FEBURARY 2021 | ISSUE #02

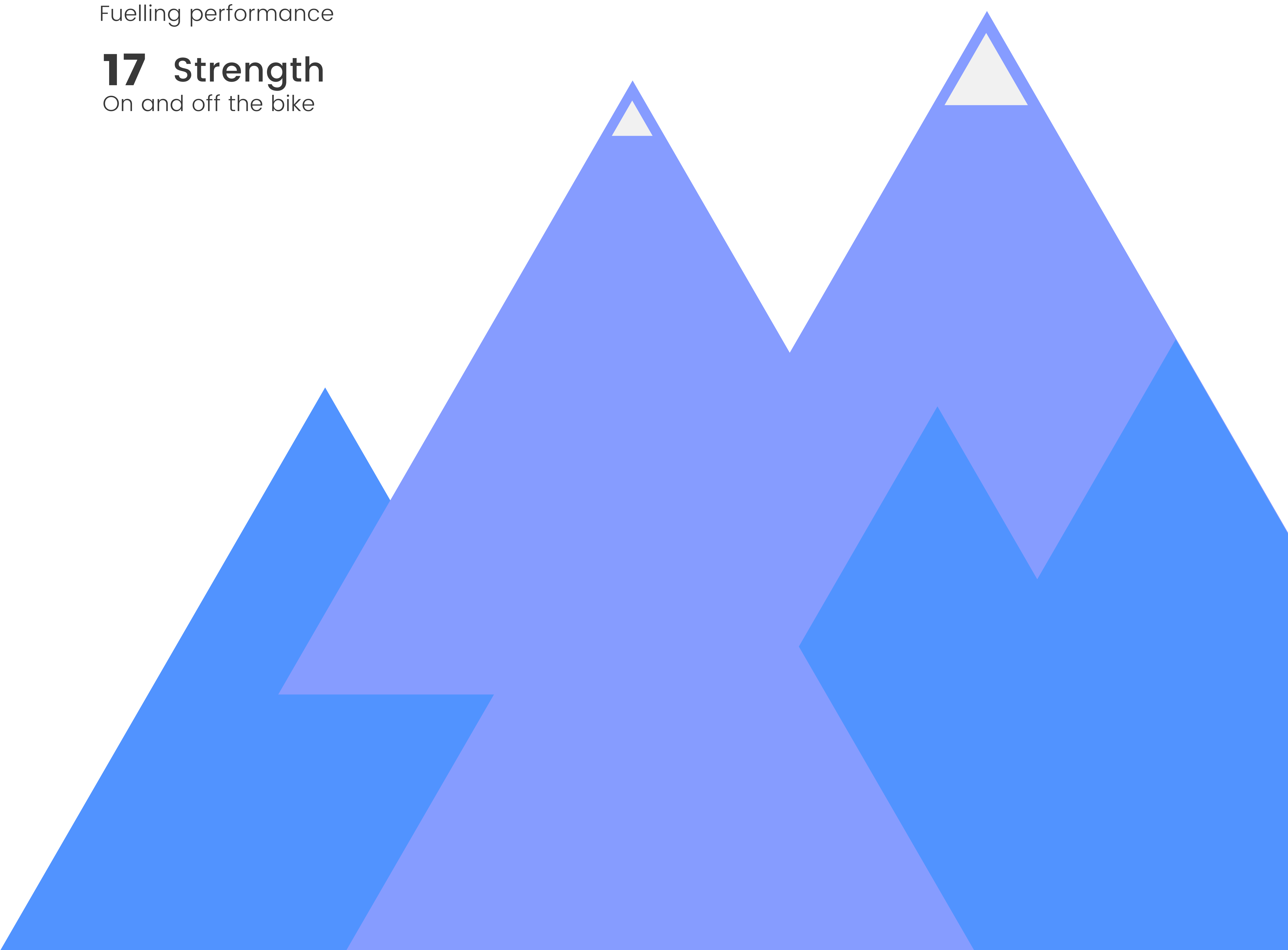
SEMIPRO CYCLING

CYCLING SCIENCE

DIGEST

A MONTHLY SUMMARY OF THE LATEST CYCLING PERFORMANCE RESEARCH

Contents



How to read the digest

Page number → 16

Section → Classic

Link to abstract → Abstract

Title →

The role of resistance exercise intensity on muscle fibre adaptations

Study details →

OBJECTIVE

Although many training variables contribute to the performance, cellular and molecular adaptations to resistance exercise, relative intensity (% 1 repetition maximum [%1RM]) appears to be an important factor.

This review aimed to provide an examination of the role of resistance training load on adaption of human skeletal muscle.

As Fry says "Only when knowledge of muscle physiology and the appropriate application of training stimuli are combined can we hope to optimise the adaption process".

WHAT THEY DID

This review examines the scientific literature concerning the role of resistance exercise intensity on cellular and molecular adaptions of human skeletal muscle.

