training load, assessing its relationship with session rating of perceived exertion (session-RPE) and (b) to analyze the differences in terms of TBL and session-RPE among defenders, midfielders, and forwards. Twenty-two professional soccer players (Spanish first division, season 2007–2008; 26.74 ± 4.2 years; height 179.74 ± 4.04 cm; weight 73.7 ± 3.35 kg) participated in the study. During 13 training sessions composed predominantly of small-sided games, TBL and RPE multiplied by the minutes of session duration were determined using GPS and the 21-point scale, respectively. In each session, data from 10 players randomly selected and classified according to player position (defenders, midfielders, and forwards) were collected. Although session-RPE was a significant predictor of TBL ($\beta = 0.23$, $p < 0.05$), this method only accounted for 5% of the variance in TBL. No significant differences in terms of TBL and session-RPE were found regarding player position. The results of this study suggest that TBL is not a valid measure to quantify training load because it is not strongly correlated with session-RPE. Furthermore, TBL and session-RPE in small-sided soccer games do not vary according to player positions.

Key Words perceived exertion, GPS, small-sided games, soccer, position

Introduction

The ability to quantify exercise load is critical to the process of training evaluation. Over the last few years, global positioning system (GPS) technology has been extensively used for assessing the distance traveled and the speed of running in hockey (15), netball (12), lacrosse (7), and rugby (5). The validity of using GPS devices for monitoring those measures during team sports was confirmed (1,15) although this tool may not provide reliable measures for intensity activities that involve velocities >20 $km \cdot h^{-1}$ (4).

Furthermore, GPS devices allow quantification of the athlete's workload using the body load parameter. This parameter involves the acceleration forces that the athlete generates during the sport action. Body load has been used by Cunniffe et al. (5) to evaluate the physiological demands of the elite rugby union. However, there is paucity of information regarding the validity of body load for quantifying the exercise load.

Previous studies have assessed the validity of methods to quantify exercise load, evaluating their relation with other valid tools. For example, researchers (8–11,14) have found significant correlations between the session rating of perceived exertion (RPE) and an objective standard based on heart rate (HR) during nonsteady state and prolonged exercise. Therefore, it was concluded that session-RPE is a valid method of quantifying exercise training. This study assessed the validity of body load evaluating its relationship with session-RPE method during soccer practice sessions.

On the other hand, this study approached workload measurement in relation to the different positions in soccer. It has been suggested that the extensive use of small-sided games in soccer training sessions does not provide sufficient stimulus for physiological adaptation in the fittest players within the team (13). Likewise, several studies have concluded that midfield players present higher aerobic capacity than offensive and defensive players do because of their role of "linking" attacking and defensive play (6,17). Therefore, both lower TBL values and perceptions of the training stimulus were expected for midfielders than for defenders and forwards.

The aims of this study, therefore, were (a) to assess the relation between the TBL obtained from the GPS devices and session-RPE in soccer-specific training sessions and (b) to

Address correspondence to Pedro Tomás Gómez-Píriz, ptgomez@us.es.

25(8)/2100–2103

Journal of Strength and Conditioning Research

analyze the differences in terms of TBL and session-RPE among defenders, midfielders, and forwards.

Methods

Experimental Approach to the Problem

Data were collected during 13 training sessions of Real Club Recreativo de Huelva (Spanish first soccer division) in the 2007–2008 season. Data collection was carried out twice a week during the competitive period of the season from February to March 2008. The session-RPE was determined by multiplying the training duration (minutes) by RPE (21-point scale). Computation of player body load during exercise involved the use of the next acceleration zone forces provided in "*g*" force by the accelerometer of the GPS: 5–6*g*: light impact, hard acceleration, deceleration, or change of direction; 6–6.5 *g*: light to moderate impact (player collision, contact with the ground); 6.5–7*g*: moderate to heavy impact (tackle); 7–8 *g*: heavy impact (tackle); 8–10g: very heavy impact (scrum engagement, tackle); and 10+*g*: severe impact, tackle, or collision. Total body load was calculated automatically using the system software provided by the manufacturers (Team AMS; GPSports, V1.2, Canberra, Australian Capital Territory, Australia). Subjects were familiarized with the modified RPE 21-point scale and GPS units before beginning the study, because they had been using it from the start of the season in August 2007. In each training session, data from both dependent variables (TBL and RPE-session) were collected from 10 players randomly selected and classified according to the independent variable player position (defenders, midfielders, and forwards).

