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Submission type: Original Research

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Running head: Invisible monitoring in team sport

Abstract count: 250

Text only word account: 3500

Numbers of tables: 1

Numbers of figures: 3

Conflicts of interest: The authors do not have any conflict of interest.

Abstract

Purpose: The aim of this research was to investigate the convergent validity, reliability and sensitivity over a week of training of a standardized running test to measure neuromuscular fatigue. **Methods:** Twenty male rugby union players were recruited for the study, which took place during preseason. The standardized running test consisted of four 60 m runs paced at ≈5 $m \cdot s^{-1}$ with 33 seconds of recovery between trials. Data from micromechanical electrical systems (MEMS) were used to calculate a running load index (RLI) which was a ratio between the mechanical load and the speed performed during runs. RLI was calculated by using either the entire duration of the run or a constant velocity period. For each type of calculation, either an individual directional or the sum of the three components of the accelerometer were used. A measure of leg stiffness was used to assess the convergent validity of the RLI. **Results:** Unclear to large relationships between leg stiffness and RLI were found (r ranged from -0.20 to 0.62). Regarding the reliability, small to moderate (0.47 to 0.86) standardized typical errors were found. The sensitivity analysis showed the leg stiffness presented a *very likely* trivial change over the course of one week of training, while RLI showed *very likely* small to a *most likely* large change. **Conclusion:** This study showed that RLI is a practical method to measure neuromuscular fatigue. Additionally, such a methodology aligns with the constraint of elite team sport set up due to its ease of implementation in practice.

Key words: Fitness monitoring, GPS, leg stiffness, running mechanisms.

Introduction

Team sport practitioners are required to assess player readiness for training and matches using valid and reliable tests[1]. The constraints of a high level sport environment (*e.g.* access to players, competition focus, time pressures) make fatigue monitoring challenging[2]. Neuromuscular function is a commonly measured fatigue indicator in team sports[3] and is usually estimated via variations of jumping actions (*e.g.* countermovement jump, drop jump, reactive jumps)[4]. Despite the regular use of jump testing within the literature, several limitations of this methods exist from a practical and scientific perspective[2,5]. In practice, implementing a monitoring system for a full squad (*e.g.* 50 players in rugby union) can be time consuming especially when training time during the season is limited. For example, employing a jumping task may be challenging due to coach and player reluctance, as well as perceived risk of injury[2,6]. Jump tests may also not be specific enough to capture the actual level of fatigue induced by training sessions or games due to the horizontal nature of displacements in team sport[7]. Methods of neuromuscular fatigue monitoring need to evolve to allow data to be collected rapidly and without interfering with practice.

Micromechanical electrical systems (MEMS) provide sport science practitioners with large amounts of data, which are collected during training and match play. Using methods of data processing (*e.g.* R, Python), MEMS may allow a more practical method of fatigue monitoring within team sports[8]. One relevant variable for fatigue monitoring that can be calculated from data obtained via commercially available MEMS units is the sum of instantaneous rate of change from the 3 axis planes (*e.g*. PlayerLoad™, Force Load). Such metrics are influenced by the presence of neuromuscular fatigue during both small sided games and game play, suggesting a relationship with an athlete's state of fatigue [9,10].

Whilst the use of accelerometer data during game situations shows promise as a fatigue measure, it is not without its challenges (e.g. reluctance from coaches to use the same standardized drills on a week to week basis, effect of contextual variables such as team composition, rules, number of players necessary to perform the drills of interest[11]). For these reasons, in some contexts a more practical approach may be to examine the relationship between work load and immediate physiological responses during a standardized running task (*e.g.* box to box runs)[7,12]. This approach has the advantage of being able to be conducted during a warm up (even on a low intensity training day). For example, Buchheit and colleagues[7] demonstrated that the ratio between "velocity load" and "force load", designated Running Load

Index (RLI), performed during a standardized running test presented small to moderate typical errors. Moreover they found a session-dependent sensitivity of RLI while changes in “traditional” test results (countermovement jump [CMJ] and groin squeeze) were trivial to small after different small sided games suggesting a better sensitivity of this “running load” variable[7]. However, some aspects of such a test remain questionable. For instance, the agreement of RLI with established neuromuscular fatigue measures like leg stiffness test have yet to be established[11]; the inclusion of all the components of the accelerometer remains questionable due to the potential major implication of the vertical component[9] and the inclusion of the full run (acceleration and deceleration phase) remain debatable due to the potential implication of constant velocity on leg stiffness[13].

The aim of this study was to investigate the convergent validity, reliability and sensitivity of RLI as a method to monitor neuromuscular fatigue during a standardized running test.

