Acta Kinesiologiae Universitatis Tartuensis, 2017. Vol. 23, pp. 7–18
https://doi.org/10.12697/akut.2017.23.01

MONITORING TRAINING LOAD: NECESSITY, METHODS AND APPLICATIONS

Rasmus Pind, Jarek Mäestu

Institute of Sport Sciences and Physiotherapy, University of Tartu, Tartu, Estonia

ABSTRACT

Regular physical activity and participation in organized sports is important contributor to performance and for overall health and fitness in humans of various age range. In performance related areas, every detail in the training sessions is important for the athlete to be in the best shape the chosen competition day. Sport scientists have been making hard effort to find out how the training has the influence on performance. Thus, training monitoring is important tool to evaluate an athlete's response to training. Banister developed the 'training impulse' (TRIMP) as a method to quantify training load. The TRIMP consists of the exercise intensity calculated by the heart rate (HR) reserve method and the duration of exercise. Foster et al. [23] developed a modification of the rating of the perceived exertion method, which uses Rated Perceived Exertion (RPE) as a marker of training intensity within the TRIMP concept. For quantifying and calculating training load, the athlete's RPE (1–10pt scale) is multiplied by the duration of the session. Ideally, the perceptions of training load should match between athlete and coach to have optimal adaptation. Thus, this brief review article is evaluating training monitoring opportunities without the need of expensive equipment.

Keywords: *external load; internal load; training adaptation; monitoring*

INTRODUCTION

Success in the sporting events, such as Olympic Games or World Championships is in the mind of almost every athlete. Those are the competitions where athletes would like to show their optimal performance achieved. Every detail in the training sessions is important for the athlete to be in the best shape the chosen competition day. Thus, sport scientists have been making hard effort to find out how the training has the influence on performance.

Training for specific sport, improvements in performance, needs manipulations in training load (frequency, intensity and duration), where temporarily increased training load periods alternate with recovery periods [36]. "The more the better" is not always the answer. Therefore, scientists, coaches and athletes have been measuring the training load in the past, present and will do it in the future [25]. We may assume that because of that, nowadays the trainings are getting more and more optimal and we increase our knowledge on how different training load manipulations influence performance.

Due to time consuming feedback and high cost of today's training monitoring opportunities, much of the proposed methods for training monitoring are not suitable for use in practical sports settings in daily basis. Thus, the aim of the current review article is to evaluate training monitoring opportunities without the need of expensive equipment.

TRAINING MONITORING

Training load

Regular physical activity and participation in organised sports is important contributor to the overall health and fitness in children and adolescents. It has been shown [34] that training loads in youth sport increase after the pubertal growth spurt, as body becomes adaptive to targeted training for endurance and strength which form the basis for sport performance in different disciplines. Increase in training load needs careful monitoring, especially in children and adolescents to avoid the increase of stress factors to the limit, where stagnancy in performance, injury or drop-out from sport may occur [5, 13]. Furthermore, quite often athletes continue to train and to compete despite the presence of health problems from overuse and in elite athletes´ threshold for ceasing sports participation seem to be too high [14].

In the past, the first evidence of training monitoring was in Scandinavia, by Finnish middle- and long distance running Olympians. They frequently carried a stopwatch during training sessions [25]. Contemporary training monitoring began in German in the late 1930s [25], where interval training was developed to quantitate the training load. Training was based on several repetitive runs (100–400 m repetitions) to heart rate (HR) of 180 beats per min (bpm), with recovery between intervals to HR of 120 [25]. Coach Bill Bowerman developed concepts, including the value of low intensity training, the value of hard and easy days, and the concept of date pace and goal pace

[11]. His training program was rooted in the concept of the progression of the training load. This period might be considered the zenith of the external-training-load (ETL) period, where the concept of training monitoring meant that if an athlete was able to do a certain training sessions, they could expect certain competitive results [25].

With further improvements in technology in the beginning of 1980s the scientists were able to monitor training loads with better markers of the physiological responses. Majority of the training programs have traditionally been described by ETL, i.e. training time, covered distance, lifted weight etc. However, it is the relative physiological stress imposed (internal training load; ITL), and not the ETL completed by the athlete, that determines the stimulus for training adaptation [27]. ITL depends on individual characteristics such as age, body composition and physical fitness [46]. Variety of training monitoring methods regarding ITL have been discussed in the literature [27, 37], however, due to time consuming feedback and high cost, most of them are not suitable for use in practical sports settings in daily basis. Furthermore, it has also been indicated that in elite level, the most frequent forms of training monitoring nowadays are different self-reports due to the aforementioned reasons [44].