Subjects

Twenty-two professional male soccer players of the Real Club Recreativo de Huelva (Spanish first division; mean ± *SD*: 26.74 ± 4.2 years, height 179.74 ± 4.04 cm, weight 73.7 ± 3.35 kg) participated in the study. They trained on a 5 sessions per week basis. Each subject provided informed consent before participation. The study was approved by the University of Seville Ethical Advisory Committee.

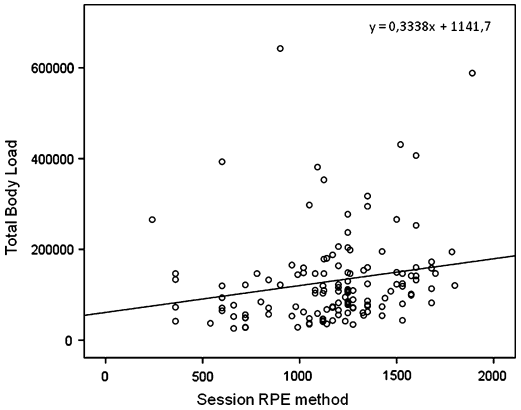

Figure 1. Comparison of the session rating of perceived exertion (RPE) method and the total body load during all the training sessions. Note that the relation is significant ($p < 0.05$). However, this relation is weak as the R^2 value is 0.053. Moreover, the relation is not linear.

Procedures

Training sessions took place in the Real Club Recreativo de Huelva training ground from 10 AM to 12 PM. Players had a continental breakfast 1 and a half hours before the start of the session. All the sessions started with a standardized warm-up for a period of 20 minutes. The sessions aimed to integrate technical, tactical, and physiological requirements. As a consequence, they were predominantly composed of small-sided games performed on various sized pitches involving 5, 6, 7, or 8 players on each side, without goalkeepers, free touches, with coach encouragement, and a second ball always available for prompt replacement. The rectangular pitches had playing areas ranging from 1,785 m^2 (52.5 × 34 m) to 5,440 m^2 (80 × 68 m). In each small-sided game, players performed in their usual playing positions (defender, midfielder, or forward), and substitutes were not allowed. Each small-sided game lasted 20 minutes approximately and was performed as interval training consisting of 4 bouts of 4-minute duration separated by 2 minutes of active recovery between exercise bouts. Players were allowed to consume commercially available isotonic sports drinks ad libitum, during the recovery periods. Sessions finished with a standardized 20-minute warming-down procedure.

Body load was collected using a GPS tracking device (SPI Elite; GPSports Systems). Players wore an individual GPS unit (mass: 80 g; dimensions: 91 × 45 × 21 mm) encased within a protective harness between

Table 1. Comparison of session-RPE and total body load scores among defenders, midfielders, and forwards. *†‡

Playing position	Session-RPE (min)	Total body load (Au)
Defenders	1,172.1 ± 291.8	124,100.5 ± 114,143.2
Midfielders	1,120.7 ± 310.5	153,998.5 ± 125,495.5
Forwards	1,245 ± 284.2	107,554.3 ± 60,369.1

*RPE = rating of perceived exertion; Au = arbitrary units.
†Values are given as mean ± *SD*.
‡There are no significant differences among playing positions.

the player's shoulder blades in the upper thoracic–spine region (estimated). Devices were switched on 5 minutes before the start of the training and turned off immediately after training had ended. Global position system data were recorded at 1 Hz. After collection, data were downloaded to a personal computer. Six of the GPS data were not recorded because of transmission issues from the GPS receiver to the software Team AMS. Therefore, a total of 124 data were obtained and analyzed.

