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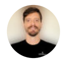
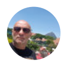
**7 authors**, including:


Fernando Matzenbacher
Londrina State University



Bruno Pasquarelli
Bahrain Women's National Football Team



Felipe Rabelo
Londrina State University



Antonio Carlos Dourado
Londrina State University

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# The Use of the Rating of Perceived Exertion to Monitor and Control the Training Load in Futsal

Fernando Matzenbacher[1,4], Bruno Natale Pasquarelli[2], Felipe Nunes Rabelo[3], Antonio Carlos Dourado[4] ,Julia Zocolaro Durigan[4], Hélcio Gonçalves Rossi[4], Luiz Cláudio Reeberg Stanganelli[4]

[1]Passo Fundo University, Passo Fundo, RS, Brazil, [2]State University of Campinas, SP, Brazil, [3]Clube Atlético Paranaense, PR, Brazil, [4]State University of Londrina, PR, Brazil

## ABSTRACT

**Matzenbacher F, Pasquarelli BN, Rabelo FN, Dourado AC, Durigan JZ, Rossi HG, Stanganelli LCR**. The Use of the Rating of Perceived Exertion to Monitor and Control the Training Load in Futsal. **JEPonline** 2016;19(4):42-52. This study applied the Rating of Perceived Exertion (RPE) to quantify the internal load of Futsal training sessions and to correlate it with other methods based upon the heart rate (HR) response. The sample was composed of nine athletes (age, 17.2 ± 0.4 yrs; weight, 68.1 ± 9.3 kg; height, 176.4 ± 6.6 cm. In total, 330 on court training sessions were monitored for RPE, HR, and the training impulses (TRIMPs) of Edwards and Banister. The correlations between the internal load based on the RPE compared to TRIMPs were strong (r = 0.58; r = 0.48) to very strong (r = 0.79; r = 0.78), respectively. When compared to the Banister´s, the Edwards´ TRIMPs showed a better correlation with the RPE method. The mean intensity of the training sessions was 69 $\%HR_{max}$ and 55 $\%HR_{res}$. The perceived intensity presented by the athletes was considered strong (5.8 ± 1.5 Arbitrary Units) according to the Borg CR10 scale. Thus, the RPE method seems to be a valid tool for monitoring the global internal load of Futsal training sessions at this age group.

**Key Words**: Perceived Exertion, Futsal, Training Load

## INTRODUCTION

Futsal is ruled by the Fédération Internationale de Football Association (FIFA). It is played regularly in more than 130 countries in all continents. The intermittent characteristics of the sport imply high physical, tactical, and technical demands requiring a process of decision-making in a very short period of time (2,8). In order to reach and sustain an optimum performance level, training programs rely on many fields of the sport sciences such as exercise physiology, sport biomechanics, sport psychology, and fitness training (22). The application of an appropriate training load is critical to ensuring positive physiological adaptations that lead to an improvement in performance. Therefore, to monitor the training loads and the athletes' responses, it is imperative that the sport science major understands the internal physiologic demands of futsal training sessions (13).

The training process is usually described by the external load values. But, the training stimulus that induces the adaptations is the physiological stress (i.e., internal load) imposed on athletes through the external load (7,15,16). Although the external load is a determining factor on the internal load, other factors such as genetic potential, fitness level, and nutritional status may also influence the training load imposed on the individual and hence the result of the training process (6,7,15). Due to these factors, each individual may respond differently to the same external training load. Hence, it seems necessary to monitor the internal load, mainly on team sports, in which very often the external load is the same for all athletes (6,15).

The most commonly used methods to assess the physiological parameters (i.e., internal indicators) in futsal are heart rate monitoring (HR) and blood lactate concentration during matches and training sessions. However, these methods rely on certain logistics and may involve high costs. This makes them unfeasible for many teams, particularly those in the lower divisions. The training impulse equations (TRIMP) obtained by the use of HR values and the duration of the training session according to the minutes accumulated at each different HR zones can also be used to identify the levels of stress and to quantify the internal load in training sessions. Related to each of the latter methods, the two current best-known TRIMPs are those proposed by Edwards and Banister (5,9,15,16). In addition, the rating of perceived exertion (RPE) method has been frequently used to quantify training load in team sports such as football (15) and futsal (13,17-21) in order to maximize training outcomes by ensuring a proper control of training and monitoring the athlete's internal loads.

