Original Research

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Training Progression in Recreational Cyclists: No Linear Dose-Response Relationship With Training Load

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Abstract

Vermeire, KM, Vandewiele, G, Caen, K, Lievens, M, Bourgois, JG, and Boone, J. Training progression in recreational cyclists: no linear dose-response relationship with training load. *J Strength Cond Res* XX(X): 000–000, 2019—The purpose of the study was to assess the relationship between training load (TL) and performance improvement in a homogeneous group of recreational cyclists, training with a self-oriented training plan. Training data from 11 recreational cyclists were collected over a 12-week period. Before and after the training period, subjects underwent a laboratory incremental exercise test with blood lactate measurements to determine the power output associated with the aerobic threshold (P_{AT}) and the anaerobic threshold (P_{ANT}), and the maximal power output (P_{MAX}) was also determined. Mean weekly TL (calculated using the training impulse (TRIMP) of Banister, Edwards TRIMP, Lucia TRIMP and the individualized TRIMP) were correlated to the progression in fitness parameters using Pearson Correlation. Training intensity distribution (TID) was also determined (% in zone 1 as <AT; % in zone 2 as between AT and ANT; % in zone 3 as >ANT). No significant correlations between mean weekly TRIMP values and the improvement on P_{MAX} ($r = -0.22$ to 0.08), P_{ANT} ($r = -0.56$ to -0.31) and P_{AT} ($r = -0.08$ to 0.41) were found. The TID was significant in a multiple regression with P_{ANT} as dependent variable ($y = 0.0088 + 0.1094 \times Z1 - 0.2704 \times Z2 + 1.0416 \times Z3$; $p = 0.02$; $R^2 = 0.62$). In conclusion, this study shows that the commonly used TRIMP methods to quantify TL do not show a linear dose-response relationship with performance improvement in recreational cyclists. Furthermore, the study shows that TID might be a key factor to establish a relationship with performance improvement.

Key Words: TRIMP, endurance training, training quantification, cycling

Introduction

Since it has been suggested that training load (TL) is related to performance improvement and injury risk, the quantification of TL has become an essential part both in the development of training schedules and in the follow-up of individual and team sport athletes (15). To optimize fitness improvement and to minimize the risk of injuries, it is important to balance TL and recovery periods. To quantify TL, the calculation of training impulses (TRIMPs) has been suggested (2). Together with the technological development of heart rate (HR) monitors and analysis software (e.g., TrainingPeaks and GoldenCheetah), TRIMP calculations gained popularity. However, there is still some controversy concerning the validity of this method and the dose-response relationship with performance improvement (5).

Banister and Calvert (2) were the first to propose the term TRIMP. This TRIMP is calculated using the duration and mean HR of a training session and an exponential weighting factor for intensity. Edwards, Lucia et al., and Manzi et al. all refined the original formula as they deemed best. Edwards' TRIMP (eTRIMP) is calculated using 5 different zones, based on percentage of the maximum HR (HRmax), and weighting them with a linear intensity factor (IF) ranging from 1 to 5 (12). Lucia's TRIMP (luTRIMP) is computed using 3 HR zones with a linear IF (1–3), with zones demarcated by the gas exchange threshold and the respiratory compensation point (19). In pursuance of further individualizing TRIMP, the individualized TRIMP (iTRIMP) derives an exponential weighting factor from the individual HR-lactate relationship which results in a different weighting factor for each HR point (22).

In some recent studies, it was suggested that for a TL measure to be relevant, the weekly TL must be related with the improvement in fitness or performance variables (22,26). It is shown, both in team sports (1,21) and in endurance sports (22,26), that iTRIMP correlates best with the improvement on different performance variables. On the basis of that relationship, some researchers even suggested a minimal iTRIMP value to sustain or improve performance and fitness variables (21,22,26). However, the relationship between TRIMP and performance improvement is far from straightforward, with some studies finding no linear relationship (29), some reporting a relationship with only 1 performance parameter (1,21) or with only one of the TRIMP methods (1,22). Also, closer examination of the linear dose-response relationship between TRIMP and performance improvement in endurance sports showed that the significant correlation values were almost always accompanied by large confidence intervals (CIs).