Monitoring training load is a complicated task as nowadays frequently used blood lactate, oxygen uptake, generated power, etc. require specific apparatus and are therefore not always feasible in practical setting, especially for young athletes [4, 31]. Currently in practice, the most widely used method for ITL is HR. However, it can be poor method for evaluating intensity and ITL in interval, intermittent, weight or plyometric training or for specific disciplines like swimming [4].

Training impulse, the TRIMP method

Achieving optimal athletic performance at the exact time of the competition requires an understanding of the effects of training during a competitive season so that strategies may be designed to place an athlete in peak condition. Banister [1] developed the 'training impulse' (TRIMP) as a method to quantify training load. The TRIMP consists of the exercise intensity calculated by the HR reserve method and the duration of exercise.

TRIMP is calculated using the formula [3]:

$$w(t) = D(\Delta\mathrm{HR\ ratio})\ Y$$

where D being the duration of exercise, ΔHR ratio the ratio of elevation of exercise to maximum HR, with both above resting value and Y the weighting factor [38].

The method has been helpful in relative to understanding the training response and has been modified by Edwards [17], Lucia [35] and Stagno [42]. Edwards [17] proposed a zone based training monitoring with 10% zone widths, where each zone corresponded to coefficients (Table 1). Time spent in each zone was multiplied by pre-defined arbitrary coefficients. Lucia's [35] approach to training load calculation was based on the ventilatory thresholds, where exercise intensities were multiplied by time spent in those 3 phases. Phase I ("light intensity," below ~70%VO_{2max}); phase II ("moderate intensity," between ~70% and ~90%VO_{2max}); phase III ("high intensity," above ~90%VO_{2max}) [35]. Despite to that, Foster [23] points out two important limitations to the TRIMP concept by Bannister [19, 38]: i) information of HR regarding that training session might get lost if an athlete forgets to use HR monitor or HR monitor has a technical failure; and ii) HR is a poor method of evaluating very high-intensity exercise such as weight training, high-intensity interval training and plyometric training. To reduce those factors, Foster et al. [23] developed a modification of the rating of the perceived exertion method (the session RPE; sRPE), which uses RPE as a marker of training intensity within the TRIMP concept [22, 24]. In addition to that, Stagno's [42] modified the TRIMP method to quantify training load within a team sport setting to monitor training load and the concomitant changes in physiological profile.

Table 1. Edward's zone based training monitoring [17]

HR Zones	Coefficient
50–60%	1
60–70%	2
70–80%	3
80–90%	4
90–100%	5

Session RPE and the Foster's 0–10 scale

A widely used psycho-physiological tool to assess subjective perception of effort during exercise is Borg's rating of Perceived Exertion (20-pt scale), that has been suggested to add precision to HR monitoring in exercise intensity, therefore exercise recommendations and prescriptions regularly include RPE to establish and monitor intensity [43]. It has been shown that RPE correlates well with HR during steady-state and high intensity trainings, but not in short duration-high intensity exercise [10]. To simplify the Borg's RPE ratio, he developed a scale with simple number range 0–10 [7]. Foster et al. [23] modified it and developed the sRPE method for quantifying and calculating training load, which involves multiplying the athlete's RPE (1–10pt scale) (Table 2) by the duration of the session. Foster's 0–10 scale does not have the same number range as the Borg's 0–10 scale, the semantic descriptors and fractionated numbers originally described by Borg [7] are different. Original Borg CR-10 scale described the number 10 as "*very, very strong (almost maximal)*" [7], in comparison of Fosters scale [23], which describes number 10 as *maximal effort*. Thus, it is important not to mix up different RPE scales. This simple method, multiplying the athlete's RPE on Fosters scale [23] by the duration of the session, has been shown to be valid and reliable. The correlations between sRPE and HR are valid by up to r=0.90 [23]. Perceived exertion involves the interplay of afferent feedback from cardiorespiratory, metabolic and thermal stimuli and efferent feed-forward mechanisms to enable an individual to evaluate how hard or easy an exercise task feels [18]. It is moderated by i) psychological factors – among which are cognition, memory and understanding of the task; and ii) situational factors – which include knowledge of the duration and temporal characteristics of the task (e.g., continuous, intermittent or spasmodic) and knowledge of the target distance or total amount of work to be completed.