Considering the importance of continuously monitoring these variables throughout the entire season, previous studies (4,23) that have investigated the effects of training programs in futsal varied from 4 to 12 wks of training. However, it is necessary to monitor both the external load and the internal load responses for longer macrocycles (i.e., a plan that works towards a quality preparation phase, a high priority for competition, and transition for mental reasons). This adjustment in time reflects the necessary organization and training in advance of a competition of young futsal athletes.

Therefore, the purpose of this study was to determine whether the RPE method is as a good indicator of internal load as the HR methods (TRIMPs) during a macrocycle of 31 wks. This was accomplished by describing and analyzing the intensity of futsal training sessions by RPE, $HR_{max}$, $HR_{res}$ and the training impulse methods. The hypothesis was that a simple, practical, and inexpensive method such as RPE could be considered a valid tool to monitor internal training load in futsal by presenting a good correlation with the methods based on HR and TRIMPs values.

## METHODS

### Subjects

Twelve male futsal athletes were included in this study. However, three of the subjects missed more than 20% of the training sessions. Their results were not considered. The final sample of 9 athletes consisted of a mean and standard deviation of: age, 17.2 ± 0.4 yrs; height, 176.4 ± 6.6 cm; and body weight, 68.1 ± 9.3 kg. The subjects had practiced the sport for at least 5 yrs prior to this study. The Ethics Committee of the State University of Londrina, Brazil (35902/2011) in accordance with the resolution of the National Health Council (196/96) for human research approved this study.

### Procedures

The present investigation lasted 31 wks, which was divided into eight mesocycles. At total, 57 days of training sessions were monitored (i.e., 57 technical/tactical sessions - specific skills of futsal, tactical training, small-sided games, and 5 x 5 simulated matches). Also, at least 90% of the 57 sessions, one of the fitness components was prescribed such as muscular power, repeated sprints (RSA), interval training, agility, and flexibility. The training sessions averaged approximately 90 min each. The data for external training load was collected since the first week while the internal training load was collected after the fourth week of training when the subjects were already adapted to the experimental procedures.

Control of the internal training load was carried out by means of the RPE method in accordance with previous studies (13,15,17-21) in which, 30 min after the training session, the athletes had to answer to the following question: "What was the intensity of your training today?" The 10-point Borg RPE by Foster et al. (12) was used of which they could report a value between 0 and 10, including decimal as well (e.g., 7.5). These data were multiplied by the total duration of the training session in minutes (external load) and the final training intensity expressed as an arbitrary unit (AU). In addition, an index of training monotony was obtained by dividing the mean session-RPE by its standard deviation. This procedure was applied for every on-court training session.

Heart rate was monitored every 5 sec using a telemetry system (Suunto Team Pod, Suunto Oy, Finland) throughout all the on-court training sessions. The results were presented as mean percentages of maximum heart rate ($HR_{max}$) and heart rate reserve ($HR_{res}$). The information for the analysis of training impulse was collected concurrently with the HR data and further calculated according to the equations described by Edwards (TRED) (11) and Bannister (TRBA) (3).

### Statistical Analyses

Data are presented as mean ± standard deviation. The assumption of normality was verified by the Shapiro-Wilk test for subsequent analysis for parametric or nonparametric statistical inference. The Pearson correlation coefficient for parametric data and the Spearman correlation coefficient for nonparametric data were used when analyzing the individual's correlations of the training sessions, the correlations between the session RPE, and the training impulses of Edwards and Banister.

## RESULTS

The external training load was quantified and out of 5.103 min of a combination of tactical-technical and physical condition, 3.929 min (77%) were dedicated to specific on-court futsal drills and 1.174 min (23%) to develop the fitness component of the prescribed training loads (Table 1).

**Table 1. Absolute Total Time (Minutes) and Percentage (%) Values Related to the Components of Training during Each Mesocycle.**

| Training Load Mesocycle | Meso 1 | Meso 2 | Meso 3 | Meso 4 | Meso 5 | Meso 6 | Meso 7 | Meso 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Total Time** (min) | 355 | 972 | 634 | 708 | 475 | 639 | 638 | 682 | 5.103 |
| **Tech/Tactical** (%) | 111.5 (32) | 631 (65) | 507 (80) | 511 (72) | 413 (87) | 570 (89) | 528 (83) | 635 (93) | 3.929 (77) |
| **Repeated Sprint** (%) | 44 (12) | 37 (4) | 23 (4) | 30 (4) | 21 (4) | 29.5 (5) | 15 (2) | - | 204 (4) |
| **Muscle Power** (%) | 39 (11) | 146 (15) | 25 (4) | 90 (13) | 10 (2) | - | 41 (7) | - | 306 (6) |
| **Aerobic** (%) | 96 (27) | 76 (8) | 26 (4) | 34 (5) | - | - | - | - | 256 (5) |
| **Agility** (%) | 35 (10) | 22 (2) | 10 (1.5) | 12 (1.5) | 9 (2) | - | 8 (1) | - | 102 (2) |
| **Flexibility** (%) | 29.5 (8) | 60 (6) | 42 (6.5) | 31 (4.5) | 22 (5) | 40 (6) | 44 (7) | 47 (7) | 306 (6) |

