No meaningful difference between absolute and relative speed thresholds when converted to a standard-ten score within a load monitoring system

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Headline

For monitoring and prescribing high-speed running, practitioners may use pre-defined (absolute) or individualised (relative) speed thresholds (1-3). Research has demonstrated clear differences in the total distance covered above a pre-defined threshold (high speed; HSD) using either absolute or relative thresholds (1), potentially due to individual physical capacities. However, typical load monitoring strategies convert these data to standardised scores when assessing changes in loads, which may mask the proposed benefit of individualising speed thresholds.

Aims

The purpose of this investigation was to establish whether differences exist between training load data (exponentially-weighted moving average; EWMA) calculated using either absolute or relative speed thresholds, following a typical standardisation process (standard ten; STEN) to assess changes in loads (4).

Methods

Athletes. This research included data from seventy-seven male professional athletes from two sports; rugby league (RL; n = 32) and Australian Football (AF; n = 45). The RL athletes (age; mean ± SD = 24 ± 4) competed in the National Rugby League (NRL) competition, where data was collected over an entire season, totaling 2800 observations. The AF athletes (age; 23 ± 4 yr) competed in the Australian Football League (AFL), with data collected across an entire pre-season period, totaling 1002 observations. Together, the dataset was comprised of 3802 observations, and was de-identified for research purposes. The study conformed to the recommendations of the Declaration of Helsinki.

Design

An observational research design was employed, where data were investigated retrospectively, as it was collected as part of routine athlete monitoring practices throughout the program. No interventions were necessary.

Protocol

External load. During all RL training sessions and matches, athletes were fitted with a global positioning system (GPS) device (SPI HPU, GPSports, Canberra, Australia), recording at a sampling rate of 5 Hz. Files were downloaded and trimmed using the appropriate proprietary software (Team AMS, GPSports, Canberra, Australia). Using customised software (R Studio, v 1.1.463), HSD (absolute and relative) were calculated. Specifically, absolute HSD was the volume covered >24.9 km·h^{-1} and relative HSD was the volume >80% of each athlete's maximum velocity. Maximum velocity was obtained via GPS, during either training or competition. When a new maximum velocity was obtained, this replaced the existing maximum velocity, and the sprint thresholds were adjusted accordingly. This relative speed threshold (80%) was selected, as data (un-published) in AF demonstrated that there was limited difference between absolute (>24.9 km·h^{-1}) and relative speed volumes (mean difference of 0.1 km·h^{-1}; 90% CL = -2.5 - 2.3). The AF athletes were similarly fitted with a GPS device (Optimeye S5, Catapult Innovations, Melbourne, Victoria, Australia), recording at a sampling rate of 10 Hz. Data were trimmed and cropped using the proprietary software (Openfield, Catapult Innovations, Melbourne, Victoria, Australia). Using the same methods as described above, absolute and relative thresholds were calculated. Although two different measurement systems were utilised, this was unavoidable due to the constraints of conducting applied research. Further, differences between STEN and raw volumes were calculated within-subjects, therefore this was deemed to have no effect of the outcomes of this study.

Data analysis. Each athlete's training load data were organised chronologically, including days of no training ('0' values were included). Using customised software (R Studio, v 1.1.463), exponentially-weighted moving averages (EWMA) were calculated for both absolute and relative speed volumes, using methods described previously (4). Specifically, EWMA were calculated using a seven-day time period, and were then standardised by converting to a Z-score, using the previous 28 days' data points. Finally, Z-scores were converted to STEN scores as follows (4):

$$STEN = (2Z) + 5.5$$

Statistical analysis. Linear mixed models examined differences between STEN scores calculated using either the absolute or relative thresholds, including only training days in the analyses. The model design included the STEN score as the outcome, the method (absolute or relative) as the fixed effect, and athlete identification as the random effect (5). Additionally, the effect of sport on the relationship between absolute and relative STEN scores was assessed using a linear mixed model. In this model, the difference between the absolute and relative STEN scores was the outcome measure, the sport was the fixed effect and athlete identification was the random effect. In both models, differences were described using