Table 2. Session RPE (Foster's 0–10) scale. Subjects rating 30 minutes after exercise in response to the "How was your workout?" [16, 29]

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

Perceptual instruments have been used during and after exercise and it has been shown that the estimation-production paradigm supports the use of in-task RPE for prescribing, regulating, and assessing exercise intensity [29]. However, there are several factors that can affect the accuracy of this rating, like athlete's experience, cognition, and memory [18]. While this concept has been researched mainly in terms on describing relationships between exercise intensity and sRPE [31, 46] and in recent years also to prescription on the effort of the entire workout as well as for accumulation of ITL after multiple workouts in adults [12], research is lacking in terms of interaction of RPE and ITL in adolescents. Furthermore, there is a lack of knowledge on RPE compared to objectively assessed metabolic criterion, in particular, target intensity points like aerobic and anaerobic threshold that could significantly increase the individual validity of the instrument. Recently, Scherr et al. [41] investigated 20-pt RPE relationships with lactate concentration in a population based cohort (age range 18–44) and concluded that the tool is valid independent of age, gender, cardiovascular diseases and exercise modality. However, no data today indicate how this kind of approach, where individual perception is validated to objective effort, can influence the relationship between sRPE and HR based training load, and can it be used in long-term monitoring.

Monitoring training load – difference between athlete and coach

Ideally, the perceptions of training load should match between athlete and coach to have optimal adaptation, assuming that the plan coach uses is scientifically and optimally planned. Previous studies have indicated some controversy between coaches and athletes' perceptions regarding ITL, with studies indicating relatively high relationship [31], while others have found those concepts to be poorly related [4, 12]. One possible reason for this discrepancy might be the experience of the athlete [12] as correlations have been shown to increase when athlete matures. However, ITL might be affected, at least in adolescents, by factors outside from planned workout such as habitual physical activity or the involvement in other sport trainings [12], which might result in more than 5-time difference in moderate-to-vigorous physical activity between subjects [32]. Furthermore, accumulation of fatigue and sleep loss or deprivation can have significant effects on performance, motivation, perception of effort and cognition [27]. Monitoring sleep quality and quantity can be useful for early detection and intervention before significant performance and health decrements are observed.

The RPE-based training load between athletes and coaches has been described and studied in the literature before in different sports disciplines, such as cross-country skiing [28], triathlon [15], swimming [4, 46] and soccer [31]. The study [15] which involved junior-elite triathletes aimed to monitor the ITL during a training camp. They found an intra-individual variation in individual RPE despite the same ETL. Comotto et al. [15] concluded that sRPE can be considered an easy tool to administer in monitoring individual responses to the same ETL when performed in a group. One study [28] was performed where the aim was to investigate how the sRPE scale can be used in characterizing training intensities in young cross-country skiers and whether perceptions of training intensity of coach and athlete are related. The authors concluded that sRPE of the coach and athlete did not differ significantly among different types of training (long-distance aerobic training, interval and speed trainings and recovery trainings). The study also found that sRPE scale was a practical method for young athlete training intensity zone distribution assessment. Subjective assessments of coach and athletes indicated the highest correlations ($p<0.05$) between zone2 (between aerobic and anaerobic threshold) ($r=0.80$) and interval trainings ($r=0.71$), but were lower for recovery trainings ($r=0.35$). The study [46], which purpose was to examine the ecological validity of the sRPE method for quantifying ITL in competitive swimmers using HR-based methods and distance as criterion measures also examined the correspondence between athlete and coach perceptions of ITL using sRPE method. This study indicated that coach RPE was lower than athlete RPE for low-intensity sessions and higher than athlete RPE at high-intensity sessions. The sRPE scores were correlated to HR-based methods for measuring ITL as well as training distance for each swimmer. All individual correlations between sRPE, HR-based methods ($r=0.05–0.94$; $p<0.05$), and distance measures ($r=0.37–0.81$; $p<0.05$) were significant [46]. Wallace et al. [46] suggested that sRPE may provide a practical, non-invasive method for quantifying ITL in competitive swimmers. Barroso et al. [4] study findings add that the more experienced the swimmers are, the more accurate their sRPE is. Also, the soccer player's study [31], which aim was to quantify ITL and to assess its correlations with various methods used to determine ITL based on the HR response to exercise. All individual correlations between various HR-based training load and sRPE were statistically significant (from $r=0.50$ to $r=0.85$, $p<0.01$). All these studies [4, 15, 28, 31] in the literature that used different sports disciplines, found that sRPE can be considered a good indicator for coaches and athletes to monitor and control ITL. However, these studies are mostly cross-sectional, with less knowledge how long-term use of sRPE contribution to training load measurements, especially in conditions where trainings might be too stressful and athletes might suffer overtraining.

