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Research Article

The eTRIMP method for bodybuilding training load assessment: A review with a case study

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Summary

Objective: The objective of this study is to know if the method of calculating full training load session eTRIMP using pulse monitors would be able to demonstrate a monotony like the total internal load model through the session-RPE using workload method in a resistance athlete.

Methods: This is a one-week observational study that evaluated time, heart rate, and session RPE in a 32-year-old adult during prescribed resistance training to compare Internal Training Load (ITL) using the eTRIMP method with traditional assessment methods that use session RPE multiplied by training session duration, known as session workload calculation.

Results: The total load for the week varied between models due to the method of obtaining the result being different, 417 au for the weekly summation based on eTRIMP versus 3321 au using the workload method. However, the monotony of the weekly training prescription was similar, observationally evaluated, between the groups (2.4 for the workload method versus 2.9 for the eTRIMP method).

Conclusion: The internal load evaluated by the eTRIMP model seems to show a monotony value like the value calculated by the weekly load using session-RPE and workload. Therefore, evaluating resistance training using the eTRIMP by pulse monitoring model seems to be a useful tool in analyzing training week monotony to maintain high loads favoring the hypertrophy and fat-burning process.

Introduction

Quantifying load is an essential part of the athletes' training-monitoring process. The External Training Loads (ETL) are the distance a cyclist can cover, the time a runner intends to improve, and the number of kilos a resistance athlete can lift, already the Internal Training Load (ITL) depends on the measures of metabolic, cardiovascular, and respiratory, that can be applied to quantify the reaction of the athlete's body to a given external load. Even knowing that the ITL assessments are not practices commonly used to evaluate the training load of resistance athletes and not knowing what are the best methods for describing this response, the monitoring of internal training load is used to evaluate training effects under each athlete during each training periodization [1]. This way, two simple tools to assess an athlete's internal training load are well known; heart rate, using pulse monitors or heart straps, and self-reports of the Rate of Perceived Exertion (RPE), perception reported by the athlete about the intensity of the training session [2].

To quantify the Internal Load of Training (ITL) through heart rate, it was proposed the method termed Training Impulse (TRIMP), which integrates training duration and Heart Rate (HR) for the final load result [3]. The Training Impulse (TRIMP) can be used to measure Internal Training Load (ITL) and is obtained through wearable technology, such as pulse monitors [4]. Thus, the formula that integrates just training time within

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each heart rate zone through simple mathematical formula was proposed by Edward in 1993 and posteriorly abbreviated to eTRIMP [5] which the ITL result is determined by measuring a product of the accumulated training duration in minutes of 5 HR zones by a coefficient related to each zone (50% to 60% of HRmax x 1; 60% to 70% of HRmax x 2; 70% to 80% of HRmax x 3; 80% to 90% of HRmax x 4; and 90% -100% of HRmax x 5). The result is obtained in Arbitrary Units (AU), the unit that determines the total quantification of the internal load by this method. It is interesting to comment that bodybuilding uses periodization of training using muscle groups, often distinct, and the interaction of internal training load assessed by heart rate and session-RPE tends to be linear [6].

The eTRIMP method is a model that has a relationship moderate to large between measures of training load and percentage change in mean power output [7] and it can be measured through pulse monitors, which has been proven common to the public and scientifically validated as having good heart rate accuracy to validate time measurements in each heart rate zone [8]. Therefore, it seems interesting and at the same time easy to use this methodology to determine the internal load of the resistance training session, because the use of wrist devices to assess heart rate is common and scientifically validated as having good heart rate accuracy.

Another easy-to-use measure would be the session RPE (session rate of perceived exertion) appears to be the most commonly used ITL tool among resistance athletes [9]. Generally, these athletes use a modified version of Borg's CR-10 subjective perceived exertion scale, referred to as the RPE of the session and obtained after the training session based on the question like "How hard was your workout?" and, from that, the training load (workload) for the session is then quantified by multiplying the RPE by the duration of the session in minutes [7]. The training load commonly used by physiologists to evaluate the total load of the training session consists of multiplying the session-RPE by the duration to obtain a value in Arbitrary Units (AU), known as "workload" [10], being this, an interesting and at same time easy to use to determine the internal load of resistance training session, because for the Borg scale be used there is no extra cost or equipment to carry out the evaluation of the training session, only the athlete's self-report [11].