It should be noted that the TRIMP value is a parameter in which both the volume and intensity of a training are integrated. This implies that an equal TRIMP can be obtained with different combinations of volume and intensity. In this context, it is shown that

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training intensity distribution (TID), i.e., using a threshold vs. polarized vs. pyramidal model strongly determines the outcome of a training program with regards to performance improvement (28).

In addition, it has been shown that a training session results both in a positive training outcome, i.e., fitness, and a negative outcome, i.e., fatigue (the fitness-fatigue model). Several studies have shown that the accumulation of fitness and fatigue within a training program results in a specific pattern of evolution of performance (6,7,23). In the aforementioned studies (1,21,22,26), the interaction of fitness and fatigue is not taken into account which could lead to an oversimplification of the relationship between training input and performance outcome.

Taken together, the above arguments question the observations of the direct linear dose-response relationship between TL (i.e., TRIMP) and performance progression. Also, in this context, a recent review on the association between TL and performance improvement gives a clear view on the conflicting results for this association in team sports (14).

The purpose of this study is thus to assess whether a linear dose-response relationship between TL, assessed using different TRIMP methods, and performance improvement exists in a homogeneous group of recreational cyclists training for a similar goal (e.g., The ascent of a col in the Alps) but with heterogeneous self-oriented training plans for volume and intensity. This is the optimal setting to observe whether or not a linear relationship between TRIMP and performance improvement exists. Based on the arguments above, we hypothesize that such a relationship will not be present and that improvements in fitness can be more accurately predicted accounting for more training variables such as the TID.

Methods

Experimental Approach to the Problem

Before and after a 12-week training period, subjects underwent a maximal exercise test in the laboratory to assess performance variables. The subjects all trained with a similar goal, i.e., the ascent of a single col in the Alps or Pyrenees, but they were not provided with a specific training program. All training data over the 12-week period were collected.

A homogeneous group with a heterogeneous training program with regard to volume was chosen since this would maximize the chances of finding a relationship between TL and performance improvement.

Subjects

Eleven healthy male recreational cyclists (mean ± *SD*; aged 40.1 ± 6.4 years, height 179.5 ± 4.9 cm, body mass [BM] 79.9 ± 6.9 kg) participated voluntarily for this study. Subjects all had at least 5 years of recreational cycling experience (5,000–8,000 $\text{km}\cdot\text{y}^{-1}$) and had no history of disease or metabolic disorders. Subjects were informed about the risks of the study, and written informed consent was obtained from all subjects before participation. This study was approved by the Ethical Committee of the Ghent University Hospital, Ghent, Belgium.

Procedures

Fitness Assessment. Before the start of the study, all subjects reported that they were at their lowest point of training volume (1 or 2 sessions per week) of the year as it was the winter period. Before and after the training period, subjects underwent a laboratory incremental exercise test with blood lactate concentration ($[\text{La}^-]$) measurements to identify the individual $[\text{La}^-]$ profile, the power output associated with the aerobic threshold (P_{AT}), and the power output at the anaerobic threshold (P_{ANT}). The maximal power output (P_{MAX}) and HRmax were also determined. The subjects avoided any exercise in the 48 hours preceding the pre-test and post-test. Before the start of the test, the resting HR (HR_{rest}) was defined as the lowest 5-second average HR when subjects lay in a supine position for 5 minutes in a quiet room. The exercise test started at 60 W and increased with 40 W every 5 minutes until volitional exhaustion. Subjects were asked to keep their cadence between 70 and 90 rpm. When cadence fell more than 5 rpm for more than 5 seconds despite encouragements, the test was stopped. All tests were performed on the subjects' own bicycle which was placed on an electromagnetically braked ergometer (Cyclus2 ergometer; RBM Electronics, Leipzig, Germany). Capillary blood samples were taken from a fingertip at the end of every stage and analyzed using the Lactate Scout$^+$ analyzer (Lactate Scout$^+$; SensLab GmbH, Leipzig, Germany). Heart rate was recorded every second (Polar Beat; Polar Electro oy, Kempele, Finland). The highest 5-second mean HR was used as the reference value for HRmax. Testing took place in the Sport Science Laboratory—Jacques Rogge (Ghent University, Belgium), under controlled environmental conditions (18–19° C, 50% relative humidity).