Training load measurement in the prevention of injuries

There is general consensus, that high training loads are associated with different signs and symptoms of overtraining or overreaching [37]. Furthermore, the use of inadequate training loads may result in increased rate of injuries, reduced fitness and poor performance [26]. Another possible contributor that might result as de-adaptation to training is week-to-week changes in training load [40] that could be also a significant predictor of overuse injuries in team sport [33, 45].

Considering the fact that for adolescents' high load and the number of stressors arise outside of the training sessions indicates, for a coach it is even more complicated to evaluate how the planned ETL will have the effect on ITL. Therefore, there is a clear need for a valid and practical method for ITL measurement. Any injuries that could potentially be considered 'training load-related' are commonly viewed as 'preventable' [26]. Banister et al. [2] have proposed that the long-term performance of an athlete can further be estimated from the difference between the negative (fatigue) and positive (fitness) function (acute: chronic load). In adult soccer and cricket players it has been shown that using acute-chronic load ratio, the deviation of the ratio from its normal value is related to injuries, specifically injuries resulted directly from too high acute load [6, 30].

Surprisingly, little is known about the sRPE responses in adolescents and more research is needed to better understand the perceptual responses and the optimal rating scale to use in this age group. This is significant given that adolescence is usually a time when a child's level of physical activity begins to decline [32]. Knowledge of a perception of exercise and the physiological factors mediating perceived exertion in this age group and how it might change with further maturation may be important in optimising training loads, promoting healthy physical activity and exercise recommendations and to prevent child from dropping out of sport.

CONCLUSIONS

Monitoring ITL can provide a scientific explanation for changes in performance. Understanding ITL in practical and everyday training process is important in terms of preventing overtraining and illness. The correct measuring and relating coaches and athletes sRPE will promote safety in training process.

Session RPE has already been shown to be a valid in terms of evaluating exercise intensity and monitoring training load in a number of published literature papers [20–22, 24]. Session RPE method is not only reliable during repeat challenge by the same exercise stimulus, but is also well related to widely accepted objective measures of exercise training intensity [29]. sRPE is a valid and reliable measure of momentary exercise intensity [8, 9] and reliable to calculate/measure training load.

The results provide knowledge on the use of sRPE as a potential tool for training monitoring in young athletes. We suggest that the initial validation to individual objective intensities will increase the validity of the item and can describe some of the variation between cross-sectional analysis of athlete and coach sRPE. In team sport ITL monitoring can be even more difficult for coaches to be aware of the ITL as many of the exercises are performed in groups. As a consequence athlete may over- or under-train. Providing evidence around the effects of acute and chronic training load on physical fitness, performance and for injuries will allow practitioners to systematically prescribe appropriate loads while minimising the risk of de-adaptation to training loads. Furthermore, relating individual subjective RPE to objective effort will help to build algorithms to be used in different training settings for calculating individual training load that is more reliable for coaches to consider. Algorithms can further help coaches to discover the deviation of individual variation, that might indicate the need for intervention for proper adaptation of the athlete. As the concept of RPE is relatively simple to measure, its recording with smartphones provides a practical mean of data collection and later analysis.

In the future, there is further need to investigate sRPE in terms of training monitoring of different sport disciplines and also for younger age groups, especially for early specialization sports. There is a lack of knowledge regarding ITL and injury rate in adolescents. Furthermore, different disciplines indeed have different levels of safe training loads that will not result in overuse injuries. This, however, has to be further investigated.

ACKNOWLEDGEMENTS

This study was supported by the Estonian Research Council grant nr PUT1395.

