Usefulness of typical tests of short-duration maximal effort used to assess players readiness to perform

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Headline

Monitoring performance and fatigue is key in elite sports, particularly to allow optimal loading (1) and in turn, optimize overall players fitness, health and decrease injury risk (2) relative usefulness. To assess true changes in performance and thus infer on potential fatigue, practitioners need to know the signal-to-noise ratio of their measures to make the right decisions (3). While reliability data have been reported in the literature for both maximal cycling performance (4) and jumping performance (5), no studies have yet compared these two test in the same population to assess their relative usefulness.

Aim. The aim of this study was to assess intra-day and inter-day reliability of two field tests typically used to assess short-duration maximal effort performance (i.e., a 6-s cycling sprint and a counter-movement jump (CMJ)) in elite team-sport players to select the most useful test and variable to monitor.

Methods

Athletes. Twelve senior amateur rugby players (179±3 cm; 80.2±7.2 kg) participated in the study. Players were informed about the aim of the study and gave consent to take part in this project. This study conformed to the recommendations of the Declaration of Helsinki.

Design. Players were tested over 6 separate sessions, including two familiarization sessions. Testing was scheduled in October, during the early in-season period. Players first completed two testing sessions on the same day (i.e., in the afternoon, interspersed with 1 hour of recovery) to assess intra-day reliability. These two testing sessions were repeated one week later, on the same week day and at the same time of the day. Players were asked to avoid training for the last 48h before each testing session. Each testing session was designed as follow : standardized warm-up including 10 min of cycling on a ergocycle between 100-150 watts; mobility drills, lunges (2 sets of 6 reps without additional weight), squats (2 sets of 10 reps, full range of motion, 30 and 40 kg), submaximal CMJs (2 sets of 2 reps) ; 3-min recovery ; CMJ testing (4 reps) ; 4-min recovery ; 5-min specific warm-up ending with 1 submaximal sprint of 4-seconds on the ergocycle ; 2 sprints of 6-s on the ergocycle interspersed with 1-min passive recovery period.

Short-duration maximal cycling performance. Cycling sprints were performed on a Wattbike cycle ergometer (Wattbike Pro, Nottingham, United Kingdom). Gear level was set at 10 and magnetic resistance at 3 for maximal sprints. Players were familiar with sprinting on the testing equipment, which they used during their regular training program. In elite Australian football players, within-subject typical error for peak power during a 6-s cycling sprint on a Wattbike was 3.0±1.2%; intraclass correlation coefficient was 0.96±04 has been reported (4).

Short-duration maximal jumping performance. Jumping performance was assessed by the means of a counter-movement jumps (CMJ) using a portable linear encoder device (GymAware Power Tool, Kinetic Performance Technologies, Canberra, Australia). Players completed a set of 4 reps of CMJs, with a recovery of 3 to 5 seconds between jumps. They were asked to jump keeping their back straight. The mean value of the 3 best jumps was used in the analysis to improve reliability. Mean power and peak velocity were chosen since they have been shown to be sensitive to fatigue (5); jump height was collected since it is a measure frequently used in elite teams to monitor readiness to train (6).

Analyses. Data in the figures are presented as means with 90% confidence limits (CL). All data were first log-transformed to reduce bias arising from non-uniformity error. The smallest worthwhile change in performance (SWC) was calculated by multiplying the between-subject standard deviation (SD) by 0.2 (7). The intra-day and inter-day reliability of each variable was assessed while calculating both the typical error of measurement (TE, expressed as a coefficient of variation, CV, 90% CL (8) and standardized, Cohens approach) and the intraclass correlation coefficient (ICC, 90% CL, relative reliability) (9) with a specifically-designed spreadsheet (10). Threshold values for standardized differences were >0.2 (small), >0.6 (moderate), >1.2 (large) and very large (>2) (11).

The usefulness of the test variables was assessed by comparing their noise (TE) to the SWC. The test was considered as good when the TE was below the SWC, as OK when TE was similar to the SWC and as marginal when TE was higher than the SWC (12).

Results

Overall, TEs were small for the two variables recorded during the cycling test (0.20±0.05 to 0.27±0.07) and small-to-moderate for the variables measured during the CMJ (0.40±0.10 to 1.05±0.27) (Table 1). Figure 1 presents standardized typical error and ratings of usefulness for the different variables. Overall, only variables recorded during the cycling sprints were rated as good or OK.