On the other hand, resistance athletes tend to create training routines with variability between muscle groups divided into upper and lower body always seeking to reach high-intensity training [12], which is why we can say that workouts have low variability between loads. Based on the prescribed weeks of training and its respective loads, monotony is calculated to reflect the oscillation of the weekly loads, this variable can be calculated by dividing the average of the sum of the week's loads by its standard deviation [13], where values above 2 Arbitrary Units (AU) are considered a reflection of little fluctuation in training loads, what it shows repeatedly raised loads.

As resistance athletes tend to maintain their training with high loads for several reasons, including the use of different muscle groups in the following training sessions, enhancement of muscular hypertrophy, and increase or maintenance of body fat burning, may become interesting to obey a monotony above 2 AU to evaluate whether the week's internal training load was high. Therefore, the objective of this study is to know if the method of calculating full training load session eTRIMP using pulse monitors would be able to demonstrate a monotony like the total internal load model through the session-RPE using workload method in a resistance athlete. This way, this work may offer athletes, coaches, and practitioners, a training model with simple evaluation by pulse monitor, something that, until the present moment was able to show.

Methods

The author used the PubMed database to structure his bibliographic research. In this way, the author used the keyword "eTRIMP" in the database and found 4 results, 3 of which specifically cited the method proposed by Edwards [14-16]. However, when the author used the keyword "TRIMP", 61 results were exposed and only 12 articles met the inclusion criteria. The inclusion criteria were subjectively evaluated by the researcher and should include a methodology that addressed the calculation of athletes' internal load using the TRIMP method or specifically using the eTRIMP method. If the articles did not directly address eTRIMP or some other TRIMP proposed by the bibliographic references to find calculations of internal load for training or competitions in arbitrary units, they would not be passed on to subsequent analyses. The case study is a one-week observational study that evaluated time, heart rate, and session-RPE in a 32-year-old adult during prescribed resistance training to compare week Internal Training Load (ITL) using the eTRIMP method with session RPE multiplied by training session duration, known as session "workload" calculation and the monotony calculation. The research was approved by the Local Research Ethics Committee (process 04463980-5) in accordance with the Helsinki Declaration and all participants signed an informed consent form. The article in question does not present any pre-established statistical calculation model, only interpretations and mathematical calculations of the various ones evaluated.

Training sessions, heart rate and session-RPE assessment

At the gym, the division of muscle groups required by physical education teacher in training was as follows: Monday was chest and shoulder training; Tuesday was biceps, triceps, and calf; Wednesday was legs (hind and fore legs); Thursday was back and calf; on Friday, only a low-intensity treadmill walk training session was carried out; on Saturday another chest and shoulder workout and on Sunday another biceps, triceps, and calf workout. The series and repetitions were required for high-volume training and the loads were between 70% and 80% of the 1RM (one maximum repetition) reported by the participant. A pulse monitor Galaxy Watch 4 (GW4; Samsung®) was used to measure time and heart rate sessions. The CR-10 Borg scale was used to evaluate participant effort perceived using numbers from 0 to 10 to represent the range of subjective feelings, from 'nothing at all' to 'extremely strong' after all training sessions [14].

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Body composition, energy expenditure and dietary intake

An anthropometric assessment was carried out where the weight was collected using an InBody® 120 scale, height was measured using an MD-2M-Center Medical ® stadiometer. The skinfolds were measured using a Sanny® AD1011-LDC adipometer using the 4-fold protocol (Petroski), thus, the folds required by the protocol were collected and placed in the formula [006Dale subjects=1.10726863−0.00081201(subscapularis+triceps+suprailiac+medial calf)+0.00000212 (subscapularis+triceps+suprailiac+medial calf)−0.00041761 (age in years); and also was measured the wrist and femur bone diameters with the AVA Nutri® bone caliper and was calculated using the Von Döbeln equation [(bone weight=height^2 × wrist diameter × femur diameter × 400) 0.712 × 3.02] [15]. Energy expenditure was measured using indirect calorimetry performed with the HandyMET FIT device (Industrial, MDI) and the eating plan was calculated using the Diet Box® software.