Methods

Subjects

Twenty male rugby union players taking part in the highest university rugby competition in England were included. Three players were excluded because they missed one of the testing sessions. Finally, 17 male rugby union players (age: 21.0 ± 1.3 years; height: 185.2 ± 6.1 cm; body mass; 97.3 ± 10.3 kg). Participants provided informed consent prior to starting the study. Ethics approval was granted by the Leeds Beckett University ethics board and the recommendations of the Declaration of Helsinki were respected.

Design

The study took place over four non-consecutive sessions during the first two weeks of pre-season of a University rugby union team (Figure 1). Each testing session consisted of 5 minutes standardized warm up including mobility, squats, lunges and hopping. Following this, leg stiffness was measured via a submaximal hopping test performed on a force platform. After ≈15-minute break (which corresponded to the time to set up all the MEMS units and go to the pitch), participants performed a standardized warm up which consisted of 5 minutes running (≈9 $km \cdot h^{-1}$) followed by 3 minutes of recovery. Participants then performed the standardized running test. For each session, this procedure was conducted at the same time of the day, before the first training session in order to control for any chronobiological effects on performance.

During the first session (session 1), a familiarization with the testing measures (described below) was conducted. The familiarization session included a full explanation of the procedure. Then, each test was performed twice with feedback regarding the hopping technique and the pace of the standardized running test if it was not satisfactory. The convergent validity of the standardized running test was assessed during the session 2. The week to week reliability procedure was undertaken on the session 2 and 3. Each session was preceded by two days of no lower body training; as such a physiological and non-fatigued state was expected. The sensitivity analysis aimed to assess the ability of the different RLI to detect meaningful change over a typical week of training. This analysis was conducted during the second week of our study. The standardized running test and the hopping test were conducted at the beginning (session 3) and at the end of the training week (session 4). Data gathered during the session 3 were used as baseline for comparison.

Insert Figure 1 about here

Methodology

Double leg hopping test: Participants completed one submaximal hopping test which consisted of sub-maximal rebounding at 2.5 Hz to provide a measure of leg stiffness on a force platform (NMP Technologie Ltd., ForceDecks Model FD4000a, London, UK). This method has been used in a similar rugby union population[14]. Participants completed a total of 20 consecutive hops and hopping frequency was controlled with a digital metronome[14]. Data were processed on R Studio Statistical software (Version 1.1.442, R Foundation for Statistical Computing) as explained by Lloyd and colleagues [15]. Leg stiffness was calculated through Dalleau's equation [16] where M is the mass (kg), Ft and Ct are flight time (ms) and contact time (ms) respectively.

$$Leg\ stiffness = \frac{M \times \pi(Ft + Ct)}{Ct^2((Ft + \frac{Ct}{\pi}) - (\frac{Ct}{4}))}$$

Standardized running test: Participants performed four paced, high speed runs. Each run was 60 m long and players were directed to complete the run in 12 seconds (mean velocity ≈ 18 $km \cdot h^{-1}$) in a similar manner to previous research [17]. Players began from a static start with a 3 second count down to ascertain a static position. Cones were displayed every 20 m and whistle signals were given at 4 and 8 seconds to assist with pacing. Each standardized run was interspersed by ≈30 seconds rest according to precedent work in soccer [7]. During the standardized run, participants wore the same GPS unit (Optimeye S5, Catapult Innovations, Melbourne, Australia) between scapulae in a specific tightly fitting vest. Each unit contains a GPS system and a tri-axial accelerometers sampling at 10 and 100Hz respectively.

RLI calculation: The raw data from the accelerometer sampled at 100 Hz were first downloaded from the Openfield software (Openfield software, Catapult Innovations, Melbourne, Australia). Each file included the four runs. All the files were then uploaded in R Studio Statistical software (Version 1.1.442, R Foundation for Statistical Computing). Initially the entire 12 second of the run minus the recovery period was included to calculate RLI noted $RLI_{0\text{-}12}$. A second layer of analysis was applied to identify a specific period of run that took place at constant velocity in order to avoid the effect of the acceleration and deceleration phases on the calculation noted RLI_{cvel}. Thus, we could double-check that the period of run used for analysis were at a constant velocity. The acceleration threshold was set at $|0.25m^{-2}|$ and determined arbitrarily by the research team. A specific algorithm that detects the beginning and the end of each run was written. For each determined interval, the mechanical load was calculated by the sum of instantaneous rate of changes from 1) all of the 3 components of the accelerometer noted $_{\text{'full'}}$; 2) only with the vertical component noted $_{\text{'vert'}}$; 3) with the anterio-posterior component noted $_{\text{'fwd'}}$; 4) with the medio-lateral component noted $_{\text{'side'}}$. Each calculated mechanical load was then divided by the average velocity ($m{\cdot}s^{-1}$) performed over the period of the running analysis. Based on these 2 different methods, 8 different RLI were used in this study: 1) $RLI_{0\text{-}12\text{-}full}$; 2) $RLI_{0\text{-}12\text{-}vert}$; 3) $RLI_{0\text{-}12\text{-}fwd}$; 4) $RLI_{0\text{-}12\text{-}side}$; 5) $RLI_{cvel\text{-}full}$; 6) $RLI_{cvel\text{-}vert}$; 7) $RLI_{cvel\text{-}fwd}$; 8) $RLI_{cvel\text{-}side}$.