The internal training load was measured over 28 wks of the study. The distribution of total weekly load averaged 1.039 ± 379 AU (RPE); 408 ± 135 AU (training impulse of Edward) and 185 ± 61 AU (training impulse of Banister). The monotony of the loads had an average value of 0.63 ± 0.15 AU.

The intensity of the training sessions was monitored using the subjects' RPE, the training impulses of Edwards and Banister, and the $\%HR_{max}$ and $\%HR_{res}$. In total, 330 individual training sessions were analyzed during the study, which are described in Table 2. The correlations between the internal load based on the RPE when compared to both the Edwards and the Banister´s TRIMPs were classified from strong (r = 0.58; r = 0.48) to very strong (r = 0.79; r = 0.78), respectively.

**Table 2. Average Intensity of the Training Sessions (n = 330) for the Subjects' RPE, the TRIMP of Edwards, the TRIMP of Banister, $\%HR_{max}$ and $\%HR_{res}$.**

| | **RPE** (AU) | **RPE** (CR10) | **TRIMP Edwards** (AU) | **TRIMP Banister** (AU) | **$\%HR_{max}$** | **$\%HR_{res}$** |
|---|---|---|---|---|---|---|
| **Minimun-Max** | 80 - 882 | 2 - 10 | 22 - 347 | 11 - 183 | 47 - 83 | 25 - 74 |
| **Mean ± SD** | 452 ± 151 | 5.8 ± 1.5 | 180 ± 61 | 81 ± 32 | 69 ± 6 | 55 ± 9 |

Max = Maximun; RPE = Rating of Perceived Exertion; AU = Arbitrary Unit; TRIMP = Training Impulse; $\%HR_{max}$ = Percentage of Maximum Heart Rate; $\%HR_{res}$ = Percentage of Heart Rate Reserve

During the eight mesocycles the average values for the RPE-scale was 5.5 ± 1.5 AU and the RPE method was 1.018 ± 443 AU. When quantifying the TRIMP methods during seven macrocycles, the TRED and TRBA methods present means of 396 ± 127 AU and 179 ± 59 AU, respectively (Table 3).

**Table 2. Average Internal Load of the Training Mesocycles Obtained Using the Methods of RPE scale, RPE, TRED and TRBA.**

| **Internal Load** | **Meso** 1* | **Meso** 2 | **Meso** 3 | **Meso** 4 | **Meso** 5 | **Meso** 6 | **Meso** 7 | **Meso 8** |
|---|---|---|---|---|---|---|---|---|
| **RPE –** Scale (CR10) | 6 | 4.8 | 4.2 | 6.1 | 5.8 | 5.5 | 5.9 | 6.1 |
| **RPE** (AU) | 1077.5 | 1180 | 535.8 | 1429 | 689 | 887.5 | 944 | 1398 |
| **TRED** (AU) | | 499 | 239 | 539 | 278 | 334 | 341.5 | 539 |
| **TRBA** (AU) | | 223.5 | 104 | 254 | 127 | 153 | 152.5 | 240 |

*Adaptation Period; RPE = Rating of Perceived Exertion; AU = Arbitrary Unit; TRED = Training Impulse of Edwards; TRBA = Training Impulse of Banister; Meso = Mesocycle.

The individual correlations related to internal loads based on the RPE method and training impulse of Edwards and Banister are described in Table 4.

**Table 4. Individual Correlations Between the Training Loads Based on the Foster Scale (Session RPE) and the Training Loads from the Training Impulses (TRIMPs).**