To assess the fitness level of the subjects, the $[\text{La}^-]$-curve of the subjects was analyzed. The AT was determined as the first visual rise in $[\text{La}^-]$ above resting values (18). The evaluation of AT was performed by 3 independent researchers. When there was discrepancy between the values of the researchers, consensus was sought. The ANT was calculated using the modified D_{MAX} method as described by Bishop et al. This is the point on the polynomial regression curve that yields the maximal perpendicular distance to the straight line formed by the AT and the final lactate point (4).

Training Program. All subjects trained for a period of 12 weeks from March to June. Subjects did not receive any prescribed training program. Subjects were nevertheless encouraged to train 2–4 times a week and to refrain from any other form of training i.e., strength or running training. Global Positioning System devices and HR monitors had to be worn during all training sessions and had to be set up to record data second-by-second. Training was recorded using the subjects' own HR and Global Positioning System devices: Mio 315 (MiTAC, Taipei, Taiwan), Garmin Edge 820 (Garmin Ltd., Olathe, KS), Garmin Edge 1,000 (Garmin Ltd), Polar M600 (Polar Electro oy), and Polar V650 (Polar Electro oy).

Training Load Calculation. Training load was calculated using different methods of HR-based TRIMPs. bTRIMP was calculated using the training duration, average HR, and an IF using following equation:

$$\text{bTRIMP} = \text{duration training(min)} \times \Delta\text{HR} \times 0.64e^{1.92x},$$

where $\Delta\text{HR} = (\text{mean HR}—\text{HR}_{rest})/(\text{HR}_{max}—\text{HR}_{rest})$, e = the base of the Napierian logarithms, 1.92 and 0.64 = generic constant for men, and $x = \Delta\text{HR}$ (3). Five predefined zones (50–59% HRmax, zone 1, IF = 1; 60–69% HRmax, zone 2, IF = 2; 70–79% HRmax, zone 3, IF = 3; 80–89% HRmax, zone 4, IF = 4; 90–100% HRmax, and zone 5, IF = 5) were used to calculate eTRIMP. The time spent in each zone was multiplied by the respective IF and then summated to compute a total eTRIMP score (11). For the calculation of luTRIMP, 3 predefined HR zones

Table 1

Overview of individual training characteristics.*

Subject	Training-sessions	Total time (min)	Mean duration (±*SD*)	Mean weekly TRIMP (A.U.)				Training intensity distribution (%)		
				bTRIMP	eTRIMP	luTRIMP	iTRIMP	Z1	Z2	Z3
1	38	5,939	156 (±126)	771	1,497	742	1,367	48.4	45.6	6.0
2	20	3,120	156 (±84)	504	984	568	679	24.3	44.7	31.0
3	30	4,928	164 (±92)	600	1,257	710	1,234	53.3	40.6	6.1
4	34	4,344	128 (±73)	548	1,096	567	461	63.0	22.5	14.5
5	32	5,906	185 (±66)	637	1,358	870	732	39.9	48.6	11.5
6	22	4,529	206 (±106)	579	1,324	601	713	91.1	8.6	0.3
7	32	4,072	127 (±70)	609	1,202	400	740	66.3	24.8	8.9
8	28	3,764	134 (±74)	482	1,034	469	603	52.5	32.3	15.2
9	38	5,775	152 (±63)	681	1,393	771	873	78.4	17.5	4.1
10	34	5,213	153 (±76)	562	1,194	564	764	75.2	24.5	0.3
11	53	9,100	172 (±110)	982	2070	986	1,145	52.9	38.4	8.7
Mean	33	5,154	158	632	1,310	659	847	58.7	31.6	9.7
SD	8	1,522	23	135	282	167	269	18.8	13.0	8.6

*Z1 = zone 1; Z2 = zone 2; Z3 = zone 3.

based on the $[La^-]$-HR curve were used. Zone 1 (IF = 1) was defined as below AT, zone 2 (IF = 2) between AT and ANT, and zone 3 (IF = 3) above ANT, a slightly different approach than intended by Lucia et al. (19) where they used ventilatory thresholds. Again, the time in each zone was multiplied by its respective IF and then summed to provide a total luTRIMP. Calculation of iTRIMP was performed using the individual's $[La^-]$-ΔHR relationship as an exponential IF using the best-fitting method. This exponential IF was used to weight every measured HR (22).