Results

To descriptive data on the participants were as follows: age (years) 32; height (cm) 184; weight (kg) 90; BF (body fat in %) 9; muscle mass (kg) 48.26 (kg); bone mass (kg) 11.95; fat mass (kg) 8.1; fat-free mass (kg) 81.9; and BMI (kg/cm2) 26.58. All results are shown in Table 1. For better control of the study analyses, the result of the dietary prescription, including all foods prescribed in the dietary plan that were consumed by the participant, is shown in Table 2.

Using the "athlete" function to characterize physical activity in the calorimetry equipment, 2458 kcal.d^{-1} of Basal Metabolic Rate (BMR) and 5408 kcal.d^{-1} of total energy expenditure was obtained. Therefore, the participant was placed in a moderate calorie deficit receiving a diet of 3347 kcal.d^{-1}, being 346 g.d^{-1} from proteins, 265 g.d^{-1} from carbohydrates and 99 g.d^{-1} from fats. The adjustment of macronutrients was stipulated as follows: proteins at 3.8 g. kg^{-1}.d^{-1} (41.5%); carbohydrates at 2.92 g. kg^{-1}.d^{-1} (31.9 %) and fats at 1.09 g. kg^{-1}.d^{-1} (26.7 %). The complete prescription of the participant's diet is shown in Table 3.

The results of the training evaluations following the eTRIMP method, the session evaluations, RPE, and the workload calculation obtaining its monotony are shown in Table 3. The total load for the week varied between models due to the method of obtaining the result being different, 417 au for the weekly summation based on eTRIMP versus 3321 au using the workload method. However, the monotony of the weekly training prescription was similar, observationally evaluated, between the groups (2.4 for the workload method versus 2.9 for the eTRIMP method). The calculation formula was the same as that used but for different parameters, therefore, the monotony was obtained by the weekly load mean multiplied by the standard deviation.

The findings about 12 articles that met the author's inclusion criteria may make the individuals understand ITL calculation by pulse monitors. As the devices display the zone in real time on the display itself, there is a display of the individual's heartbeat level at that period of training or competition. And with that greater efforts to adjust rest time and the volume of training sets and repetitions, can be necessary to optimize the internal training load amount. Knowing that is interesting to avoid more than 10% of the time in the five zones (> 90% maximum HR) due to injury risk. On the other hand, longer time rates in low-intensity zones (< 50% maximum HR) may demonstrate a low internal training load. Therefore, the assessment of bodybuilding internal training load (ITL) using the eTRIMP method may be used by athletes, non-athletes, and coaches, to assess training loads based on comparison to past and future training loads. In Table 4, the author provides recommendations for athletes, non-athletes, and coaches, on how to understand the optimal measurement of bodybuilding internal training load by the eTRIMP method.

Table 1: Body composition assessment results.

Age	32 years
Height	184 cm
Weight	90 kg
BF (%)	9 %
Muscle mass	48.26 kg
Bone mass	11.95 kg
Fat mass	8.10 kg
Fat-free mass	81.90 kg
BMI	26.58 kg/cm^2

Abbreviations: BMI: Body Mass Index; BF: Body Fat.

Table 2: Food composition prescribed dietary intake.