Insert Table 1 about here

Training load: During the second week, total time 'on feet' (hour:minute [hh:mn]), total distance covered (TD), high-speed distance (HSD) both expressed in meter (m) and PlayerLoad^{TM} (Arbitrary Units [AU]) were used to quantify training load. HSD was determined by the distance covered above Maximal aerobic speed (MAS). MAS was assessed during the first week of preseason with the 30-15 Intermittent Fitness Test [18]. The MAS score ranged from 16 to 20.5 $km{\cdot}h^{-1}$ for this population. The training schedules as well as the training load are reported in Figure 1.

Statistical Analyses

All data were first log-transformed to reduce bias arising from non-uniformity error. Pearson correlations and 90% confidence intervals (CI) were used to assess the convergent validity of the RLI with the double hopping test. Correlations were interpreted as follow: if the 90%CI over-lapped positive (0.1) and negative (-0.1) trivial values, the magnitude was deemed unclear. Clear correlations were interpreted as follows: trivial (0.0-0.1), small (>0.1-0.3), moderate (>0.3-0.5), large (>0.5-0.7), very large (>0.7-0.9) and nearly perfect (>0.9-0.1) [19]. The reliability of the standardized running test was assessed while calculating both the typical error of measurement expressed as a coefficient of variation (CV, 90% CI), standardized typical error and the smallest worthwhile change (SWC) with a specific spreadsheet [20]. A magnitude-based inferential (MBI) approach to statistics was used to assess differences between the RLI and leg stiffness changes gathered at the beginning and at the end of the week 2 [19]. Effect sizes (ES) and 90% CI were quantified to indicate the practical meaningfulness of the differences [19]. Threshold values for ES and standardized typical error were >0.2 (small), >0.6 (moderate), >1.2 (large) and >2 (very large) [21].

Result

The relationships between the different RLI and leg stiffness are reported in Figure 2. When the full run was included unclear to moderate relationships were found for $RLI_{0\text{-}12\text{-}full}$ (r= 0.07 [-0.33 – 0.45]), $RLI_{0\text{-}12\text{-}vert}$ (r= 0.36 [-0.04 – 0.66]), $RLI_{0\text{-}12\text{-}fwd}$ (r= -0.20 [-0.57 – 0.18]) and $RLI_{0\text{-}12\text{-}side}$ (r= 0.01 [-0.38 – 0.40]). Considering $RLI_{cvel\text{-}vert}$ and $RLI_{cvel\text{-}full}$, large relationships were found (r= 0.62 [0.30 – 0.81]; r= 0.52 [0.16 – 0.76]) respectively. Unclear to moderate relationship was found for $RLI_{cvel\text{-}fwd}$ (r= 0.16 [-0.25 – 0.51]) and $RLI_{cvel\text{-}side}$ (r= 0.39 [0.01 – 0.68]).

Insert Figure 2 about here

The results regarding the reliability are reported in Table 1.

Insert Figure 3 about here

The results regarding the sensitivity are displayed in Figure 3. Over the period of training used for the sensitivity analysis, players performed two rugby sessions. The total time “on feet” was 02:51±00:01hh:mn with a TD of 9816±833m and HSD of 1224±287m. The global PlayerLoad™ was 949±89AU. A *very likely* trivial change between the beginning and the end of the week of training was observed for leg stiffness (ES= 0.01 [-0.15 – 0.16]). *Possibly* small increases were found for $RLI_{0\text{-}12\text{-}full}$ (ES= 0.27 [-0.09 – 0.64]) and $RLI_{0\text{-}12\text{-}vert}$ (ES= 0.25 [-0.02 – 0.51]). A *possibly* trivial increase was found for $RLI_{0\text{-}12\text{-}fwd}$ (ES= 0.14 [-0.15 – 0.42]) while the change observed for $RLI_{0\text{-}12\text{-}side}$ (ES= -0.08 [-0.47 – 0.31]) was deemed *unclear*. A *most likely* very large increase was found for $RLI_{cvel\text{-}full}$ (ES= 2.03 [1.71 – 2.35]) over the course of one week of training. *Most likely* large increases were found for $RLI_{cvel\text{-}vert}$ (ES= 1.74 [1.49 – 1.99]), $RLI_{cvel\text{-}fwd}$ (ES= 1.61 [1.23 – 1.98]) and $RLI_{cvel\text{-}side}$ (ES= 1.90 [1.42 – 2.39]) over the same period.