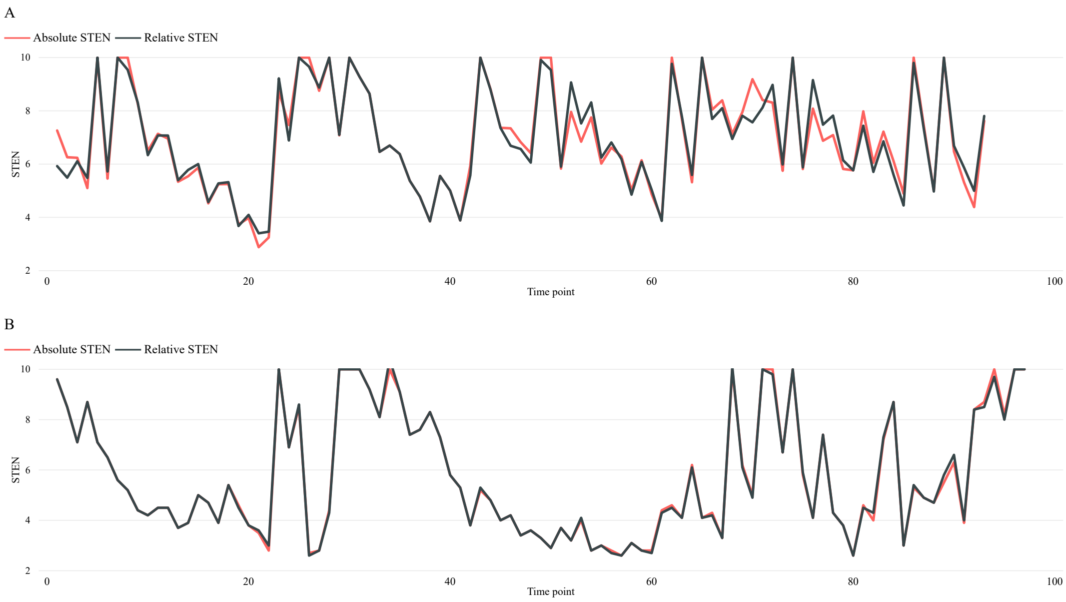

Fig. 1. The absolute and relative STEN scores across each time point for AFL (A) and rugby league (B).

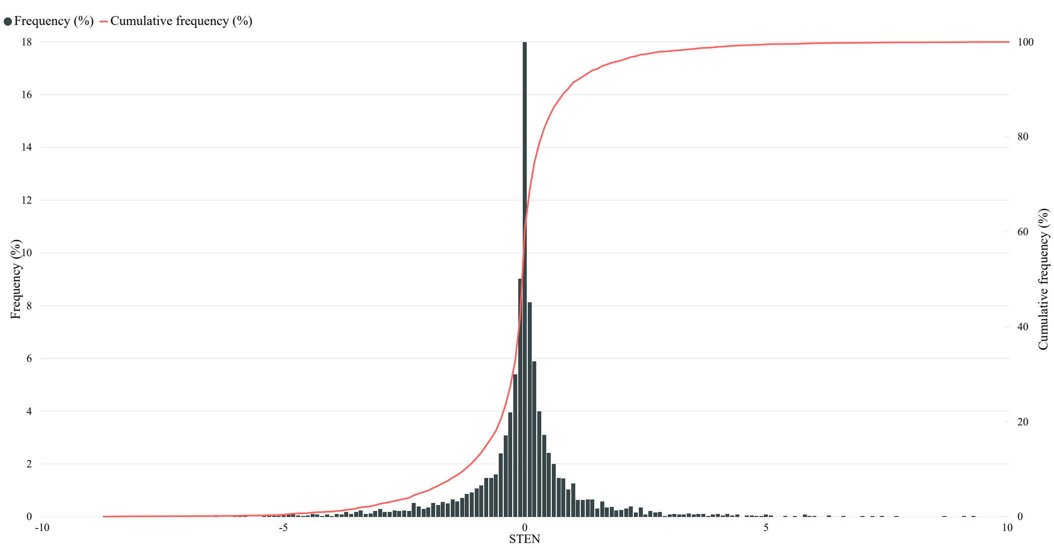

Fig. 2. The distribution (frequency and cumulative frequency [%]) of data points demonstrating difference between the absolute and relative STEN scores for both AFL and rugby league.

standardised effect sizes (ES) and 90% confidence limits (CL), categorised using the thresholds of; <0.2 trivial, 0.21 – 0.60 small, 0.61 – 1.20 moderate, 1.21 – 2.0 large and >2.0 very large (5). These were further interpreted using non-clinical magnitude-based inferences (6). Analyses were conducted using customised software (R Studio, v 1.1.463).

