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EDITORIAL

Standardizing the Quantification of External Load Across Different Training Modalities: A Critical Need in Sport-Science Research

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The debate around training-load management has been and will continue to be one of the most divisive topics in sport science.[1] More specifically, quantifying external training load is crucial for sport and exercise science research and optimizing sport performance, yet standardization across different training modalities remains a challenge.[1–3] In comparing the effects of different modalities of training, it is important to assess whether the amount of work (or training load) is comparable across the different interventions. Thus, the interest is in whether the training outcome results from the exercise modality per se rather than from a substantial difference in the amount of exposure to exercise. However, equating training loads across different training modalities and exercise modes within these modalities constitutes a major challenge, as highlighted by recent research on endurance exercise.[4,5]

While the importance of quantifying training load is well established, the methods used vary substantially across different training modalities, making comparisons difficult.[2,6] To illustrate our point, we refer to training programs pertaining to 3 fundamental fitness components: aerobic endurance, strength, and sprint training.[2,7] Currently, distinct measures are employed for quantifying external training load for each training modality. Table 1 illustrates the variety of methods of quantifying training load across these modalities, highlighting the challenge of standardizing load measurements. This creates a significant barrier, potentially confounding research outcomes and limiting our ability to make meaningful comparisons.[1–3]

While various methods exist for quantifying training load, the session rating of perceived exertion (sRPE) has shown promise in providing a unified approach across different training modalities.[3,6,8] The primary challenge lies in balancing the workload across different training modalities while accounting for the unique physiological stresses each modality imposes, as well as individual athlete factors.[2,3,5] Yet, absence of a unified, validated metric for quantifying external training load across various modalities impedes rigorous comparative studies, potentially leading to misinterpretation of outcomes. Although a unified metric may be unattainable due to the distinct stress each training modality places on various physiological systems, we should aim at developing a multidimensional approach that captures each modality's unique components.

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To address this critical gap in sport-science methodology, we suggest a 2-step approach: first, to investigate the utility of a global multicomponent metric, and, second, to establish conversion relationships. This approach should account for the unique characteristics of each training modality while considering individual factors such as training status and athlete type, providing a framework for comparison.[9] While perfect equivalence may not be achievable, developing more accurate conversion methods and standardized reporting practices would significantly advance our understanding of training-load management across training modalities.[2,10]

We propose 3 potential solutions here. First, the sRPE method, which has been widely validated across various sports and training modalities, could be used for quantifying and equalizing training load.[6,8] This method combines the duration of the training session with the athlete's perceived exertion, providing a comprehensive measure of internal training load.[11]

A second solution would be to standardize load components across modalities using an analogy approach with 3 primary determinants:

Volume: Convert various volume indices to "time under tension" (strength training) or "time under activity" (endurance and sprint training), while acknowledging the inherent differences in sustainable durations across exercise modes.[4,5] More particularly, in endurance and sprint training, time under activity (s) × repetitions (n) × sets (n) may be considered, while for strength training, time under tension (s) × repetitions (n) × sets (n) could be employed.[2,12]

Intensity: While maintaining analogous intensity indices for each fitness component (eg, percentage of heart-rate reserve for endurance, percentage of 1-repetition maximum for strength, and percentage of maximum speed for sprint) could provide a starting point, it is crucial to recognize that equivalent percentages across modalities may not result in comparable physiological stress or recovery demands.[10,11] Research should focus on exploring whether "theoretical analogous intensity indices" have the same energetic cost and internal training-load effects.

Frequency: This parameter is readily controllable and can be standardized across modalities.

A third solution for load standardization is to quantify energy expenditure across training modalities, but it is important to recognize its limitations. Indeed, for endurance athletes, the ability to sustain higher training volumes at lower intensities is a key training principle, and matching energy expenditure across modalities may not accurately reflect the intended training stimulus.[4,13] It

Table 1 Comparative Analysis of Training-Load Quantification Methods Across Different Training Modalities

Training modality	Volume	Intensity	Frequency
Endurance training[2,9]	Total time under activity (s) = time per interval (s) × repetitions (n) × sets (n) or Total distance (s) = distance per interval (m) × repetitions (n) × sets (n)	$\%HR_{max}$ (beats·min^{-1}) or $\%HR_{reserve}$ (beats·min^{-1}) or $\%\dot{V}O_2max$ (mL·kg^{-1}·min^{-1}) or MAS (m·s^{-1}) or Running pace (min·km^{-1})	Sessions (n) per week
Strength training[12,16]	Total load (kg) = load per repetition (kg) × repetitions (n) × sets (n) or Time under tension (s) = tempo of movement (eccentric (s)/isometric (s)/ concentric (s)/isometric (s) phase of each repetition) × repetitions (n) × sets (n)	%1RM (kg) or *x*RM (kg)	Sessions (n) per week
Sprint training[10]	Total distance (m) = distance per interval (m) × repetitions (n) × sets (n) or Total time under activity (s) = time per interval (s) × repetitions (n) × sets (n)	Percentage of maximum speed (m·s^{-1}) or Sprinting pace (min·km^{-1})	Sessions (n) per week

Abbreviations: 1RM, 1-repetition maximum; HR_{max}, maximum heart rate; $HR_{reserve}$, heart-rate reserve; MAS, maximal aerobic speed; Math input error, maximal oxygen consumption; *x*RM, load in *x* maximum repetitions number.

is important to note that while standardizing load across different training modalities is crucial for research purposes, in practical settings, the specific demands of each sport and athlete should primarily guide the prescription of training load.[2,10] Mechanical energy cost, relevant for strength and speed training, could be quantified using force plates, accelerometers, and linear position transducers.[14] By converting energy expenditure across modalities using metabolic equivalents of task (METs),[13] training loads could be standardized and the validity of analogy-based training methods investigated.[15]

Development of a comprehensive framework for quantifying external training load across modalities constitutes a significant challenge. The training modalities are designed to provide distinct stimuli stressing selected physiological systems differently, even though these various training modalities are often complementary to each other to reach a final outcome.[11] Therefore, we urge researchers to collaborate in addressing this critical methodological opportunity.[1] While a single universal load metric may not be achievable, efforts should focus on developing a more comprehensive understanding of the different components of load specific to each modality. This approach involves creating frameworks that account for the unique characteristics of each training type and individual athlete factor.[2,4,5] By improving our understanding of load quantification across training modalities, we could enhance the rigor of comparative studies, improve the quality of training prescription, and ultimately advance our knowledge of dose–response relationships in various training approaches.[2,3]

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