Insert Table 1 about here

Discussion

The main findings of this study suggest under the constant velocity condition and when using the full or vertical accelerometer components RLI demonstrates 1) a large relationship with leg stiffness, 2) small typical errors and 3) a high sensitivity to fatigue during a typical week of training. As a consequence, practitioners should consider the present RLI based on constant velocity (*i.e.* $RLI_{cvel\text{-}vert}$) outlined here in order to make the monitoring process and assessment of readiness to play more efficient and less intrusive.

This study is the first study to correlate data computed from MEMS devices gathered during a standardized running test and a measure of leg stiffness. When RLI was calculated with the whole run as proposed by other studies [7,12], only a moderate (*i.e.* $RLI_{0\text{-}12\text{-}vert}$) and unclear (*i.e.* $RLI_{0\text{-}12\text{-}full}$, $RLI_{0\text{-}12\text{-}fwd}$ and $RLI_{0\text{-}12\text{-}fwd}$) relationships were found with leg stiffness. Based on our method that included only the constant velocity period, large relationships were found with leg stiffness for both $RLI_{cvel\text{-}vert}$ (r= 0.62 [0.30 – 0.81]) and $RLI_{cvel\text{-}full}$ (r= 0.52 [0.16 – 0.76]) suggesting a better convergent validity of this method to monitor neuromuscular fatigue. The lack of relationship when the full run was included is possibly due to the integration of the acceleration and deceleration phase in the calculations. Indeed it has been shown that leg stiffness may remain constant from 4 to 7 $m \cdot s^{-1}$ [13]. As a consequence, the variation in the speed could deteriorate the relationship and explain the present results [13]. An appealing consideration is that if RLI ratio is more accurate during the constant velocity portion of a run, it may not be necessary to normalize the accelerometer measures to speed. This aspect of the RLI measure requires further investigation.

Moreover, removing the other components and focusing only on the vertical component of the accelerometer (*i.e.* $RLI_{cvel-vert}$) increases the relationship with leg stiffness. This may be explained by the multicollinearity between $RLI_{cvel-vert}$ and $RLI_{cvel-full}$ suggesting that the vertical component of the accelerometer explain the major part of the relationship with leg stiffness. The absence of stronger (*i.e.* $RLI_{cvel-vert}$) or absence (i.e. $RLI_{cvel-fwd}$ and $RLI_{cvel-side}$) correlation could be explained by the nature of the task involved to perform the validity analysis. Indeed, projecting the center of mass forward during running necessitates different muscle activity with changes in the electromyography profiles compared to vertical jumps or hops [22]. Such different patterns of activation may explain the lack of better correlation. As a result, further studies could evaluate the concurrent validity of the RLI with a gold standard such as use of an instrumented treadmill as criterion.

The results from this study suggest that typical errors ranged from small to moderate for the different RLI tested (Table 1). These results are slightly different than results found by Buchheit and colleagues in term of reliability[7]. Such differences could be explained by the difference of period used in our study. Indeed, our study was performed during preseason while Buchheit and colleagues conducted their research during several consecutive in season macro cycle[7]. Using the new testing method outlined here (*i.e.* measurements based on a constant velocity), standardized typical errors found were lower than observed when the full run was included in the calculation (*i.e.* $RLI_{0-12vert}$, $RLI_{0-12-full}$). Nevertheless, typical errors need to be considered in relation with the change in a variable (Signal) and its usual SWC [1]. Considering this noise/signal ratio in our study, the method based on a constant velocity interval remained better than when the full run was included and should be considered. Even if only moderate to large effect can be detected, the cost/benefit of the method is promising. The present standardized running test is particularly useful as it can be difficult for practitioners to repeat maximal testing (*e.g.* CMJ) across the season[2]. Therefore, with the present methodology, it is easier to implement a monitoring during warm-up and more efficient to complete for a full team. Additionally, it has been proposed that accelerometer activity during small side game could be used to measure neuromuscular fatigue [10]. While this methodology seems appealing it could be difficult to use such approach to assess readiness to train after the game due to several contextual challenges[11]. However, the present methodology here outperforms the aforementioned issue related to SSG because such a test is performed during warm up which is led by the strength and conditioning coach.