REFERENCES

1. Banister EW. (1991) Modeling elite athletic performance. Physiol Test Elite Athletes, 403–424
2. Banister EW, Calvert TW, Savage MV, Bach T. (1975) A systems model of training for athletic performance. Aust J Sports Med, 7: 57–61

3. Banister EW, Good P, Holman G, Hamilton CL. (1986) Modeling the training response in athletes. Sport Elite Perform, 3: 7–23
4. Barroso R, Cardoso RK, Carmo EC, Tricoli V. (2014) Perceived exertion in coaches and young swimmers with different training experience. Int J Sports Physiol Perform, 9: 212–216
5. Baxter-Jones AD, Thompson AM, Malina RM. (2002) Growth and maturation in elite young female athletes. Sports Med Arthrosc Rev, 10: 42–49
6. Blanch P, Gabbett TJ. (2015) Has the athlete trained enough to return to play safely? The acute: chronic workload ratio permits clinicians to quantify a player's risk of subsequent injury. Br J Sports Med, 0: 1–5
7. Borg GA. (1982) Psychophysical bases of perceived exertion. Med Sci Sports Exerc, 14: 377–381
8. Borg G, Hassmén P, Lagerström M. (1987) Perceived exertion related to heart rate and blood lactate during arm and leg exercise. Eur J Appl Physiol, 56: 679–685
9. Borg G, Ljunggren G, Ceci R. (1985) The increase of perceived exertion, aches and pain in the legs, heart rate and blood lactate during exercise on a bicycle ergometer. Eur J Appl Physiol, 54: 343–349
10. Borresen J, Lambert MI. (2009) The quantification of training load, the training response and the effect on performance. Sports Med, 39: 779–795
11. Bowerman WJ, Freeman WH. (1991) High-performance training for track and field. Leisure press Champaign, IL
12. Brink MS, Frencken WG, Jordet G, Lemmink KA. (2014) Coaches' and players' perceptions of training dose: not a perfect match. Int J Sports Physiol Perform, 9: 497–502
13. Caine D, Maffulli N, Caine C. (2008) Epidemiology of injury in child and adolescent sports: injury rates, risk factors, and prevention. Clin Sports Med, 27: 19–50
14. Clarsen B, Myklebust G, Bahr R. (2012) Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology. Br J Sports Med, 47: 495–502
15. Comotto S, Bottoni A, Moci E, Piacentini MF. (2015) Analysis of session-RPE and profile of mood states during a triathlon training camp. J Sports Med Phys Fitness, 55: 361–367
16. Day ML, Mcguigan MR, Brice G, Foster C. (2004) Monitoring exercise intensity during resistance training using the session RPE scale. J Strength Cond Res, 18: 353–358
17. Edwards S. (1994) The heart rate monitor book. Med Sci Sports Exerc, 26: 647
18. Eston R. (2012) Use of ratings of perceived exertion in sports. Int J Sports Physiol Perform, 7: 175–182
19. Fitz-Clarke JR, Morton RH, Banister EW. (1991) Optimizing athletic performance by influence curves. J Appl Physiol, 71: 1151–1158