Breakfast	Cooked rice (2 serving spoons or 100g) Chicken breast, cooked or grilled (100g) Boiled or scrambled chicken egg (7 Units)
Snack	Whole milk powder (2 tablespoons/20g) Oat flour (2 heaped tablespoons - 40g) Whey Protein Concentrate (60g) Banana (1 Unit)
Lunch	French bread (1 Unit) Beef, braised or cooked, ground or not (50g) Coalho cheese (1 Slice or 20g) Protein milk drink (1 Unit of 200ml)
First-afternoon snack	Whole milk powder (2 tablespoons/20g) Oat flour (2 heaped tablespoons - 40g) Whey Protein Concentrate (60g)
Second-afternoon snack	French bread (1 Unit) Beef, braised or cooked, ground or not (50g) Coalho cheese (1 Slice or 20g) Protein milk drink (1 Unit of 200ml)
Dinner	Whole milk powder (2 tablespoons/20g) Oat flour (2 heaped tablespoons - 40g) Whey Protein Concentrate (60g)

Discussion

Another work managed to evaluate the eTRIMP method to quantify the internal training load of resistance athletes [3] including another study on the effectiveness of this method in relation to its accuracy in evaluating the internal load of high-performance athletes, which was evaluated [7] and had as a statistical result a moderate to large relationship between

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Table 3: Parameters evaluated for each training routine.

	Muscular group activity	Duration (t)	Session-RPE	eTRIMP	Workload (t*RPE)
Monday	Chest and shoulder	01:11:13	8	94.6 au	568 au
Tuesday	Biceps, triceps, and calf	01:02:18	7	73.1 au	434 au
Wednesday	Legs (hind and fore legs)	01:15:33	10	120.3 au	750 au
Thursday	Back and calf	01:00:05	8	83.4 au	480 au
Friday	Treadmill walks	00:42:40	3	42 au	126 au
Saturday	Chest and shoulder	01:01:40	9	101.4 au	549 au
Sunday	Biceps, triceps, and calf	00:46:10	9	76.2 au	414 au
	Based on traditional workload		**Based on only eTRIMP**		
Weekly load	3321 au		417 au		
Weekly load SD	190 au		29 au		
Weekly load mean	474 au		83 au		
Monotony	2.4 au		2,9 au		

Abbreviations: RPE: Rate Of Perceived Exertion; eTRIMP: edward's Training Impulse; AU: Arbitrary Units.

Table 4: Recommendations for understanding the optimal measurement of bodybuilding internal training load by eTRIMP method for athletes, non-athletes, and coaches.

Zone 1	Zone 2, 3 and 4	Zone 5
Must contain a lower rate of training time (< 50% of total time).	They must comprise the remaining portion of the time (40% of the time).	Must contain less than 10% of the total training time.
Training above 50% may not be effective in increasing performance or muscle hypertrophy.	For greater internal loads, a greater rate of time in zones 3 and 4.	Training above 10% can lead to a risk of injury, increased fatigue, and overtraining.
Increased by high rest time between sets, few loads, and/or repetitions.	Interesting time range for adequate intensities and optimization of muscle hypertrophy.	Hardly achieved in bodybuilding training.

training load measurements and percentage variation in average power production. This would already demonstrate that the eTRIMP method would be able to provide an interesting assessment of the internal load assessment of the training session, even without using session-RPE.

Because it is created with a formula that involves only the use of addition and subtraction, requiring only the time within each heart rate zone for data weighting, the eTRIMP method appears to be ideal for athletes and sports practitioners who wish to visualize their internal training loads by heart rate zone frequency using just your own pulse monitor. However, the practice of calculating internal training load is not yet commonly used among athletes and sports practitioners in general [16] but the use of pulse monitors seems to be common among them and something that can help them to carry out an assessment of the internal load of a given training session [17], using a simple mathematical calculation as long as it is stimulated. Besides that, the eTRIMP method seemed to include the analysis of parameters that can guarantee that the training week followed a high monotony (> 2 au) [13], which predicts high internal training loads, as previously demonstrated.