Over the course of one week of training during preseason with rugby union players, a trivial change (ES=0.01 [-0.15 – 0.16]) was found in leg stiffness. Our results are similar than those found by Oliver and colleagues[14] among a similar population after a week of training. The absence of change found in this study could be explained by the lack of specificity of the vertical based test used. Indeed hopping test involve only a vertical dimension while a great majority of force applications occur horizontally in run-based sports [7]. For example, it has been shown that CMJ after a training session did not change while sprint performance did [23]. Conversely, the different RLI changed from a small to a very large magnitude over the same week of training suggesting a better sensitivity than leg stiffness [14]. Similarly to our study, Buchheit and colleagues [7] found only small changes in results of the "vertical based test" (*i.e.* CMJ), while a moderate to large change was observed with similar standardized tests after different football session. As such, the increase observed in the ratio could be interpreted as an impairment of running economy (more quantity of movement for a similar task). Indeed we observed increased $RLI_{(cvel)}$ in all three planes of motion indicating that fatigue from the weeks' training had altered the players running mechanics. Due to the multifactorial nature of neuromuscular fatigue, the exact mechanism of changes remains difficult to draw and will require further work. We could suggest that changes observed may be related to an impairment of the posterior chain and the running mechanics induced by fatigue accumulated during training[7]. Indeed, it has been shown a reduced maximum combined hip flexion and knee extension angle resulted in a decreased stride length and increase of stride frequency in presence of fatigue [24]. As such this increased of stride frequency may result of an increase of the quantity of movement and consequently explains the increased of RLI observed. The results concerning the sensitivity are unequivocal. Indeed, when the entire run was included, trivial to small differences were observed while the method based on acceleration interval displayed large to very large changes. The dissimilarity between both methods remained unknown. We can hypothesize that the acceleration method decreases the noise of the measure and therefore allow capturing the real fatigue state of the athlete explaining the better sensitivity observed.

Limitations

Due to players' requirements, one upper body session was undertaken the day before the first session of reliability. Nevertheless, it is unlikely that such upper body session influence results for task involving mainly the lower body [25]. Therefore, better result may have been obtained during an in-season cycle as a result of a more stable physiological status. Second, we decided to use a measure of leg stiffness to compare with RLI that is by nature different (hoping vs. running). Nevertheless, it was difficult to take the players out of their training routine in order to perform a measure of leg stiffness during a running task in a laboratory setting. Further concurrent validity studies seem warranted to ascertain the biomechanics value of such approach. It has to be acknowledged that the important change observed may be due to the period (*i.e.* second week of preseason, session the day before involving lower body exercise) used to perform this study as well the population involved. Consequently the magnitude of the changes observed may be due to important physiological perturbations and their inexperience regarding recovery practices [26]. As a result, the sensitivity results in the present study have to be considered with caution. Further research is required to cross validated this approach in other high-performance team sport environments and during an in-season macrocycle. Finally, regarding the method in itself, it could be argued that the threshold used in this study was set arbitrarily. Future research using bigger datasets may emply more advanced method of analysis (*e.g.* machine learning) in order to ascertain the most appropriate threshold to determine the constant velocity period.

Practical applications

- The present standardized running test it is a valid as well as reliable method to monitor player status.
- Performing a standardized running test during warm up is a viable and time efficient method to monitor neuromuscular fatigue in a high-performance environment.
- Practitioners should consider the RLI at constant velocity ($RLI_{cvel\text{-}vert}$ and $RLI_{cvel\text{-}full}$) period during the run due to its better sensitivity to fatigue compare the entire run and vertical based test.

Conclusions

The present study aimed to evaluate the usefulness of the RLI to improve the monitoring processes. Elite sport set ups make monitoring fatigue challenging and more practical solutions are required. This new variable could be used in practice due to its small to moderate typical error, large relationship with leg stiffness, and large sensitivity to fatigue. This research confirms the potential of microtechnology to optimize the monitoring of elite athletes in comparison to commonly used fatigue monitoring tests. Further studies are required to determine the aetiology of the changes observed in response to fatigue and to what extent these changes affect the different components of the running gait. Finally, as the use of accelerometer devices to monitor fatigue is a relatively new development, future studies could consider using microtechnology to assess other aspects of fatigue testing such as jump tests.

Acknowledgments

The authors do not have any conflict of interest. The authors would like to thank all the players and staff members for taking part in this study.