Each player's session-RPE was collected about 30 minutes after each training session to ensure that the perceived effort referred to the whole session rather than to the most recent exercise intensity (10). There have been other studies where RPE values were taken every 2 minutes (19) and at 10 and 20 minutes and at the end of the exercise (2). A similar design to that of Impellizzeri et al. (14) and Foster et al. (10) studies was carried out because it allowed us to collect data without disturbing the natural development of the training session.

Statistical Analyses

Regression analyses were performed to relate the session-RPE method and TBL parameter. Additionally, 2 separate 1-way analyses of variance (ANOVAs) were carried out to identify differences in session-RPE and TBL according to player position (defender, midfielder, forward). Eta squared (η^2) values are provided as a measure of effect size. Effect size values of 0.01, 0.06, and 0.14 were considered small, medium, and large, respectively (3). Post hoc analyses were performed using the Tukey procedure. The alpha level for significance was set at $p \leq 0.05$. For the statistical analysis, the software package SPSS version 14.0 was used.

Results

A linear regression analysis revealed that session-RPE was a significant predictor of TBL ($\beta = 0.23$, $p < 0.05$). However, session-RPE only accounted for 5% of the variance in TBL (Figure 1).

The results of the 2 separate ANOVAs show that there were no significant effects of playing position for session-RPE $F(2,19) = 0.15$, $p = 0.86$, $\eta^2 = 0.03$ nor TBL $F(2,19) = 0.28$; $p = 0.76$, $\eta^2 = 0.03$ (Table 1).

Discussion

The first aim of this study was to assess the relation between TBL and session-RPE in soccer training sessions. As opposed to the relation between session-RPE and HR, the relation between session-RPE and TBL was weak and nonlinear despite being significant (10). This suggests that body load parameter is not a valid measure to quantify training load in soccer.

Total body load may be limited on this ability to globally quantify soccer-specific load. Total body load calculations are restricted to both the acceleration forces generated by the player graded on 6 zones and time spent on each zone. However, this ignores the influence that mode of motion and the ball actions have on the energy expended during the soccer action. Thus, Reilly and Bowen (18) found that unorthodox modes of motion such as running backward and sideways and changing direction accentuate the metabolic loading. Likewise, Reilly and Ball (16) found increased RPE and blood lactate values when working with the ball compared with running normally. As opposed to body load, valid methods to quantify workload, such as session-RPE and HR, are able to evaluate those aspects (8–11,14). Therefore, monitoring acceleration forces without considering further aspects that influence the overall exercise load may contribute to the lack of validity of TBL.

The second stage of this study analyzed differences between TBL and session-RPE among defenders, midfielders, and forwards. There were no significant differences in session-RPE according to the player position. However, a trend to lower RPE values in midfielders was found with respect to defenders and forwards. This may be because of an insufficient training stimulus for them, the fittest players in the team (6,17). Possibly, midfielders had the lowest perceptions of the training stimulus, because they were the fittest players. Those results could reinforce Hoff et al.'s (13) findings about the insufficient stimulus of small-sided games for physiological adaptation in the fittest players of the team. Nevertheless, this assumption cannot be confirmed because the fitness level of participants was not evaluated at the time data were collected. Thus, we cannot state that midfielders of this study were the fittest players of the team. This is a limitation of this study.

Based on the data, TBL does not seem to be a valid parameter of quantifying global training load in professional soccer players. This was demonstrated by the weak relationship with a valid method such as session-RPE. Regarding our second objective, there were no differences in terms of TBL and RPE between forwards, midfielders, and defenders.

Practical Applications

The results of this study have not shown TBL to be a valid tool for coaches and fitness coaches to quantify exercise load during specific-soccer training. Therefore, they may use other valid tools such as HR–also provided by GPS devices–or session-RPE to obtain a global indicator of the load imposed by the training sessions on their players.