| Subjects | Number of sessions | TRIMP of Edwards | $r^2$ | TRIMP of Banister | $r^2$ |
|---|---|---|---|---|---|
| **S1** | 41 | 0.72* | 0.52 | 0.74* | 0.55 |
| **S2** | 40 | 0.71* | 0.5 | 0.71* | 0.5 |
| **S3** | 44 | 0.61* | 0.37 | 0.48* | 0.23 |
| **S4** | 47 | 0.75* | 0.56 | 0.74* | 0.55 |
| **S5** | 30 | 0.69* | 0.48 | 0.71* | 0.5 |
| **S6** | 31 | 0.75* | 0.56 | 0.71* | 0.5 |
| **S7** | 40 | 0.79* | 0.62 | 0.77* | 0.59 |
| **S8** | 27 | 0.58* | 0.34 | 0.46* | 0.21 |
| **S9** | 30 | 0.61* | 0.37 | 0.50* | 0.25 |
| **Minimum – Maximum** | 27 - 47 | 0.58 - 0.79 | 0.34 - 0.62 | 0.46 - 0.77 | 0.21 - 0.59 |
| **Mean ± SD** | 37 ± 2.4 | 0.69 ± 0.2 | 0.48 ± 0.1 | 0.64 ± 0.42 | 0.43 ± 0.1 |
| **CI 95%** | 31 - 42 | 0.63 - 0.75 | 0.4 - 0.56 | 0.55 - 0.74 | 0.31 - 0.55 |

*P<0.01

## DISCUSSION

The present study investigated whether the RPE method was a good indicator of internal load in young futsal athletes. The HR methods were used as the parameters to describe and analyze the intensity of training sessions based on the values of RPE, $HR_{max}$, $HR_{res}$, and the training impulse methods.

The prescription of the training loads focused on the specificity of the futsal during an annual macrocycle. The total training volume was approximately 5.103 min, being 77% devoted to technical/tactical training and 23% to the development of physical capacities (17% for repeated sprints; 26% for muscular power; 26% for flexibility; 22% aerobic, and 9% for agility).

Another important result of the present study was the distribution of the training volume prescribed during the macrocycle, which increased as the main competition of the season was approaching with a greater emphasis on technical/tactical training. At this moment of the periodization (competition period), the use of tactical drills seemed to be relevant for the team organization. In particular, the tactical drills promoted the athletes adaptations to specific situations in order to make adjustments to the different tactical systems employed by the team itself and also in accordance with future opponents.

There are few studies in the literature investigating the external training load in team sports, particularly for young futsal athletes. Freitas et al. (13) quantified the external training load during 14 wks in a professional futsal team, which competed in the Brazilian national league. The authors divided the training load into three training mesocycles. Two months were designated as the period of preparation, and the third one as a competitive period. According to Freitas and colleages (13), there were increases in the technical/tactical training time of 51%, 73%, and 79% for the first, second, and third mesocycles, respectively. Considering these results, the present study showed similar characteristics because there were progressive increases in the technical/tactical training time over the first three mesocycles of 32%, 65%, and 80% as well. This increase in the technical/tactical training was also accompanied by a decrease in the intensity perceived by the athletes. The volume of this type of training remained high throughout the season of which it reached the highest values after the fifth (87%) and the eighth mesocycles (93%) when the main competition of the macrocycle took place.

When transforming the training volume in arbitrary units, the verified values presented a mean of 1.017 ± 317 AU that was lower than some reports in the literature. Milanez et al. (17) who reported on 39 sessions over 4 wks of futsal training demonstrated that the accumulated training load during the observed period had an average of 3.468 ± 1.045 AU. Impellizzeri et al. (15,16) reported training loads of ~2.400 AU in young soccer subjects, suggesting that for athletes of this sport, there is a threshold and training loads applied above this reference point that may have a negative impact on the health and performance of the athletes. Coutts et al. (10) concluded that, during the competitive season, the training load should be around 2.500-2.600 AU, suggesting that weekly loads of above 2.800-2.900 AU may be considered excessive, and training loads of <1.900 AU may not be sufficient to maintain the athletes' performance during the competitive season.

However, these considerations may not apply to the present study since the subjects were semi-professional, averaging 17.2 ± 0.4 yrs old. At this age-group they are still under the influence of the maturation process and practice futsal only two to three times a week. This is a much lower training load compared to professional athletes who train on average 10-12 times a week. Thus, it is important to mention in regards to training volume, the present study showed that there was a greater proportion of a specific training load, particularly the technical/tactical component that is the main aspect to be trained in under 18 futsal athletes (6).

As to the intensity of the sessions based on the RPE scale (CR10), the mean value of 5.8 ± 1.5 (AU) reported by the athletes in the present study is considered strong. This finding is higher than the mean values presented by Freitas et al. (13) 4.3, 3.6, and 3.3 AU for professional athletes during three training mesocycles, respectively. In addition, Milanez et al. (17) monitored 4 wks of training and found a lower mean intensity of 2.9 – 5.0 (AU) perceived by the athletes during training.