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Figures and Tables

Legend

Figure 1. Schematic representation of the study design. : Monitoring session; : strength session; : Rugby training; : 'Off-feet' (bike) fitness training

Figure 2. Convergent validity analysis. Linear relationship between leg stiffness and the different RLI with the dashed lines representing the 90% confidence intervals. Figure A: $RLI_{0\text{-}12\text{-}full}$. Figure B: $RLI_{cvel\text{-}full}$. Figure C: $RLI_{0\text{-}12\text{-}vert}$. Figure D: $RLI_{cvel\text{-}vert}$. Figure E: $RLI_{0\text{-}12\text{-}fwd}$. Figure F: $RLI_{cvel\text{-}fwd}$. Figure G: $RLI_{0\text{-}12\text{-}side}$. Figure H: $RLI_{cvel\text{-}side}$.

Figure 3. Sensitivity analysis. Black dots and bold dashed lines represent group change expressed as mean±SD over 1 week of training. Grey lines represent individual change. Figure A: $RLI_{0\text{-}12\text{-}full}$. Figure B: $RLI_{cvel\text{-}full}$. Figure C: $RLI_{0\text{-}12\text{-}vert}$. Figure D: $RLI_{cvel\text{-}vert}$. Figure E: $RLI_{0\text{-}12\text{-}fwd}$. Figure F: $RLI_{cvel\text{-}fwd}$. Figure G: $RLI_{0\text{-}12\text{-}side}$. Figure H: $RLI_{cvel\text{-}side}$. *: *Possibly* trivial; **: *Possibly* small; *** *Most likely* large; **** *Most likely* very large.

Table 1. Week to week reliability analysis for the different Running Load Index. TE: Typical Error; CV: Coefficient of Variation; SWC: Smallest Worthwhile Change.

Figure 1.