Research has demonstrated that eTRIMP is an ITL assessment model that can be used to compare internal load into training and competitions [18], evaluating the results through Arbitrary Units (AU) and offering analysis parameters of what was accomplished at the event. The eTRIMP use also was demonstrated in the comparison of maximal oxygen consumption to athletes [19]. Besides that, the eTRIMP has been used to compare the training characteristics of junior and professional athletes divided into age-related categories [20]. A prospective cohort study of the dose-response relationship between training load and anaerobic performance in female athletes suggested a curvilinear relationship between the variance in changes of peak power output to the eTRIMP method during a competition [21]. Demonstrating that this method is capable of evaluating internal loads at different intensities, correlating different levels of capacity between individuals, comparing the internal training load of athletes of different age groups, and suggesting curvilinear changes in peak power output in female athletes. Therefore, eTRIMP it is seeming a method of evaluating internal training load that can be applied in various ways in various sports, provided wearable technology is used, such as pulse monitors for example. Thus, the coaches should aim to integrate these individualized measures of training load into their daily practices to better inform daily and weekly loading paradigms and associations with fitness improvements [22].

Strong correlations have been detected, especially between parameters of total activity volume and internal load parameters HR-indices and RPE or session-RPE [17], into endurance and resistance athletes, showing that changes in HR registered during intermittent or gradually increasing load conditions could be evaluated using the TRIMP method for both types of activities based on the total training time, obtaining the time in each heart rate zone. This way, a recent article brought a discussion on training zones in internal load analysis in athletes, where a significant interaction was observed in the relationship between training load and training intensity distribution for the eTRIMP model [23]. Therefore,

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in a mathematical way, the time in each zone as proposed by the eTRIMP method can determine the total ITL in UA of the training. From this number it can be assessed: i) whether the load of this training was low, moderate, or high; ii) if the load of this training was greater or lesser than the load of the last training.

Practically speaking, if a bodybuilding athlete performs biceps and triceps training in 60 minutes, with 40 minutes in zone 1 and 20 minutes in zone 2, there is a load of 80 UA by the eTRIMP method (40x1 + 20x2). However, if this same individual performs the same model training in the next week but their result is 50 minutes in zone 1 and 10 minutes in zone 2, there is a load of 70 UA (50x1 + 10x2), the training had less internal load by eTRIMP method. Although a longer time in larger HR zones can be decisive for increasing the total internal training load, training more than 10% above 90% maximum HR can lead to a risk of injury, increased fatigue, and overtraining [24]. These findings may make the individual make greater efforts to adjust rest time and the volume of training sets and repetitions, besides avoiding passing more time in the highest zones (> 90% maximum HR) to evite harm recovery from training. On the other hand, longer time rates in low-intensity zones (< 50% maximum HR) may demonstrate a low internal training load.

Thus, eTRIMP seems like a method of evaluating internal training load that can be applied in various ways in various sports, provided wearable technology is used, such as pulse monitors for example. Thus, the coaches should aim to integrate these individualized measures of training load into their daily practices to better inform daily and weekly loading paradigms and associations with fitness improvements [22]. In summary, the eTRIMP use in resistance athletes may be used, since coaches could apply this method in the training week of their athletes to calculate the internal load of each training and periodize the loads during the week. The limitations of the study in question are a sample from a single participant and the use of only one heart rate measuring device. However, the present study brings an innovative discussion to the internal load assessment scenario that has not been explored to date, bringing to light a new question for endurance athletes, bodybuilders, or high-intensity functional training practitioners, who will train using their pulse monitors: “The eTRIMP method, due to its easy execution and simple applicability, could be included in criteria for internal load analysis of the training week?” and “Would can be a calculate the weekly internal load by eTRIMP method to validate training with high internal loads?” It would be interesting if future studies with larger and better-designed samples came to answer these and other subsequent questions on this subject.

Conclusion

In summary, the internal load evaluated by the eTRIMP model seems to show a monotony value like the value calculated by the weekly load using session-RPE and workload. Therefore, evaluating resistance training using the eTRIMP by pulse monitoring model seems to be a useful tool in analyzing training week monotony to maintain high loads favoring the hypertrophy and fat-burning process. However, larger research with relevant samples and in-depth statistical calculations are necessary to better elucidate this subject.