For the TID, the time in zone was defined as every HR measured lower or equal to the HR associated with AT (zone 1), every HR lower or equal to ANT, but higher than AT (zone 2) and every HR higher than the HR associated with ANT (zone 3) (27).

Statistical Analyses

All statistical analyses were performed using SPSS Statistics version 24 (IBM Corp., Armonk, NY). Descriptive data are presented as mean ± *SD*. Before analysis, the assumption of normality was verified by using the Shapiro-Wilk test and visual inspection of Q-Q plots. Paired-samples *t*-tests were used to detect training effects for P_{AT}, P_{ANT}, and P_{MAX}. Standardized effect size (ES) is reported as Cohen *d*, using the pooled *SD* as the denominator. Interpretation of the Cohen *d* was based on the guidelines provided by Hopkins (17): 0 to 0.19 trivial, 0.20 to 0.59 small, 0.6 to 1.19 moderate, 1.20 to 1.99 large, and ≥2.00 very large. The Pearson correlation coefficient (*R*) was used to explore associations between the TRIMP methods and to detect dose-response relations between measures of TL and fitness variables. The correlation coefficients are presented with 95% CIs for the dose-response relationships. Multiple regression analyses were used to explore the influence of multiple training variables on the progression in P_{AT}, P_{ANT}, and P_{MAX}. Those variables were the total duration of training (TD), the TID (both absolute and percentual), and the starting value of the dependent variable the regression was related to. These variables were combined with each of the mean weekly TRIMP variables in separate regressions. It should be noted that subject 11 can be considered as an outlier with regards to total training time. The subject was included into the analysis, given that the purpose of this study was to obtain a considerable range in training variables in a homogenous population. Statistical significance was set at $p \le 0.05$.

Results

A total of 361 training sessions were analyzed over the course of this study. All completed training sessions were registered. An overview of the training characteristics is given in Table 1. Mean weekly TL for bTRIMP, eTRIMP, luTRIMP, and iTRIMP was 632 ± 135, 1,310 ± 282, 659 ± 167, and 847 ± 269, respectively. The time spent in zones 1, 2, and 3 ranged from 24.3 to 91.1%, from 8.6 to 48.6%, and from 0.3 to 31.0%, respectively.

There was a moderate increase in P_{AT} (11.1 ± 8%, $p = 0.002$, ES = 0.75), P_{ANT} (8.1 ± 9%, $p = 0.013$, ES = 0.68), and P_{MAX} (6.4 ± 5%, $p = 0.003$, ES = 0.71) after 12 weeks of training (Table 2).

The TRIMP values calculated all correlated strongly with each other (range $R = 0.89–0.99$) (Figure 1). Correlations between mean weekly TRIMP values (bTRIMP, eTRIMP, luTRIMP, and iTRIMP) and the progression on P_{MAX}, P_{AT}, and P_{ANT} were not significant ($p > 0.05$) (Table 3).

The R^2 for the multiple regression analysis on P_{AT} ranged from 0.84 (luTRIMP) to 0.96 (eTRIMP), on P_{ANT} from 0.91 (iTRIMP) to 0.98 (luTRIMP), and for P_{MAX} from 0.84 (iTRIMP) to 1.0 (eTRIMP).

Table 2

Physiological measures before and after the training period.*

	Pre-test mean ± *SD*	Post-test mean ± *SD*	Mean difference (95% CI)	ES	Qualitative outcome
P_{MAX}	275.7 ± 23.4	293.1 ± 24.4	17.4† (7.4–27.4)	0.71	Moderate effect
P_{AT}	164.1 ± 21.9	182.0 ± 25.6	17.9† (8.5–27.3)	0.75	Moderate effect
P_{ANT}	224.9 ± 25.6	241.6 ± 23.9	16.7‡ (4.4–29.1)	0.68	Moderate effect

*CI = confidence interval; P_{MAX} = maximal power output; P_{AT} = power output at aerobic threshold; P_{ANT} = power output at anaerobic threshold; ES = effect size.

