Validity of daily and weekly self-reported training load measures in adolescent athletes.

ABSTRACT

The primary aim of the study was to assess the level of agreement between the criterion session-rating of perceived exertion ($sRPE_{30min}$) and a practical measure of a self-reported web-based training load questionnaire 24-hours post-training ($sRPE_{24h}$) in adolescent athletes. The secondary aim was to assess the agreement between weekly summated $sRPE_{24h}$ values ($\Sigma sRPE_{24h}$) and a weekly web-based training diary ($sRPE_{weekly}$) for all field-based training accumulated on a subsequent training week. Thirty-six male adolescent rugby players (age 16.7 ± 0.5 years) were recruited from a regional academy. $sRPE_{30min}$ measures were recorded 30-minutes following a typical field-based training session. Participants then completed the $sRPE_{24h}$ via a web-based training load questionnaire 24-hours post-training, reporting both session duration and intensity. In addition, on a subsequent week, participants completed the $sRPE_{24h}$ daily and then completed the $sRPE_{weekly}$ at the end of the week, using the same web-based platform, to recall all field-based training session durations and intensities over those seven days. Biases were trivial between $sRPE_{30min}$ and $sRPE_{24h}$ for sRPE (0.3% [-0.9 to 1.5]), with nearly perfect correlations (0.99 [0.98 to 0.99), and small typical error of the estimate (TEE; 4.3% [3.6 to 5.4]). Biases were trivial between $\Sigma sRPE_{24h}$ and $sRPE_{weekly}$ for sRPE (5.9% [-2.1 to 14.2]), with very large correlations (0.87 [0.78 to 0.93]), and moderate TEE 28.5% [23.3 to 36.9]). The results of this study show that $sRPE_{24h}$ is a valid and robust method to quantify training loads in adolescent athletes. However, $sRPE_{weekly}$ was found to have a substantial TEE (29%), limiting practical application.

Keywords: Training Load, Perception of Effort, Athlete Monitoring, Youth

INTRODUCTION

The quantification and evaluation of training load (TL) data are important for practitioners working with athletes to maximize positive training outcomes and minimize negative risk factors (e.g. illness, overtraining and injury) (6, 7, 9). In professional sporting environments, TL data can be easily obtained as athletes undertake the majority of their training under the supervision of their respective coaching and support staff. However, in late specialisation sports (e.g. rugby union), adolescent athletes may undertake training with multiple teams supervised by various coaches concurrently (14), as they are not contracted to one particular organisation. Coordinating the optimal training programme for youth athletes is essential to maximize player development, however collecting valid and reliable information on accumulated TLs can be challenging (15).

In adolescent sport the availability of expensive TL monitoring technologies may also be limited compared to elite adult athletic environments. Session-rating of perceived exertion (sRPE; duration x intensity), has been shown to be a valid measure of global TL in collision sports (3), and highly correlated to heart rate and blood lactate measures (4, 5). Therefore, the use of sRPE may be useful for practitioners working in adolescent athletic populations to gather data for training design and monitoring purposes (9). Recently, rating of perceived exertion has also been shown to be temporally robust from 5 minutes to 24 hours post-exercise using a visual-analogue scale (2). However, as mentioned previously, many coaches working with adolescent athletes may not have contact on a daily basis to collect TL data using this method. Therefore, the validity of a self-reported measure in the absence of practitioners, away from the training environment, would likely have relevance for the youth athlete engaged in various training programmes.

Daily TL questionnaires and weekly recall diaries are often used in practice but are suggested to have limitations related to accuracy and compliance (11, 16). Currently, there are

limited quantitative data on the precise margins of error in these self-reported data collection methods (1). Monitoring training volumes have been previously shown to have a significant margin of error using a self-reported measure of training duration in adult athletes (1). A freely accessible web-based self-reported questionnaire could provide a simple solution for individual athletes to remotely report their TL when undertaking training sessions away from sports science or strength and conditioning staff. Training exposures could then be modified to optimize an athlete's workload and to reduce the likelihood of potential injuries associated with large variations in workloads on an individual basis (6). A web-based questionnaire could gather useful and trustworthy information, with minimal burden to the athlete, and could also be time-stamped to monitor compliance (15). Therefore, the primary aim of the present study was to assess the levels of agreement between the criterion measure of supervised sRPE collection ($sRPE_{30min}$) (5), and a freely accessible self-reported web-based TL questionnaire reported 24 hours post-exercise ($sRPE_{24h}$).