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References

1. Borresen J, Lambert MI. The quantification of training load, the training response and the effect on performance. Sports Med. 2009;39(9):779-95. doi: 10.2165/11317780-000000000-00000. PMID: 19691366.

2. Uchida MC, Teixeira LF, Godoi VJ, Marchetti PH, Conte M, Coutts AJ, Bacurau RF. Does the Timing of Measurement Alter Session-RPE in Boxers? J Sports Sci Med. 2014 Jan 20;13(1):59-65. PMID: 24570606; PMCID: PMC3918568.

3. Lupo C, Capranica L, Tessitore A. The validity of the session-RPE method for quantifying training load in water polo. Int J Sports Physiol Perform. 2014 Jul;9(4):656-60. doi: 10.1123/ijspp.2013-0297. Epub 2013 Nov 13. PMID: 24231176.

4. Gardner C, Navalta JW, Carrier B, Aguilar C, Perdomo Rodriguez J. Training Impulse and Its Impact on Load Management in Collegiate and Professional Soccer Players. Technologies. 2023;11(3).

5. Edward S. High-performance training and racing. In: The Heart Rate Monitor Book, editor. Feet Fleet Press. 8th. Sacramento, CA, USA; 1993.

6. Pind R, Hofmann P, Mäestu E, Vahtra E, Purge P, Mäestu J. Increases in RPE Rating Predict Fatigue Accumulation Without Changes in Heart Rate Zone Distribution After 4-Week Low-Intensity High-Volume Training Period in High-Level Rowers. Front Physiol. 2021 Sep 16;12:735565. doi: 10.3389/fphys.2021.735565. Erratum in: Front Physiol. 2022 Jan 31;13:834667. PMID: 34603086; PMCID: PMC8481779.

7. Silva P, Lott R, Wickrama K a S, Mota J, Welk G. Methods of Monitoring Training Load and Their Relationships to Changes in Fitness and Performance in Competitive Road Cyclists. Int J Sports Physiol Perform. 2017;12(5):668–75.

8. Kim C, Song JH, Kim SH. Validation of Wearable Digital Devices for Heart Rate Measurement During Exercise Test in Patients With Coronary Artery Disease. Ann Rehabil Med. 2023 Aug;47(4):261-271. doi: 10.5535/arm.23019. Epub 2023 Aug 4. PMID: 37536665; PMCID: PMC10475817.

9. Jurasz M, Boraczyński M, Wójcik Z, Gronek P. Neuromuscular Fatigue Responses of Endurance- and Strength-Trained Athletes during Incremental Cycling Exercise. Int J Environ Res Public Health. 2022 Jul 21;19(14):8839. doi: 10.3390/ijerph19148839. PMID: 35886690; PMCID: PMC9319915.

10. de Dios-Álvarez V, Suárez-Iglesias D, Bouzas-Rico S, Alkain P, González-Conde A, Ayán-Pérez C. Relationships between RPE-derived internal training load parameters and GPS-based external training load variables in elite young soccer players. Res Sports Med. 2023 Jan-Feb;31(1):58-73. doi: 10.1080/15438627.2021.1937165. Epub 2021 Jun 14. PMID: 34121539.

11. Larsen S, Kristiansen E, van den Tillaar R. Effects of subjective and objective autoregulation methods for intensity and volume on enhancing maximal strength during resistance-training interventions: A systematic review. Int J Sports Physiol Perform. 2017;9.

12. Chappell AJ, Simper T, Barker ME. Nutritional strategies of high level natural bodybuilders during competition preparation. J Int Soc Sports Nutr. 2018 Jan 15;15:4. doi: 10.1186/s12970-018-0209-z. PMID: 29371857; PMCID: PMC5769537.