Discussion

Present findings showed that mean and peak power output during a short-duration maximal cycling test on Wattbike provide a better signal-to-noise ratio than performance measured during a CMJ with a linear encoder (Gymaware) (figure

Table 1. Reliability of short-duration maximal cycling and jumping -related indices of performance.

				Intra-day reliability			Inter-day reliability		
Tests	**Variable**	**Mean±SD**	**SWC**	**TE (%)**	**Magnitude**	**ICC**	**TE (%)**	**Magnitude**	**ICC**
Jumping	Height (cm)	43.1±4.9	2.3%	4.4±1.2	small	0.88±0.09	5.4±1.4	small	0.81±0.12
Jumping	Peak V ($m.s^{-1}$)	3.3±0.3	1.7%	3.2±0.8	small	0.87±0.09	4.0±1.0	small	0.80±0.13
Jumping	Mean Po (W)	3304±961	5.8%	16.8±4.7	moderate	0.65±0.20	20.2±5.8	moderate	0.50±0.26
Cycling	Max Po (W)	1219±159	2.6%	2.6±0.7	small	0.97±0.02	3.4±0.9	small	0.94±0.04
Cycling	Mean Po (W)	1101±129	2.3%	3.0±0.8	small	0.94±0.04	3.2±0.8	small	0.94±0.05

SD: standard deviation. TE: typical error ICC: Intraclass correlation coefficient. SWC: smallest worthwhile change (0.2 x between-player SD). V: Velocity. Po: Power.

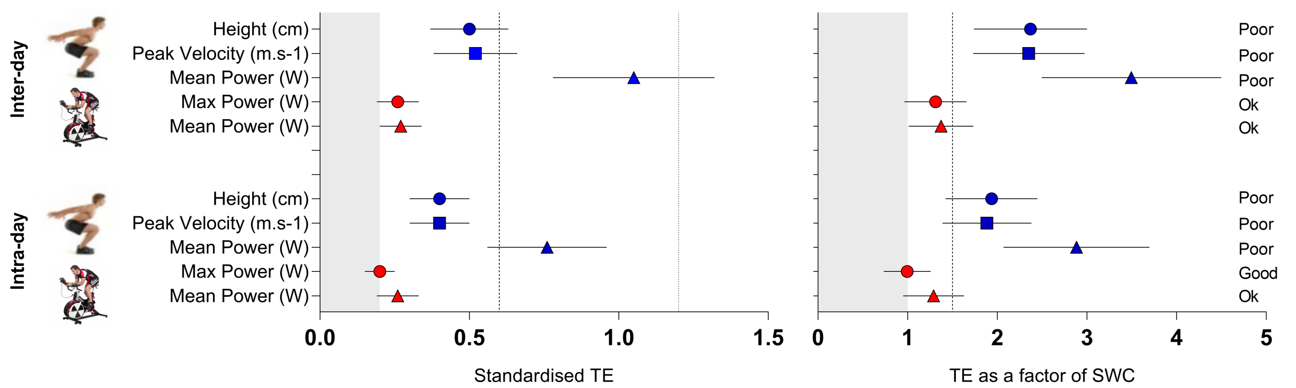

Fig. 1. Intra-day and inter-day standardized typical error of estimate (left) and as a factor of smallest worthwhile change (SWC) (right) of the variable recorded during an short-duration maximal cycling or jumping test. Left panel: Grey area represents trivial typical error (TE). Black dashed line: Moderate; Light dashed line: Large. Right panel: Grey area represents Good usefulness. Black dashed line: Poor usefulness.

1). These data confirm previous work (1) showing the potential of short-duration maximal sprints as useful performance-monitoring tool. However, when practitioners have no other solution than using CMJs to evaluate freshness and/or fatigue in rugby players, peak velocity may be the least bad option (i.e., usefulness rated better than that of mean power). In fact, while the usefulness of jump height was also better than that of mean power, its sensitivity to fatigue may be limited (5), which questions further its use as a monitoring tool.

Practical applications

- Practitioners aiming at tracking readiness to train or fatigue are encouraged to record peak power measured during a 6-s cycling sprint on an ergocycle, rather than CMJ performance.
- Practitioners monitoring fatigue in elite players by the means of CMJ performance variations may better use peak velocity rather than mean power or jump height.
- As TE decreases by a factor of $\sqrt{n}$ (11), pooling more trials (e.g. 4 trials instead of 2 for sprint testing) increases the signal-to-noise ratio and in turn, the ability to detect changes in performance.

Limitations

- The participants of the present study were amateur players. Whether their training status can affect the transferability of these results to elite players remains to be examined.

Dataset

Dataset available on SportPerfSci.com

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