According to Coutts et al. (10), one possible explanation for these findings is that young athletes generally feel a higher perception of exertion (~10 to 15%) than more experienced athletes from the same team (since as they are still developing strength, aerobic power, and fundamental physical abilities in the sport). Another explanation for these differences, as shown by Milanez et al. (17), is that aerobic power could be a factor that influences the athletes' RPE. They found that athletes who had a higher $VO_2$ max perceived a lower training load than those with a lower $VO_2$ max. According to the authors, athletes with a high $VO_2$ max recover more quickly during high intensity efforts, and have less cardiovascular stress. Thus, the athletes are able to avoid the acid/base disturbances related to exercises above the respiratory compensation point and, consequently, present less fatigue.

On the other hand, in reference to the present study, Moreira et al. (20) reported a higher mean value of 6.5 (AU). However, the observations were made in two simulated matches during the training sessions for professional athletes. So far, there are no reports focusing this relationship for young futsal athletes and during the entire season.

The present study is the first to calculate the magnitude of the monotony of the loads in young futsal athletes and found the mean value of 0.63 ± 0.15 AU. It is lower than those reported by Miloski et al. (19) that averaged 1.18 ± 1.0 (AU) during 12 wks of the preparatory period and 1.11 ± 0.08 (AU) for 25 wks of the competitive season. Their sample was composed of 13 professional futsal athletes who competed in Brazilian National League. These values are also lower than those reported by Coutts et al. (10) who suggested that undergoing a training program with a high monotony of loads (>2 AU) can lead to negative adaptive responses in the athletes, such as the appearance of injuries, respiratory diseases, and the decrease in performance. However, our data demonstrated that it seems the athletes were submitted to an appropriate training program, which included a high variability of loads, and consequently, a low monotony.

The intensity of the training sessions had a mean of 69 ± 6 $\%HR_{max}$ and 55 ± 9 $\%HR_{res}$. According to the American College of Sports Medicine (1), an intensity of exercise between 64 and 76 $\%HR_{max}$ and 40 and 59 $\%HR_{res}$ is considered moderate. Many studies have reported that HR was monitored during official and friendly matches as well as simulated games during the training sessions (2,8,24,25), but not over an entire macrocycle of futsal training.

The values found in the present study are lower than those obtained by Barbero et al. (2) and Rodrigues et al. (24), who observed four official Spanish League matches and thirteen official Brazilian futsal league games, and revealed the mean intensities of 90 $\%HR_{max}$ and 86.4 ± 3.8 $\%HR_{max}$, respectively. In addition, Castagna et al. (8) presented a value of 90 $\%HR_{max}$. But, this was in simulated matches performed by professional futsal players from the Spanish second division.

The lower intensity observed in the present study may be the result of monitoring HR throughout the entire training session, including the warm-up, cool-down, and intermission periods. This is in contrast to the other studies in which HR was monitored only for the time the athletes remained on the court doing the prescribed drills. Hence, it seems apparent that other factors need to be taken into consideration (e.g., the load content, the time and type of recovery during the intermission periods, and the effort/rest relationship) in addition to the psychological factors involved in a competition (14).

The individual correlations between session RPE, TRED, and TRBA corresponded to average coefficients of explanation of 48% (TRED) and 43% (TRBA). In futsal, only Milanez et al. (18) attempted to correlate the internal load of session RPE with training impulse. The values of the individual correlations were greater than those reported in the present study. They ranged from r = 0.64 to 0.91, corresponding to a factor of mean explanation of 67%. It shows that the Edwards' training impulse had a greater explanation factor than the Banister training impulse. Thus, it strengths the use of session RPE as a method to monitor the internal loads during an entire macrocycle since a regular monitoring of training adaptations is an important tool to improve training load and recovery as well, which is an element that may lead to a successful training.

## CONCLUSIONS

The outcomes of the present study showed that the session RPE method provided similar and validated evidence when compared to those methods based on HR to quantify the internal training loads in young futsal athletes. The RPE is a psychophysiological marker that seems to allow coaches and trainers to monitor the internal training load and develop specific strategies for both individual and team training. The session RPE is a simple, noninvasive method with a low operating cost that could be considered a valuable tool for quantifying training load in futsal. Future investigations should focus on long term training that monitors an entire microcycle to better understand the regular training adaptations that lead to the improvement of performance in young futsal athletes.

**Address for correspondence:** Luiz C. R. Stanganelli, PhD, State University of Londrina, Department of Sport Science, Rua Caracas, 555 – ap. 1304, Londrina, Parana, Brazil, 86050-070, Email: stanga@sercomtel.com.br

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