13. Foster C, Rodriguez-Marroyo JA, De Koning JJ. Effects of subjective and objective autoregulation methods for intensity and volume on enhancing

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maximal strength during resistance-training interventions: a systematic review. Int J Sports Physiol Perform. 2017;12(2):24. https://doi.org/10.1123/ijspp.2016-0388

14. Zhao H, Seo D, Okada J. Validity of using perceived exertion to assess muscle fatigue during back squat exercise. BMC Sports Sci Med Rehabil. 2023;15(1):1–11. https://doi.org/10.1186/s13102-023-00620-8

15. Ginszt M, Saito M, Zięba E, Majcher P, Kikuchi N. Body Composition, Anthropometric Parameters, and Strength-Endurance Characteristics of Sport Climbers: A Systematic Review. J Strength Cond Res. 2023 Jun 1;37(6):1339-1348. doi: 10.1519/JSC.0000000000004464. Epub 2023 Mar 17. PMID: 36930882; PMCID: PMC10212580.

16. Dudley C, Johnston R, Jones B, Till K, Westbrook H, Weakley J. Methods of Monitoring Internal and External Loads and Their Relationships with Physical Qualities, Injury, or Illness in Adolescent Athletes: A Systematic Review and Best-Evidence Synthesis. Sports Med. 2023 Aug;53(8):1559-1593. doi: 10.1007/s40279-023-01844-x. Epub 2023 Apr 18. PMID: 37071283; PMCID: PMC10356657.

17. Helwig J, Diels J, Röll M, Mahler H, Gollhofer A, Roecker K, Willwacher S. Relationships between External, Wearable Sensor-Based, and Internal Parameters: A Systematic Review. Sensors (Basel). 2023 Jan 11;23(2):827. doi: 10.3390/s23020827. PMID: 36679623; PMCID: PMC9864675.

18. Leo P, Spragg J, Simon D, Lawley JS, Mujika I. Training Characteristics and Power Profile of Professional U23 Cyclists throughout a Competitive Season. Sports (Basel). 2020 Dec 17;8(12):167. doi: 10.3390/sports8120167. PMID: 33348618; PMCID: PMC7766290.

19. Mckee JR, Wall BA, Peiffer JJ. Temporal Location of High-Intensity Interval Training in Cycling Does Not Impact the Time Spent Near Maximal Oxygen Consumption. Int J Sports Physiol Perform. 2021 Jul 1;16(7):1029-1034. doi: 10.1123/ijspp.2020-0354. Epub 2021 Mar 10. PMID: 33691284.

20. Gallo G, Leo P, March MM, Giorgi A, Faelli E, Ruggeri P, Mujika I, Filipas L. Differences in Training Characteristics Between Junior, Under 23 and Professional Cyclists. Int J Sports Med. 2022 Dec;43(14):1183-1189. doi: 10.1055/a-1847-5414. Epub 2022 May 9. PMID: 35533684.

21. Huang X, Wang G, Zhen L, Zhao J, Gao B. Dose-response relationship between training load and anaerobic performance in female short-track speed skaters: A prospective cohort study. Physiol Behav. 2022 Oct 1;254:113909. doi: 10.1016/j.physbeh.2022.113909. Epub 2022 Jul 9. PMID: 35820626.

22. Malone S, Hughes B, Collins K, Akubat I. Methods of Monitoring Training Load and Their Association With Changes Across Fitness Measures in Hurling Players. J Strength Cond Res. 2020 Jan;34(1):225-234. doi: 10.1519/JSC.0000000000002655. PMID: 29985218.

23. Gallo G, Bosio A, Martin M, Morelli A, Azzolini M, Guercilena L, Larrazabal J, Rampinini E. Relationships between training dose and record power outputs in professional road cyclists: insights and threats to validity. Biol Sport. 2023 Apr;40(2):485-495. doi: 10.5114/biolsport.2023.114284. Epub 2022 Jul 21. PMID: 37077803; PMCID: PMC10108756.

24. Gottschall JS, Davis JJ, Hastings B, Porter HJ. Exercise Time and Intensity: How Much Is Too Much? Int J Sports Physiol Perform. 2020 Feb 28;15(6):808-815. doi: 10.1123/ijspp.2019-0208. PMID: 32365286.

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