Additionally, as weekly TL diaries are frequently used in research and practice to quantify TL in athletes (9, 10), the validity of such methods also need to be assessed due to their previously suggested limitations (11, 15). The accuracy of TL recall has been suggested to increase with time (15), however, weekly TL diaries are less time consuming for practitioners to administer and also for athletes to complete. If demonstrated valid, a weekly diary may provide a favourable method to collect this information compared to a daily questionnaire due to the reduced time commitment for both parties. Therefore, the secondary aim of the study was to assess the levels of agreement between a weekly training diary collected via a similar web-based questionnaire ($sRPE_{weekly}$) and the summated $sRPE_{24h}$ collected daily over the same training week ($\Sigma sRPE_{24h}$).

METHODS

Subjects

Thirty-six male adolescent rugby union players (mean ± standard deviation (SD); age 16.7 ± 0.5 years; height 182.6 ± 6.3 cm; weight: 84.3 ± 10.7 kg) were recruited for the study from a regional academy squad (highest regional playing standard for this age group). Ethics approval was granted by the University ethics committee and all participants and parents were provided with a plain language statement outlining the procedures and potential risks of participation. Following an opportunity to ask any questions regarding the study to the lead researcher, all participants and parents provided written informed consent prior to participation.

Approach to the Problem

The study was designed to evaluate the validity of a daily TL questionnaire by assessing the level of agreement between criterion sRPE (and its individual components; duration and intensity) collected 30 minutes post-exercise ($sRPE_{30min}$), and sRPE collected 24 hours post-training remotely ($sRPE_{24h}$). All participants were familiar with the $sRPE_{30min}$ collection method as it was a regularly used measure of TL quantification at the rugby academy. They were also familiarised with the web-based questionnaire design (Google Forms, Google, CA, USA) prior to the study, completing the $sRPE_{24h}$ daily over the previous 3 months. To assess the validity of a weekly TL diary, on a subsequent week, $sRPE_{weekly}$ was completed on the final day of the training week (recalling the intensity and duration for all field-based training sessions completed over the previous 7 days on the same web-based platform) and assessed for agreement with the summated $sRPE_{24h}$ that was also completed daily over the same period ($\Sigma sRPE_{24h}$).

Procedures

Criterion Training Load Measure: Following a typical field-based training session, all participants provided a RPE measure 30 minutes post-exercise to the lead researcher, which was multiplied by the timed session duration for each individual (determined by the lead researcher) to provide the criterion sRPE value. The RPE selection was made non-verbally, by pointing to the desired text descriptor on a modified Borg category ratio-10 (CR-10) scale (5), blinded from the other participants to avoid external influence on selection.

Self-reported Daily Training Load Questionnaire: Participants completed an online questionnaire via a freely accessible web-based platform approximately 24 hours after s-RPE_{30min} collection (24.2 ± 0.4 hours), following an email notification containing the link to the questionnaire. The duration values reported were the participant's recollection of the session durations to the nearest minute, and the corresponding intensity value was selected via a drop-down menu of text descriptors corresponding to the modified Borg CR-10 scale (5).

Self-reported Weekly Training Load Diary: On a subsequent training week, the participants were asked to complete the $sRPE_{weekly}$ on the final day of a training week, reporting training durations and intensities for all field-based training activities undertaken that week using the same web-based platform as the $sRPE_{24h}$. Ideally, the $sRPE_{weekly}$ would also be compared to the criterion measure of $sRPE_{30min}$ for each individual session. However, due to the various training locations for each athlete this was not possible, as the participants may train with school, club, academy and/or representative teams within any particular training week. Therefore, the level of agreement of the $sRPE_{weekly}$ was assessed against the $\Sigma sRPE_{24h}$ measure, which was also recorded each day of that training week.