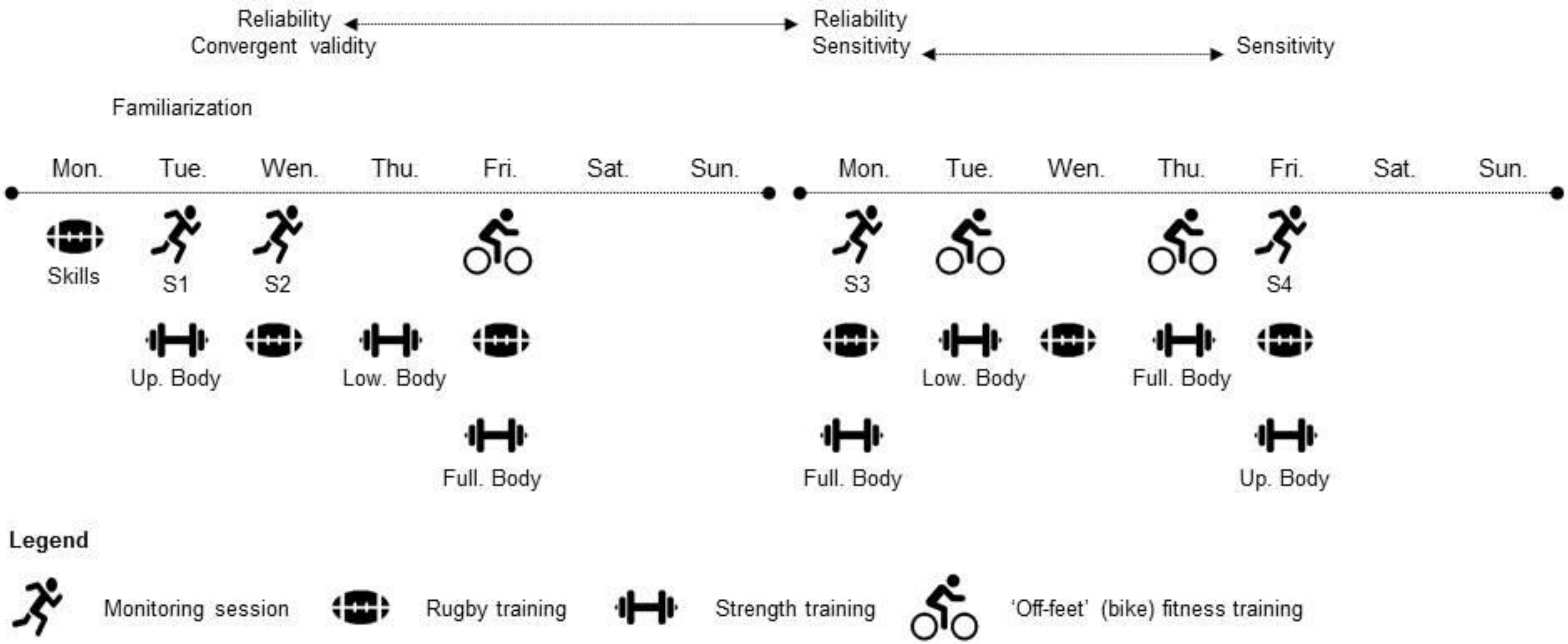
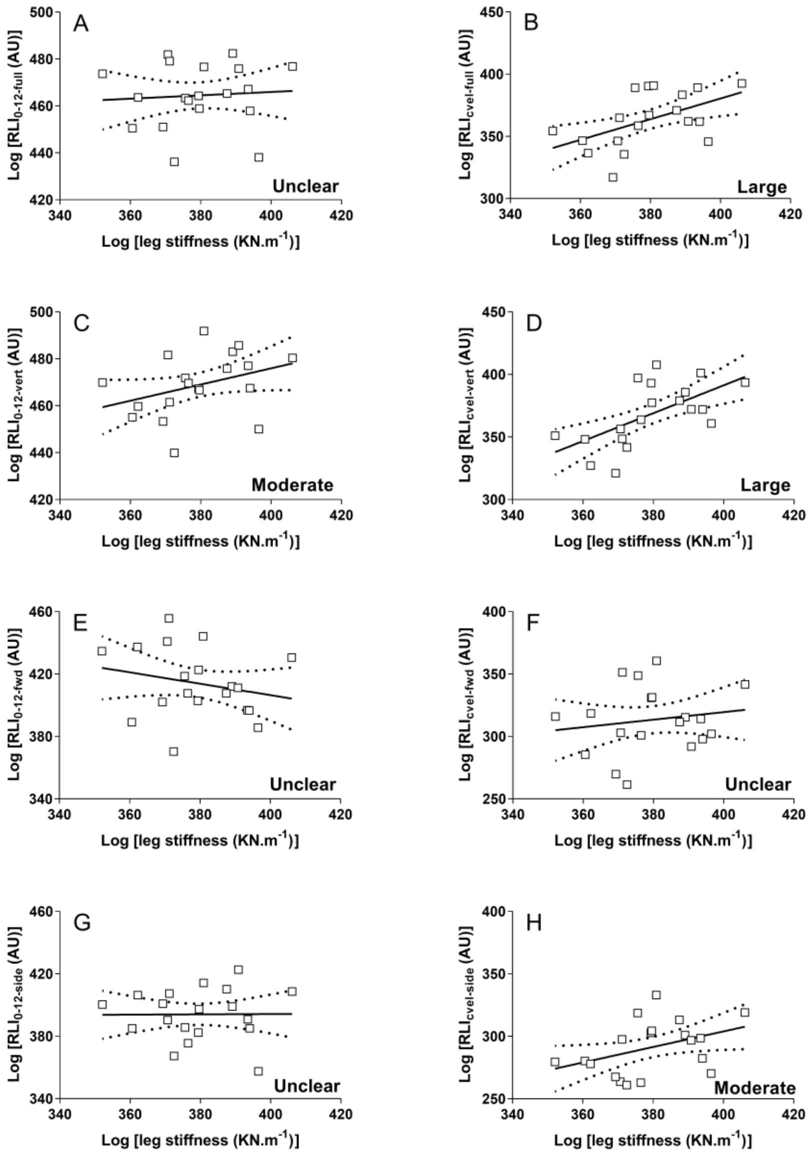
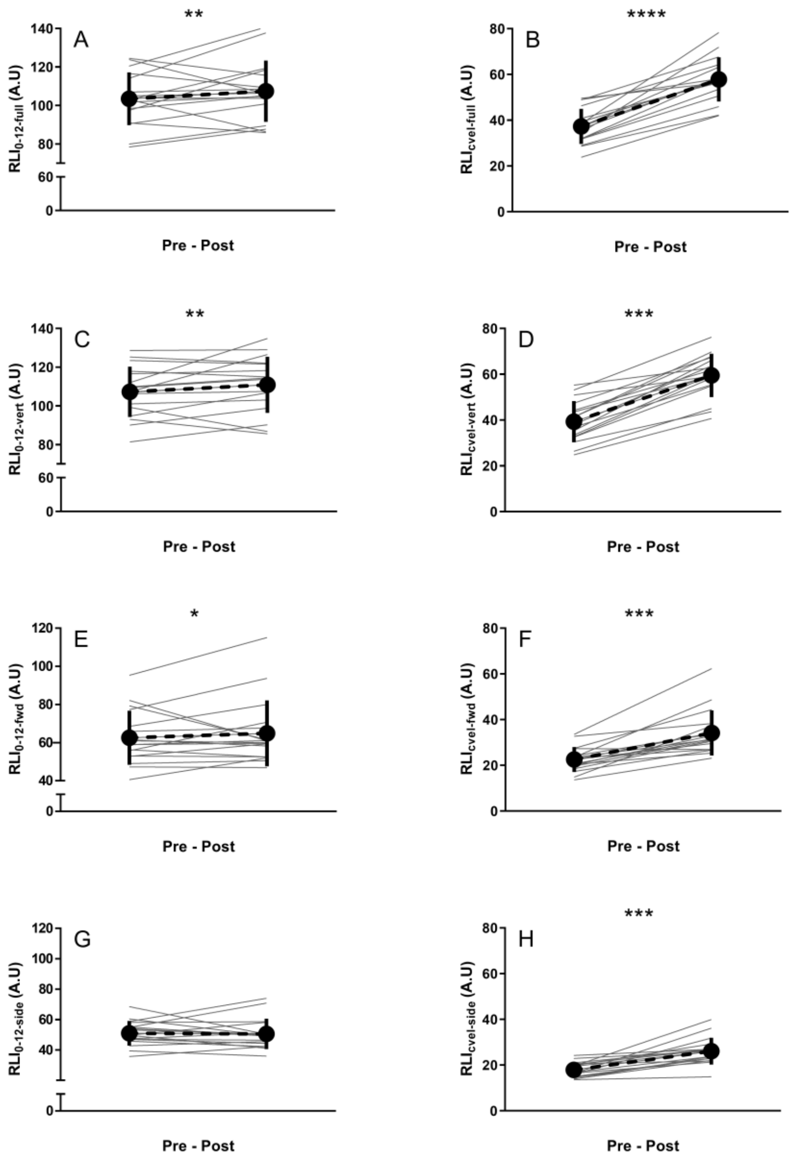

