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Analysis of different training load monitoring methods in youth women handball players

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Abstract This study examined the association between different methods for training load (TL) monitoring during youth handball training. Distance covered, heart rate and session rating of perceived exertion [SRPE] were recorded during 12 training sessions in 14 youth women handball athletes (16.9±1.1 years). Internal load models based on SRPE and Edwards' Trimp were calculated. An oscillatory feature was observed for the three methods of TL assessment (SRPE: 383±159 A.U., Edwards' Trimp: 252±71 A.U., total distance: 3997±1291 m). A large correlation was found between Edwards' Trimp and distance covered (r=0.59). A moderate correlation was observed for Edwards' Trimp vs. SRPE (r=0.36), and between SRPE vs. distance covered (r=0.49). Shared variances of 13−35% were observed between TL methods comparisons. The results suggest that different constructs seem to be measured by each load model. Additionally, SRPE is a simple and low-cost method that might be used for TL monitoring in handball.

Introduction

Monitoring sports training load (TL) is essential to address the specific demands encountered by players, preventing a permanent state of chronic fatigue, overreaching and overtraining.[1,2] TL approaches are divided into external and internal load, which interact directly and must be properly organized.[1,2] Additionally, internal TL models incorporating exercise duration to session rating of perceived exertion (SRPE) or heart rate (HR) have been the most widely used in team sports.[3]

It is outstanding that TL assessment imposes a number of challenges. Load, volume and HR assessment in sports activities may require specific equipment, which increases costs for TL monitoring. Furthermore, environmental conditions and the overall state of athletes (e.g., current training

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level, recovery and hydration status) seem to affect internal TL methods based on SRPE and HR.[4,5] Consequently, studies have been conducted to examine the commonality between TL methods and the critical parameters for TL assessment in sports. A recent meta-analysis showed that total distance was the external load that demonstrated the strongest associations with internal load.[3] Large to a very large association between internal and external measures of TL, and even between different internal load models have been reported in field-based team sports,[2,6,7] supporting the commonality between TL methods in field-based team sports. In contrast, moderate relationships (r=0.38−0.49) between internal and external load models were found in basketball, a court-based team sport.[8]

Nevertheless, few studies have monitored distance covered, SRPE or HR Trimp in handball,[9−11] and only one study appears to have concurrently examined both SRPE and HR during a handball season.[10] It is worth noting that the aforementioned studies have not addressed the relationships between TL models in handball players, even more with youth players. The high-intensity intermittent nature of the handball game, combined with the role of the player's position, seems to impose different internal loads among handball players.[12−14] Moreover, every sport is likely to place unique demands on the players. Evaluating the commonality between established internal TL models (i.e., SRPE and Edwards' Trimp [EDW-Trimp]), and its association with an external parameter of training stimulus (e.g., distance covered) may be useful for handball coaches and conditioning professionals to establish appropriate work-load monitoring practices in this sport. Therefore, the current study aimed to describe and examine the association between different methods for TL monitoring (SRPE, EDW-Trimp and distance covered) during handball training in youth women players.

Material and methods

Subjects

Fourteen youth women handball athletes (16.9±1.1 years, 166.5±8.5 cm, and 68.9±12.9 kg) participated in the current study. They were engaged in a handball team filiated in the Brazil National Handball Federation. The subjects have been trained for 4.5±1.3 years with a training volume of 5 to 8 h per week. Inclusion criteria included to be free from musculoskeletal injuries that could limit attendance to training sessions. The subjects and their parents were informed about the study procedures and all potential risks before signing an informed consent form. This research was approved by the Local Institutional Review Board (Protocol: 3.777.601).

Study design

SRPE, EDW-Trimp and total distance were assessed during 12 training sessions over 45 days. The training period took place between two state competitions. Two out of 12 training sessions (i.e., 2nd and 9th session) consisted of friendly matches. Training sessions were composed by 15 min of warm-up (stretches and Handball' drills), followed by 45 min of both technical and tactical exercises, and them, 30 min of a game simulation. Additionally, each friendly match had 60 min of duration (two halves of 30 min with 15 min interval). Before the matches, the subjects warmed-up for 20 min by performing the same warm-up routine completed in the training sessions. All training sessions were designed and supervised by the team staff.