Statistical Analyses

Agreement between the criterion measure of $sRPE_{30min}$ and practical measure of $sRPE_{24h}$, as well as the agreement between $\Sigma sRPE_{24h}$ and $sRPE_{weekly}$, for sRPE, duration, and

intensity were assessed using an excel spreadsheet designed to calculate the mean bias ($(\bar{x}_{diff}/\bar{x}_{criterion})$ x 100), typical error of the estimate (TEE; $SD_{diff}/\sqrt{2}$) and Pearson correlation coefficient, all with 90% confidence limits (12). All data were log-transformed for analyses to reduce bias as a result of non-uniformity error (100 x $\log(raw\ value)$), excluding the regression analysis (12). Raw data were presented to report the regression equations, mean and SD of the criterion and practical measures. Standardised measures were calculated using back-transformed data based on the Cohen's *d* effect size principle using the following equation; $((\bar{x}_{practical} - \bar{x}_{criterion})/SD_{criterion})$ (12). The standardised mean bias was rated as trivial (<0.2), small (0.2-0.59), medium (0.6-1.19) or large (1.2-1.99) (13). The standardised TEE was rated as trivial (<0.1), small (0.1-0.29), moderate (0.3-0.59) or large (>0.59) (12). The magnitude of correlation was rated as trivial (<0.1), small (0.1-0.29), moderate (0.3-0.49), large (0.5-0.69), very large (0.7-0.89) or nearly perfect (0.9-0.99) (13).

RESULTS

The agreement between the criterion $sRPE_{30min}$ and practical measure of $sRPE_{24h}$ for sRPE, duration, and intensity are presented in Table 1. The agreement between $\Sigma sRPE_{24h}$ and $sRPE_{weekly}$ measures for sRPE, duration, and intensity are presented in Table 2. The regression plots for the agreement between the criterion $sRPE_{30min}$ and practical measure of $sRPE_{24h}$ for sRPE, duration, and intensity are presented in Figure 1, and the regression plots for the agreement between $\Sigma sRPE_{24h}$ and $sRPE_{weekly}$ measures are presented in Figure 2. The regression equations, slope and intercept values are presented in Table 3.

****INSERT TABLE 1 NEAR HERE****

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****INSERT FIGURE 1 NEAR HERE****

Figure 1. Regression plots for agreement between criterion ($sRPE_{30min}$) and practical measure ($sRPE_{24h}$) for A) sRPE B) Time and C) Intensity.

****INSERT FIGURE 2 NEAR HERE****

Figure 2. Regression plots for agreement between practical measures of $\Sigma sRPE_{24h}$ and $sRPE_{weekly}$ for A) sRPE B) Time and C) Intensity.

****INSERT TABLE 3 NEAR HERE****

Standardised biases were trivial between $sRPE_{30min}$ and $sRPE_{24h}$ for sRPE, duration, and intensity. Standardised TEE was small between $sRPE_{30min}$ and $sRPE_{24h}$ for sRPE and intensity, and moderate for duration. Standardised biases were trivial between $\Sigma sRPE_{24h}$ and $sRPE_{weekly}$ for sRPE, duration, and intensity. Standardised TEE was moderate between $\Sigma sRPE_{24h}$ and $sRPE_{weekly}$ for sRPE, duration, and intensity.

DISCUSSION

The main finding of this study is that the self-reported daily TL questionnaire 24 hours post-exercise showed high levels of agreement with the criterion measure of supervised sRPE collection 30 minutes post-exercise. The $sRPE_{24h}$ had trivial mean bias, small TEE and nearly perfect correlation and therefore can be considered a valid and robust method of TL quantification for practitioners and sport scientists who are providing remote support for adolescent athletes. This method provides a freely accessible, web-based alternative for training load quantification, which may be used with large numbers of athletes, to provide accurate data for training monitoring purposes.

Another important finding of the present study is that, although $sRPE_{weekly}$ showed trivial bias and very large correlations compared to $\Sigma sRPE_{24h}$, the moderate TEE questions its potential use as a practical TL quantification method. As small week-to-week changes in TL (e.g. ~10%) have been related to injury risk (6), the use of a weekly training diary with a typical error of 28.5% would make it impossible to detect small meaningful changes in TL that could

be placing athletes at a greater risk of injury. A recent study investigating the factors that influence self-reported measures suggested that longer recall periods were associated with greater error (15). It has also been suggested that more experienced athletes have a better ability to recall training information (17). Therefore, the validity of weekly self-reported TL methods may need to be assessed in more experienced athletes for population-specific application. In conclusion, the use of a self-reported web-based daily TL questionnaire can be considered a valid and robust method for quantifying TL in adolescent athletes, unlike the weekly TL diary.