Reliability
Convergent validity
Reliability
Sensitivity
Sensitivity
Familiarization
Mon. Tue. Wen. Thu. Fri. Sat. Sun.
Mon. Tue. Wen. Thu. Fri. Sat. Sun.
Skills
S1
S2
S3
S4
Up. Body
Low. Body
Full. Body
Full. Body
Low. Body
Full. Body
Up. Body
Legend
Monitoring session
Rugby training
Strength training
'Off-feet' (bike) fitness training

Figure 2.



A
Log [RLI0-12-full (AU)]
Unclear
B
Log [RLIcvel-full (AU)]
Large
C
Log [RLI0-12-vert (AU)]
Moderate
D
Log [RLIcvel-vert (AU)]
Large
E
Log [RLI0-12-fwd (AU)]
Unclear
F
Log [RLIcvel-fwd (AU)]
Unclear
G
Log [RLI0-12-side (AU)]
Unclear
H
Log [RLIcvel-side (AU)]
Moderate
Log [leg stiffness (KN.m-1)]

Figure 3.



**
A
RLI0-12-full (A.U)
Pre - Post
****
B
RLIcvel-full (A.U)
Pre - Post
**
C
RLI0-12-vert (A.U)
Pre - Post
***
D
RLIcvel-vert (A.U)
Pre - Post
*
E
RLI0-12-fwd (A.U)
Pre - Post
***
F
RLIcvel-fwd (A.U)
Pre - Post
G
RLI0-12-side (A.U)
Pre - Post
***
H
RLIcvel-side (A.U)
Pre - Post

Table 1. Week to week reliability analysis for the different running load index.

	TE as CV% (90%CI)	Standardized TE (90%CI)	SWC (%)
$RLI_{0-12-full}$	8.8 (6.9-12.4)	0.86 (0.68-1.20)	2.6
$RLI_{0-12-vert}$	8.3 (6.5-11.7)	0.70 (0.55-0.97)	2.8
$RLI_{0-12-fwd}$	11.6 (9.1-16.4)	0.57 (0.45-0.79)	4.5
$RLI_{0-12-side}$	7.6 (6.0-10.7)	0.47 (0.37-0.65)	3.5
$RLI_{cvel-full}$	10.0 (7.8-14.1)	0.54 (0.42-0.74)	4.1
$RLI_{cvel-vert}$	11.5 (9.0-16.3)	0.53 (0.42-0.73)	4.8
$RLI_{cvel-fwd}$	13.4 (10.4-19.0)	0.57 (0.45-0.79)	5.2
$RLI_{cvel-side}$	13.0 (10.1-18.4)	0.73 (0.57-1.00)	4.2