†Sign at 0.01lvl.

‡Sign at 0.05 lvl.

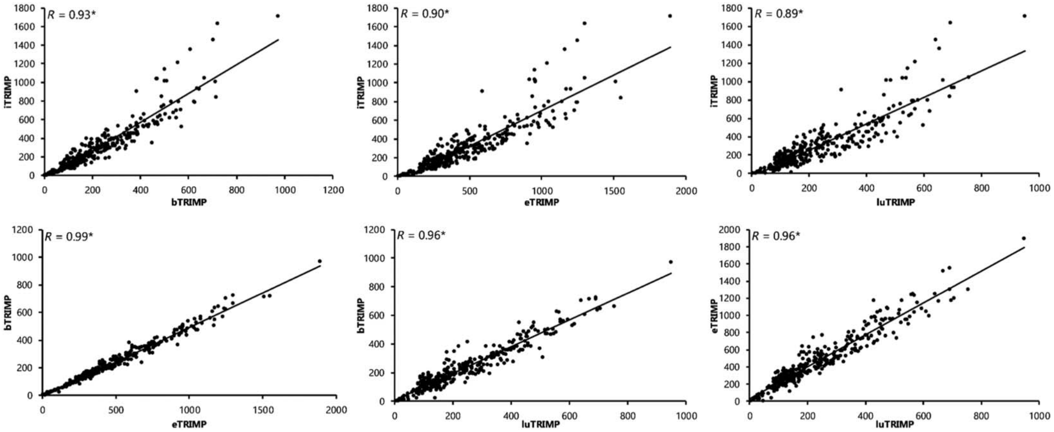

Figure 1. Correlations between TRIMP values. *R* = Pearson correlation coefficient; *Significant at the 0.001 level (2-tailed).

Discussion

The aim of this study was to investigate the relationship between TRIMP measures and the improvement in physical fitness in a homogeneous population, training for the same goal following a self-guided training program. In agreement with our hypothesis, the TRIMP measures of TL were not linearly related to the improvement in physical fitness. Also in accordance with our hypothesis, we found a better relationship when accounting for additional training variables (TD and TID).

In the past years, studies have found an association between TRIMP measures and progression in physical fitness. However, the observed relationship is currently far from straightforward. Some studies report a linear relationship between the AT, the ANT, and iTRIMP while this relation was not found for bTRIMP (22.29). However, Akubat et al. (1) found a relationship between iTRIMP and the AT but not with the ANT in football players, while none of the other TRIMP measures were related to any of the fitness parameters. Sanders et al. (26) found a linear relationship between bTRIMP, eTRIMP, luTRIMP, and iTRIMP and the improvement on both the AT and ANT in cyclists. This is in contrast with Taylor et al. (29) where a curvilinear rather than a linear relationship was found between bTRIMP, iTRIMP, and the improvement on $\dot{V}O_2max$ in rugby players, and where no other relations were found. In this study, a linear dose-response relationship could not be observed with progression in any of the fitness parameters. However, the study design, using recreational cyclists with a similar training background and homogeneous level of physical fitness (P_{Max}/BM = 3.46 ± 0.22 $W \cdot kg^{-1}$) training with a self-selected training schedule, thus resulting in different TL characteristics, would be optimal to evoke such a relationship.

The lack of a consistent dose-response relationship between TRIMP and progression in physical fitness can be attributed to inherent limitations with the calculation and the general concept of the different TRIMP methods.

In most studies (1,21,22,26,29), the iTRIMP, originating from the relationship between [La^-] and HR, has been considered as the most useful and valid TRIMP measure, given that it provides the best correlation with improvement in physical fitness. Although the iTRIMP, first proposed by Manzi et al. (22), tries to individualize TRIMPs by accounting for the individuals' HR-[La^-] relationship, the calculation of iTRIMP has its specific limitations. When modeling an exponential fit through the ΔHR-[La^-] curve, a unique formula for the calculation of iTRIMP for every individual occurs. Although interesting, this also renders the comparison between individuals irrelevant. For example, when we calculated the iTRIMP for 2 of the individuals in this study for a hypothetical training of 1 hour constantly at P_{AT}, for subject 1, this resulted in an iTRIMP score of 57, while for subject 2, it would be 109 iTRIMP (Figure 2). Since the hypothetical training would evoke an almost equal physiological load and thus training adaptations, it is clear that comparison between individuals is incorrect. This is a first argument that the linear relationship between iTRIMP specifically and the improvement in physical fitness is not straightforward.