Limitations

The results of this study are limited to this population, who have been familiarized with this method for a considerable length of time. Young athletes have been suggested to have difficulty in understanding sRPE, however with adequate familiarization and education this method may be implemented successfully, especially in older adolescents such as the participants in this study. Adolescents are progressively capable of understanding mathematical processes and should have the cognitive ability to understand and rate their sRPE at the under-18 age category (8). Although the participants were informed that this was not a memory test and that the values provided 24 hours later should reflect the perception of the session at that time, it does not discount the possibility of athletes simply remembering the value reported the day before. However, these results support the findings of a recent study where recall of perceived exertion remained consistent up to 24 hours post-exercise in a supervised environment (2). Our findings provide further flexibility for strength and conditioning coaches and sports science support staff by demonstrating the validity of a remote collection method compared to the previous study.

PRACTICAL APPLICATIONS

Considering the accuracy and practicality of the self-reported daily TL questionnaire, where multiple athletes can report workloads remotely without the need for practitioners to be present, the $sRPE_{24h}$ offers a valid and robust method for TL quantification. The weekly TL diary may not be suitable for practical use due to the substantial TEE associated with this method, where the signal may be lost in the noise.

REFERENCES

1. Borresen J and Lambert M. Validity of self-reported training duration. *International Journal of Sports Science & Coaching* 1: 353-359, 2006.
2. Christen J, Foster C, Porcari JP, and Mikat RP. Temporal Robustness of the Session RPE. *International journal of sports physiology and performance*, 2016.
3. Clarke N, Farthing JP, Norris SR, Arnold BE, and Lanovaz JL. Quantification of training load in Canadian football: application of session-RPE in collision-based team sports. *Journal of strength and conditioning research* 27: 2198-2205, 2013.
4. Coutts AJ, Rampinini E, Marcora SM, Castagna C, and Impellizzeri FM. Heart rate and blood lactate correlates of perceived exertion during small-sided soccer games. *Journal of science and medicine in sport* 12: 79-84, 2009.
5. Foster C, Florhaug JA, Franklin J, Gottschall L, Hrovatin LA, Parker S, Doleshal P, and Dodge C. A new approach to monitoring exercise training. *Journal of strength and conditioning research* 15: 109-115, 2001.
6. Gabbett TJ. The training-injury prevention paradox: should athletes be training smarter and harder? *British journal of sports medicine*: bjsports-2015-095788, 2016.
7. Gabbett TJ, Whyte DG, Hartwig TB, Wescombe H, and Naughton GA. The relationship between workloads, physical performance, injury and illness in adolescent male football players. *Sports medicine* 44: 989-1003, 2014.
8. Groslambert A and Mahon AD. Perceived exertion : influence of age and cognitive development. *Sports medicine* 36: 911-928, 2006.
9. Halson SL. Monitoring training load to understand fatigue in athletes. *Sports medicine* 44 Suppl 2: S139-147, 2014.
10. Hartwig TB, Naughton G, and Searl J. Defining the volume and intensity of sport participation in adolescent rugby union players. *International journal of sports physiology and performance* 3: 94-106, 2008.
11. Hopkins WG. Quantification of training in competitive sports. *Sports medicine* 12: 161-183, 1991.
12. Hopkins WG. Spreadsheets for analysis of validity and reliability, in: *Sportscience*. sportsci.org/2015/ValidRely.htm, 2015, pp 36-42.
13. Hopkins WG, Marshall SW, Batterham AM, and Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Medicine and science in sports and exercise* 41: 3-13, 2009.
14. Phibbs PJ, Jones B, Roe GAB, Read DB, Weakley JJW, Darrall-Jones J, and Till K. We know they train, but what do they do? Implications for coaches working with adolescent rugby union players. *International Journal of Sports Science & Coaching* 12, 2017.
15. Saw AE, Main LC, and Gastin PB. Monitoring athletes through self-report: Factors influencing implementation. *Journal of sports science & medicine* 14: 137, 2015.
16. Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *British journal of sports medicine* 37: 197-206; discussion 206, 2003.
17. Tenenbaum G, Levy-Kolker N, Bar-Eli M, and Weinberg R. Information recall of younger and older skilled athletes: the role of display complexity, attentional resources and visual exposure duration. *Journal of sports sciences* 12: 529-534, 1994.