Acknowledgments

The authors declare that they have no conflict of interest relevant to the content of this manuscript. This study was supported by a grant from the University of Seville and Real Club Recreativo de Huelva (Spanish first division). The authors wish to express their sincere gratitude to all the participants for their maximal effort and cooperation. This work was funded by the University and the Professional Football Club involved. The results of this study do not constitute endorsement by The Journal of Strength and Conditioning Research.

References

1. Barbero-Álvarez, JC, Coutts, A, Granda, J, Barbero-Álvarez, V, and Castagna, C. The validity and reliability of a global positioning satellite system device to assess speed and repeated sprint ability (RSA) in athletes. *J Sci Med Sport*, doi: 10.1016/j.jsams.2009.02.005, 2009.
2. Battisa, A, Foster, C, Andrew, J, Wright, G, Lucia, A, and Porcari, JP. Physiologic responses Turing Indro cycling. *J Strength Cond Res* 22: 4, 2008.
3. Cohen, J. *Statistical Power Analysis for the Behavioural Sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.
4. Coutts, AJ and Duffield, R. Validity and reliability of GPS devices for measuring movement demands of team sports. *J Sci Med Sport* 13: 133–135, 2010.
5. Cunniffe, B, Proctor, W, Baker, JS, and Davies, B. An evaluation of the physiological demands of elite rugby union using global positioning System tracking software. *J Strength Cond Res* 23: 1195–1203, 2009.
6. Davis, JA, Brewer, J, and Atkin, D. Pre-season physiological characteristics of English first and second division soccer players. *J Sports Sci* 10: 541–547, 1992.
7. Duffield, R, Steinbacher, G, and Fairchild, TJ. The use of mixed-method, part-body pre-cooling procedures for team-sport athletes training in the heat. *J Strength Cond Res* 23: 2524–2532, 2009.
8. Foster, C. Monitoring training in athletes with reference to overtraining syndrome. *Med Sci Sports Exerc* 30: 1164–11681, 1998.
9. Foster, C, Danies, E, Hector, L, Snyder, A, and Welsh, R. Athletic performance in relation to training load. *Wis Med J* 95: 370–374, 1996.
10. Foster, C, Florhaugh, JA, Franklin, J, Gottschall, L, Hrovatin, LA, Parker, S, Doleshal, P, and Dogle, C. A new approach to monitoring exercise training. *J Strength Cond Res* 15: 109–115, 2001.
11. Foster, C, Hector, LL, Welsh, R, Schrager, M, Green, MA, and Snyder, AC. Effects of specific versus cross-training on running performance. *Eur J Appl Physiol Occup Physiol* 70: 367–372, 1995.
12. Higgins, T, Naughton, G, and Burgess, D. Effects of wearing compression garments on physiological and performance measures in a simulated game-specific circuit for netball. *J Sci Med Sport* 12: 223–227, 2009.
13. Hoff, J, Wisloff, L, Engen, LC, Kemi, OJ, and Helguerud, J. Soccer specific aerobic endurance training. *Br J Sports Med* 36: 218–221, 2002.
14. Impellizzeri, FM, Rampini, E, Coutts, A, Sassi, A, and Marcora, SM. Use of RPE-Based Training Load in Soccer. *Med Sci Sports Exerc* 36: 1042–1047, 2004.
15. MacLeod, H, Morris, J, Nevill, A, and Sunderland, C. The validity of a non-differential global positioning system for assessing player movement patterns in field hockey. *J Sports Sci* 27: 121–128, 2009.
16. Reilly, T and Ball, D. The net physiological cost of dribbling a soccer ball. *Res Q Exerc Sport* 55: 267–271, 1984.
17. Reilly, T, Bangsbo, J, and Franks, A. Anthropometric and physiological predispositions for elite soccer. *J Sports Sci* 18: 669–683, 2000.
18. Reilly, T and Bowen, T. Exertional costs of changes in directional modes of running. *Percept Mot Skill* 58: 149–150, 1984.
19. Sweet, TW, Foster, C, McGuigan, MR, and Brice, G. Quantitation of resistance training using the session rating of perceived exertion method. *J Strength Cond Res* 18: 4, 2004.