A second, more general argument for the inconsistent dose-response relationships of the TRIMP values is inherent to the concept of TRIMP. The TRIMP methods quantify overall TL and thus integrate both intensity and volume in 1 TL score. As a consequence, a training session of long duration with low intensity (e.g., 180-minute cycling below AT: luTRIMP = 180) could result in an equal TRIMP score as a training of short duration but completed at high intensity (60-minute cycling at the ANT: luTRIMP = 180). However, it is improbable that these training sessions would lead to the same molecular, biochemical, and physiological adaptations and thus the same improvements in the different physical fitness parameters (10).

A third argument concerns the fitness-fatigue model. It has been shown that the progression in performance when following

Table 3

Relation between mean weekly training load and performance improvement.*

	bTRIMP	eTRIMP	luTRIMP	iTRIMP
%Δ P_{AT}	0.26 (−0.03 to 0.06), $p = 0.45$	0.30 (−0.01 to 0.03), $p = 0.37$	0.41 (−0.01 to 0.05), $p = 0.21$	−0.08 (−0.03 to 0.02), $p = 0.82$
%Δ P_{ANT}	−0.45 (−0.07 to 0.01), $p = 0.16$	−0.56 (−0.04 to 0.00), $p = 0.08$	−0.31 (−0.05 to 0.02), $p = 0.35$	−0.53 (−0.04 to 0.00), $p = 0.93$
%Δ P_{MAX}	0.08 (−0.03 to 0.03), $p = 0.81$	0.02 (−0.1 to 0.01), $p = 0.96$	−0.22 (−0.03 to 0.02), $p = 0.52$	−0.20 (−0.02 to 0.01), $p = 0.56$

*%Δ = percentage change pre vs. post; P_{AT} = power output at aerobic threshold; P_{ANT} = power output at anaerobic threshold; P_{MAX} = maximal power output.

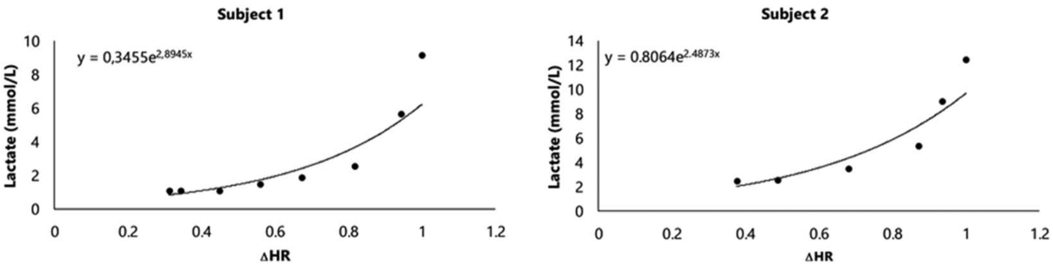

Figure 2. The [La^-]-HR curve for 2 subjects is given. The formula for the exponential fit can be seen in the form $y = ae^{bx}$. Both subjects have a similar fitness level but still have very different exponential formulas for the calculation of iTRIMP. This leads to very different iTRIMP scores, even when an identical training session (1 hour AT training) is completed for both subjects. HR = heart rate.

a training program is more complex than simply setting training input in direct relation to output, i.e., an increase in performance. The fitness-fatigue theory (8) dictates that each training session with a specific TL will induce both a positive training effect, ascribed to fitness, and a negative training effect, ascribed to fatigue. Performance can thus be considered as the difference between fitness on the one hand and fatigue on the other hand. Several studies (7,23) testing this model have shown that increasing the overall TL will initially negatively impact performance, since the negative training effects outweigh the positive training effects. However, since the negative training effects related to a single training session will dissipate faster in time than the positive training effects, the performance capacity will eventually increase (for a review on this model, see Clarke and Skiba (9)). In this regard, it is also shown that fitness and fatigue decay constants are dependent on the individual (23) and can vary over time (7). Moreover, Hellard et al. (16) have demonstrated that the body has a finite capacity to adapt to a given TL. Therefore, concluding that a higher mean weekly TRIMP leads to a greater increase in performance can be considered as an oversimplification of reality.