Training load assessment

Distance covered and HR were assessed using the Polar Team Pro (Polar Electro Oy, Kempele, Finland), with a sampling frequency of 10 Hz for total distance and 1000 Hz for HR. The monitoring device was affixed around the chest of each player before all training sessions. Data were externally downloaded to a personal computer for analysis using Polar Team software. HR was then expressed as percentage of the estimated maximal HR (201.104 - 0.7 x age).[15] It was calculated the time spent in each HR zone based on percentage of maximal HR (zone 1: 50-59%, zone 2: 60-69%, zone 3: 70-79%, zone 4: 80-89%, zone 5: 90-100%). Thereafter, TL based on EDW-Trimp was calculated by multiplying the time spent in each aforementioned HR zone by a zone-specific arbitrary weighting factor ranging from 1 (zone 1) to 5 (zone 5), and then summated to achieve a total Trimp score.[16]

SRPE was measured 30 min after each training session by individually asking the athletes: "How was your workout?".[17] They were asked to verbally give a number from 0 to 10 on the CR-10 RPE scale, which indicates how hard the exertion felt during the entire training session. SRPE TL was calculated by the product between SRPE score and training session time in minutes.[17]

Statistical analyses

Data are presented as mean±standard deviation. Skewness and kurtosis measures were obtained to determine the normality of the data (-2−+2). The Pearson product-moment correlation coefficients were used to determine the association between TL methods. Correlation coefficients (*r*) were also classified as trivial (0−0.09), small (0.1−0.29), moderate (0.3−0.49), large (0.5−0.69), very large (0.7−0.89), nearly perfect (0.9−1.0), and perfect (1.0).[18] The commonality between TL methods was calculated by the coefficient of determination (r^2). A statistical significance level was set a priori at 0.05.

Results

The mean SRPE TL was 383±159 A.U., while the mean EDW-Trimp was 252±71 A.U (Fig. 1). The mean distance covered was 3997±1291 (Fig. 2). An oscillatory feature was observed for the three methods of TL assessment.

A large correlation was found between EDW-Trimp and distance covered, and a moderate correlation was observed between the other methods (EDW-Trimp vs. SRPE, and SRPE vs. distance covered) (Table 1).

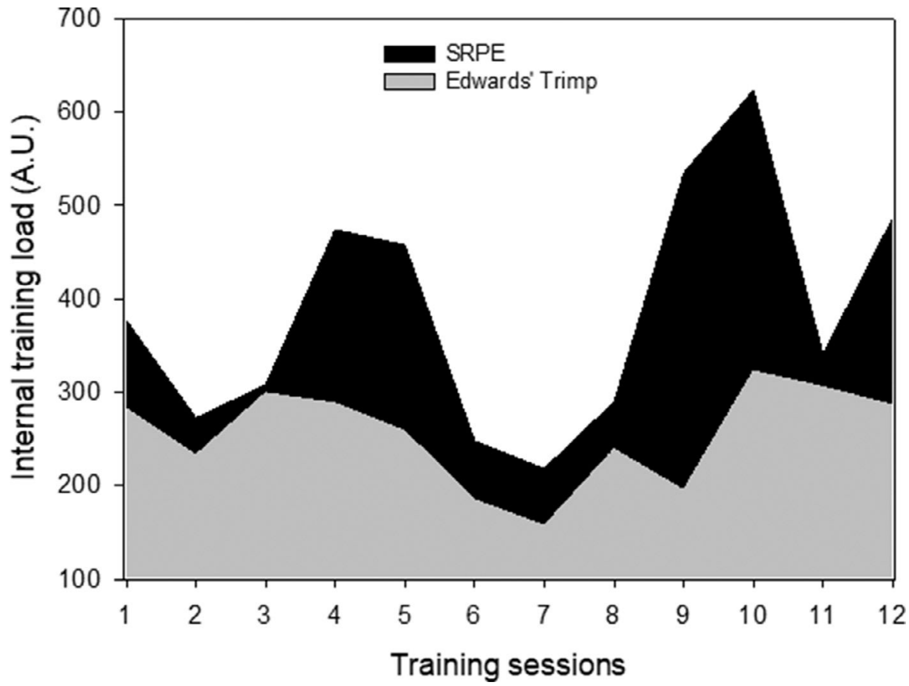

Fig. 1 Profile of session rating of perceived exertion (SRPE) and Edwards' Trimp during the training period.