20. Foster C. (1998) Monitoring training in athletes with reference to overtraining syndrome. Med Sci Sports Exerc, 30: 1164–1168
21. Foster C, Heimann KM, Esten PL, Brice G, Porcari JP. (2001) Differences in perceptions of training by coaches and athletes. South Afr J Sports Med, 8: 3–7
22. Foster C, Daines E, Hector L, Snyder AC, Welsh R. (1996) Athletic performance in relation to training load. Wis Med J, 95: 370–374
23. Foster C, Florhaug JA, Franklin J, Gottschall L, Hrovatin LA, Parker S, Doleshal P, Dodge C. (2001) A new approach to monitoring exercise training. J Strength Cond Res, 15: 109–115
24. Foster C, Hector LL, Welsh R, Schrager M, Green MA, Snyder AC. (1995) Effects of specific versus cross-training on running performance. Eur J Appl Physiol, 70: 367–372
25. Foster C, Rodriguez-Marroyo JA, de Koning JJ. (2017) Monitoring Training Loads: The Past, the Present, and the Future. Int J Sports Physiol Perform, 12: S22–S28
26. Gabbett TJ. (2016) The training-injury prevention paradox: should athletes be training smarter and harder? Br J Sports Med, 50: 273–280
27. Halson SL. (2014) Sleep in elite athletes and nutritional interventions to enhance sleep. Sports Med, 44: 13–23
28. Heinsoo E-B, Mäestu J. (2014) The subjective assessment of training load in the training process of young skiers. Acta Kinesiol Univ Tartu, 20: 60–69
29. Herman L, Foster C, Maher MA, Mikat RP, Porcari JP. (2006) Validity and reliability of the session RPE method for monitoring exercise training intensity. South Afr J Sports Med, 18: 14–17
30. Hulin BT, Gabbett TJ, Lawson DW, Caputi P, Sampson JA. (2016) The acute: chronic workload ratio predicts injury: high chronic workload may decrease injury risk in elite rugby league players. Br J Sports Med, 50: 231–236
31. Impellizzeri FM, Rampinini E, Coutts AJ, Sassi A, Marcora SM. (2004) Use of RPE-based training load in soccer. Med Sci Sports Exerc, 36: 1042–1047
32. Lätt E, Mäestu J, Ortega FB, Rääsk T, Jürimäe T, Jürimäe J. (2015) Vigorous physical activity rather than sedentary behaviour predicts overweight and obesity in pubertal boys: a 2-year follow-up study. Scand J Public Health, 43: 276–282
33. Lian ØB, Engebretsen L, Bahr R. (2005) Prevalence of jumper's knee among elite athletes from different sports. Am J Sports Med, 33: 561–567
34. Lloyd RS, Oliver JL, Faigenbaum AD, Howard R, De Ste Croix MB, Williams CA, Best TM, Alvar BA, Micheli LJ, Thomas DP, Hatfield DL, Cronin JB, Myer GD. (2015) Long-term athletic development-part 1: a pathway for all youth. J Strength Cond Res, 29: 1439–1450
35. Lucia A, Hoyos J, Santalla A, Earnest C, Chicharro JL. (2003) Tour de France versus Vuelta a Espana: which is harder? Med Sci Sports Exerc, 35: 872–878
36. Mäestu J, Jürimäe J, Jürimäe T. (2005) Monitoring of performance and training in rowing. Sports Med, 35: 597–617

37. Meeusen R, Duclos M, Foster C, Fry A, Gleeson M, Nieman D, Raglin J, Rietjens G, Steinacker J, Urhausen A. (2013) Prevention, diagnosis and treatment of the overtraining syndrome: Joint consensus statement of the European College of Sport Science (ECSS) and the American College of Sports Medicine (ACSM). Eur J Sport Sci, 13: 1–24
38. Morton RH, Fitz-Clarke JR, Banister EW. (1990) Modeling human performance in running. J Appl Physiol, 69: 1171–1177
39. Pandolf KB. (1983) Advances in the study and application of perceived exertion. Exerc Sport Sci Rev, 11: 118–158
40. Piggott B (2008) The relationship between training load and incidence of injury and illness over a pre-season at an Australian Football League club.
41. Scherr J, Wolfarth B, Christle JW, Pressler A, Wagenpfeil S, Halle M. (2013) Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. Eur J Appl Physiol, 113: 147–155
42. Stagno KM, Thatcher R, Van Someren KA. (2007) A modified TRIMP to quantify the in-season training load of team sport players. J Sports Sci, 25: 629–634
43. Stoudemire NM, Wideman L, Pass KA, Mcginnes CL, Gaesser GA, Weltman A. (1996) The validity of regulating blood lactate concentration during running by ratings of perceived exertion. Med Sci Sports Exerc, 28: 490–495
44. Taylor K, Chapman D, Cronin J, Newton MJ, Gill N. (2012) Fatigue monitoring in high performance sport: a survey of current trends. J Aust Strength Cond, 20: 12–23
45. Visnes H, Bahr R. (2013) Training volume and body composition as risk factors for developing jumper's knee among young elite volleyball players. Scand J Med Sci Sports, 23: 607–613
46. Wallace LK, Slattery KM, Coutts AJ. (2009) The ecological validity and application of the session-RPE method for quantifying training loads in swimming. J Strength Cond Res, 23: 33–38

Correspondence to:

Rasmus Pind, MSc
Institute of Sport Sciences and Physiotherapy
University of Tartu
5 Jakobi Street, 51014 Tartu, Estonia
E-mail: Rasmus.Pind@ut.ee