Results

Figure 1 demonstrates the absolute and relative STEN scores across the data collection period for AFL (A) and rugby league (B). Within AF, daily absolute HSD (91m ± 104 m) was likely greater than relative HSD (67m ± 87 m, ES; ±90% CL = 0.24; ±0.10). For RL, there were no substantial differences between daily absolute HSD (41m ± 72m) and relative HSD (49m ± 81m, ES; ±90% CL = -0.10; ±0.04). When considering the STEN scores, the mean daily STEN for AF for absolute HSD was 7.6 ± 2.7 and 7.6 ± 2.8 for relative HSD, corresponding to a mean difference of -0.1 ± 1.1 (ES; ±90% CL = 0.02; ±0.07). For RL, mean daily STEN for absolute HSD was 6.0 ± 2.6 and 6.1 ± 2.6 for relative HSD, corresponding to a mean difference of -0.1 ± 1.3 (ES; ±90% CL = -0.02; ±0.04). Irrespective of the sport, differences between the absolute and relative methods of calculating STEN scores were considered trivial (ES; ±90% CL = -0.02; ±0.04). Further, the effect of sport on the relationship between absolute and relative methods was also considered trivial (ES; ±90% CL = 0.01; ±0.07). For the difference between absolute and relative STEN scores, the frequency (%) and cumulative frequency (%) of data points is depicted in figure 2.

Discussion

This study investigated whether a variation exists between absolute (>24.9 km·h^{-1}) and relative (>80% maximum velocity) speed thresholds, including data from AF and RL when converted to a STEN score. Given the known discrepancy in volumes covered between absolute and relative thresholds within both AF and RL (1,2) and also demonstrated within this study, it was hypothesised that the corresponding STEN scores would also vary. In the present study, the EWMA method (4) was utilised, presented as STEN score reflecting the change in load by each individual. This permits a direct comparison between the absolute and relative STEN scores. Despite the variation in raw volumes between the absolute and relative speed thresholds, the difference between the corresponding STEN scores were deemed to be trivial. In addition, these trivial differences were consistent across both sports, indicating a similar efficacy of this method for standardising load. As such, expressing a change in load in standardised units (i.e. STEN scores) presents as an effective method, regardless of the variable being measured, given that the change is expressed on the same scale (4).

Typically, high-speed running volumes are prescribed in raw units, such as the distance covered above a pre-defined threshold. However, these data are commonly monitored by calculating cumulative volumes, followed by a within-individual approach (e.g. STEN score, percentage change etc.) (4), which are standardised against previous high-speed volumes. Regardless of the specific load monitoring method of determining what is a meaningful change in load, this concept is used to identify when an athletes load has changed substantially from what previously has been prepared for (4). This has important implications from a periodisation point of view, where load may be manipulated to achieve various outcomes, including the development of physical capacities, mitigating injury risk, and/or tapering for an event or competition (7). The findings of this study suggest that absolute and relative speed depict the same pattern of change (Figure 1 and 2), thus when part of a load monitoring system, may reflect the same result. As such, it seems that the method of determining this volume may not be as crucial as the chosen method of identifying changes and deviations in this workload over time. However, from a prescription point of view, practitioners may remain using raw volumes due to the simplicity of this method. Recently, there has been debate about the appropriateness of using absolute or relative high-speed thresholds for assessing running volumes within team sports (3,8,9). It may be that the use of relative thresholds have reasonable foundations from a physiological perspective and provide assistance in standardising workloads between players (1,9). However, the validity of any method for assessing such thresholds will inevitably decrease with time, and therefore regularly assessing physical capacities is required to ensure appropriate conclusions are drawn from the data. Alternatively, our findings may suggest that when an appropriate standardisation process is in place, the use of relative thresholds (in preference to their absolute counterpart) provides little additional information to the practitioner. Specifically, and regardless of sport, these findings indicate that absolute and relative speed have similar patterns of change, thus when part of a load monitoring system, may reflect the same result. This suggests that practitioners may not need to monitor both in tangent, potentially simplifying the monitoring system.

Practical Applications

- The limited difference between absolute and relative speed volumes when converted to a standardised measure suggest that using both determinants of speed may not be necessary, and an absolute measure is similarly as effective when assessing changes in load.

Limitations

- A limitation of this study is that two different GPS systems were utilised across the different sports.
- The AFL dataset was comprised of one pre-season, whereas rugby league was across an entire season.

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