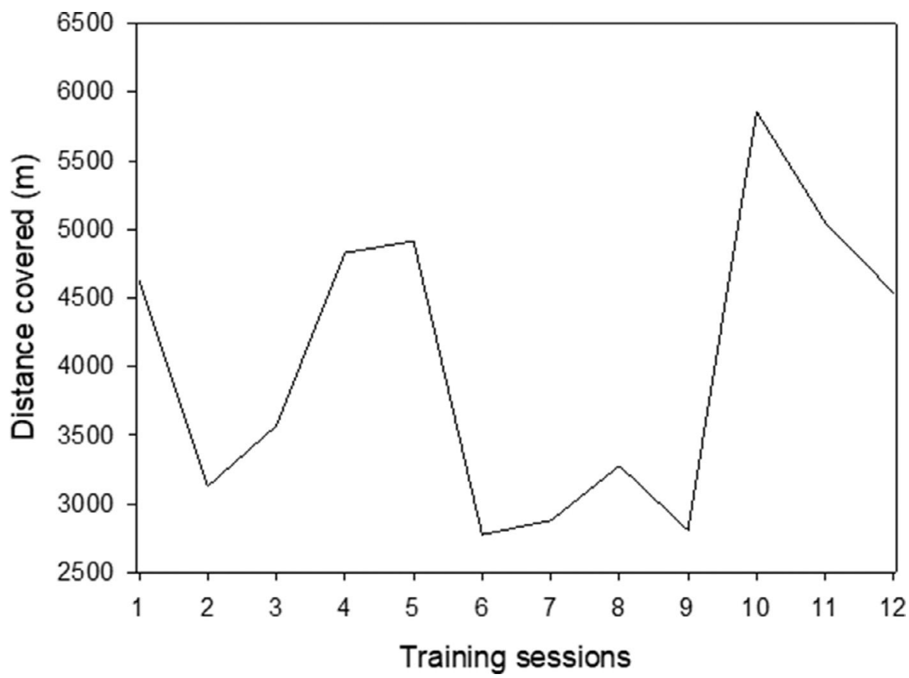

Fig. 2 Profile of distance covered during the training period.

Table 1 Pearson correlation between training load methods.

	p-value	Correlation coeficient (*r*)	Coefficient of determination (r^2)
SRPE *vs*. Edwards' Trimp	<0.001	0.36	0.13
SRPE *vs*. distance covered	<0.001	0.49	0.24
Edwards' Trimp *vs*. distance covered	<0.001	0.59	0.35

Discussion

To our knowledge, this is the first study to compare TL models on a handball team. Moderate to large correlations between TL models emerged (Table 1). Shared variances of 13–35% were also observed, suggesting that different constructs may be measured by load models based on SRPE, HR Trimp and total distance in handball training. In contrast, existing research has demonstrated greater relationships between TL methods in field-based team sports. Correlation coefficients ranging from 0.51 to 0.91 have been reported between SRPE and EDW-Trimp in soccer[6,7,19,20] and football.[21,22] Regarding the comparison between internal and external load models, very large correlations between SRPE and total distance methods (r=0.76–0.89) were found in soccer[6,7,19] and football.[2,21] In addition, correlations between Edward's Trimp and total distance ranged from moderate to nearly perfect for soccer (r=0.55–0.9),[6,7,19] and it was moderate in football (r=0.55).[2] These scientific evidences support the commonality between TL based on subjective perception, HR and total distance methods in field-based team sports. They also suggest that both SRPE and EDW-Trimp load models may be a product of the external load.[21] The discrepancy in relationship magnitudes between load methods observed with the current data compared to the studies mentioned above may be due to the characteristics of team sports examined.

Handball is an invasion court-based team sport characterized by efforts at supramaximal intensities and rapid variations in exercise intensity, given that the main actions (e.g., sprints, run with a change of direction, jumps and dribbling) are performed in the zone of anaerobic intensity.[12,13] Additionally, much body contact takes place between players during the match, suggesting considerable muscle damage.[12,23] Thus, the motor activity profile requirements combined with the small playing area indicate that handball may place a higher demand on changing direction and multidirectional running than field-based team sports. This assumption is supported by the perceived exertion, cardiovascular and metabolic responses to exercise with directional change.[24,25]

A moderate relationship was also shown between the accelerometer load model with SRPE (r=0.38) and with Banister's Trimp (r=0.49) in semiprofessional male basketball players,[8] which is a court-based team sport. However, stronger associations were reported between external load monitored by total acceleration with EDW-Trimp (r=0.63) and with the SRPE model (r=0.62) in elite female youth basketball players.[26] Other studies also found a very large correlation between SRPE and EDW-Trimp (r=0.85) in youth and professional basketball players.[27,28] The divergence on commonality between TL methods has been suggested to be caused by training mode and duration.[3,28] Team sports training is composed of different types, such as games, and conditioning, technical and tactical exercises. These activities may differ in work-rest ratios, implying in different TL models relationship.[3,29,30]

This study is not without from limitations. The effect of training type on the commonality between TL methods was not examined. Moreover, only a period between competitions was evaluated. Future studies are necessary to understand if the relationship between TL methods in handball players is affected by different training types and competitions. Any eventual competitive level influence on the association between load models needs to be also addressed.

In conclusion, the current study showed moderate to large relationships between different methods for TL monitoring during handball training. In addition, a variance greater than 50% was observed between the assessed TL methods, suggesting that each TL model provides unique information on handball load. Thus, total distance, SRPE and EDW-Trimp might be combined for optimizing TL monitoring in youth handball players. However, if no access to expensive equipment is available, a simple and low-cost method as SRPE seems to be reliable for handball training monitoring.

Data availability statement

The datasets are available from the corresponding author on reasonable request.

Conflicts of interest

The author declares no conflict of interest.

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