Previous research has also shown that to maximize training adaptations, the distribution of training time over the intensity zones is of great importance (28). In elite cyclists, and most endurance athletes, a polarized training model is preferred. Esteve-Lanao et al. (13) demonstrated that if TRIMP was held constant over 2 groups of subelite runners, the group emphasizing training time under P_{AT} at expense of training time in the zone between P_{AT} and P_{ANT} showed more improvement on a distance run. Similar results were found for recreational runners by Munoz et al. (24), where TRIMP was again held constant. It thus seems that the TID, which cannot be derived from the TRIMP score, plays an important role in performance improvement.

Therefore, in this study, we hypothesized that accounting for more training variables, including the TID, would result in stronger relationships. Accounting for these variables resulted in R^2 values ranging from 0.84 to 1.0, suggesting that these variables cannot be neglected when trying to relate training to performance improvement. Moreover, when performing a multiple regression, only accounting for the TID by means of percentual time in the training zones resulted in a significant relation with the improvement on P_{ANT} ($R^2 = 0.62$).The results of this regression were visualized in a Shapley plot (Figure 3) (20). This plot showed that spending more time of training in Z1 and Z3, instead of training in Z2, resulted in a positive effect on P_{ANT}. This is in agreement with a polarized model. It thus seems that TID explains more of the variance than the mean weekly TRIMP does.

In conclusion, this study shows that the commonly used TRIMP methods to quantify TL do not show a linear dose-response relationship with performance improvement in recreational cyclists. The lack of such a relationship can be attributed to inherent limitations to the different calculations of the different TRIMP methods. Training intensity distribution is not incorporated within these TRIMP values, but this study shows that TID might be a key factor to establish a relationship between training and performance improvement.

Future research should be focused on how the intensity distribution can be incorporated with the TRIMP methods to improve the dose-response relationship with performance improvement; the fitness fatigue model could be a starting point in this regard. Also, research integrating new machine learning approaches could be helpful to determine the most influential

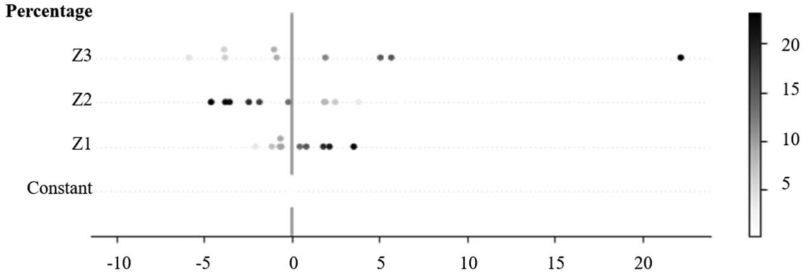

Figure 3. Shapley plot explaining the influence of the variables on the multiple regression model output. The darker the dots are, the higher the value for that feature is. On the *x* axis, the influence of the dots on the model output is given. A dot more to the right has a higher, positive influence on the model. A dot left of the zero point has a negative influence on the model. Z1, Z2, and Z3 = percentage of total time trained in zones 1, 2, and 3.

factors for training progression. The focus should also be on the difference in dose-response relationships between recreational and elite athletes.

Practical Applications

To optimally improve performance, the relationship between TL and the training outcome should be fully elucidated. It is clear from this study that the dose-response relationship between TRIMP and performance improvement is not that straightforward. Guidelines provided in previous articles concerning a minimal TRIMP value to sustain or improve performance should therefore be used with caution. The TRIMP values can be used to follow up a training program and to monitor whether the total TL is being built-up in the correct way, but intensity and volume distributions should be taken into account. It is also clear that all TRIMP methods have strong correlations with one another, so coaches should be able to select the appropriate method according to the demands of the sport and situation (25). The authors are aware of the fact that power meters are being more frequently used and are considered highly important by coaches. However, this study focused on HR measures for TL as this remains the most used method for recreational cyclists, who remain the biggest group of beneficiaries.

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