The author summarises and analyses data from numerous resistance exercise training studies that have monitored percentage fibre type, fibre type cross-sectional areas, percentage cross-sectional areas, and myosin heavy chain (MHC) isoform expression.

The review was limited to studies analysing the vastus laterlais muscle using muscle biopsies.

WHAT THEY FOUND

- Muscular hypertrophy responses to different relative training intensities follows a dose-response curve.
- There may be a threshold for optimal growth responses once intensity reaches 80% of 1RM. And maximal growth occurs with loads between 80% and 95% of 1RM.
- The optimal relative intensity range for muscular hypertrophy is 40% to 80% of 1RM.
- For endurance cyclists not wanting large levels of muscular hypertrophy, it is important to also include work at ≥80% 1RM because there are other physiological and performance reasons to train e.g. muscular strength or power.

Practical takeaways from study →

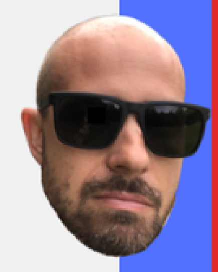
Practical Takeaways

Fry found that Fast Twitch recruitment begins at approximately 40% of maximum voluntary contraction (MVC) and peaks at ~ 80-85% MVC. Reminder: MVC is a measure of strength.

- These numbers were intended to be transferred across percentages of maximum repetitions when doing strength work. But it's also possible to use them for on the bike strength workouts using power prescriptions.

To understand how this works, we need to find an athlete's peak torque. We can calculate this using peak power and cadence. For example for an athlete that has a peak power output of 1300W (snd peak cadence of 130rpm) has a peak torque of 95 Newton meters. To prescribe strength intervals use the power that corresponds to 40-80% of peak torque. In this case 38-76 Newton meters. At 50rpm that's a power range of 200-400w.

- Once you have that information you can create interval durations that fit the athlete's ability and specificity requirements. For example, long strength endurance intervals at 40-50% of max torque might be 30-minute blocks (max 3 x 30 minutes total) at 200-250w @ 50rpm. Or shorter intervals hill reps at 80-85% of max torque might be 6 x 4-minute blocks at 400-425w @ 50rpm.



Reviewers comments on the study →

Damian's Comments

"I have used this study for many years to quantify my power prescriptions for on bike strength and strength endurance work. A quick calculation can keep an athlete in their personal hypertrophy range - and not waste their training time on guesses.

Also, having a personal range helps to measure progress (see below) and helps with motivation. Give this a try the next time you are prescribing strength endurance intervals."

Session 1

Torque Nm/kg	Torque	% of Peak Torque
Nm/kg	Nm	%
0.81	60	48
0.83	62	50
0.84	63	50
0.85	63	51
0.85	63	50
0.85	63	50
0.85	63	51
0.85	63	51

Session 2

Torque Nm/kg	Torque	% of Peak Torque
Nm/kg	Nm	%
1.01	75	60
1.11	82	65
1.11	82	65
1.10	81	65
1.10	81	65
1.10	81	65
1.08	80	64
1.10	81	65

Related links to learn more about the topic →

Want to learn more?
Check these out...

SEMIPRO Cycling

Welcome

If you're reading this right now, then I am seriously honoured you decided to invest in yourself and join SEMIPRO+. I am extremely thankful for every single member who chooses to join us on our relentless quest to get cyclists the right advice at the right time. Without you, this would simply not be possible; so thank you.

So, what's special in this month's issue?

1. Welcome to issue two of the digest. We are well underway in our process of finding the latest and best cycling research each month. This month is no different with some long-awaited papers published and some new ones popping up at the last minute. I've decided to cap the articles per section to 3. I will find a place to publish the articles that don't make the cut, but the goal of this publication is to make life easier and an endless stream of articles does not help achieve this.

2. I've made the addition of a strength section. There are many forms of strength interventions being tested on elite and non-elite populations, and it would be a shame to miss these insights.

Thanks for reading, and for being a member :)

Damian

Cycling Science Digest

Designed to help cyclists and their coaches ride better, faster. The Cycling Science Digest curates cutting-edge cycling science research and turns it into actionable advice.

The monthly Cycling Science Digest crafts each research review into one easy to read page. It only takes 2 minutes to dissect and read, freeing up plenty of time for you to implement and maximise performance from the advice.

Damian Ruse

Founder and Head Coach of SEMIPRO Cycling

Damian is an elite cycling coach and cycling science educator and has worked in the field of sports performance for over 8 years, helping athletes get the best out of themselves. Damian coaches professional, elite, and amateur athletes and has been the Performance Director of a top Australian road cycling team. Damian is also a lifelong cyclist, riding and racing bikes for over 28 years.

Performance

This month's top research on cycling performance

Heat Versus Altitude Training for Endurance Performance at Sea Level

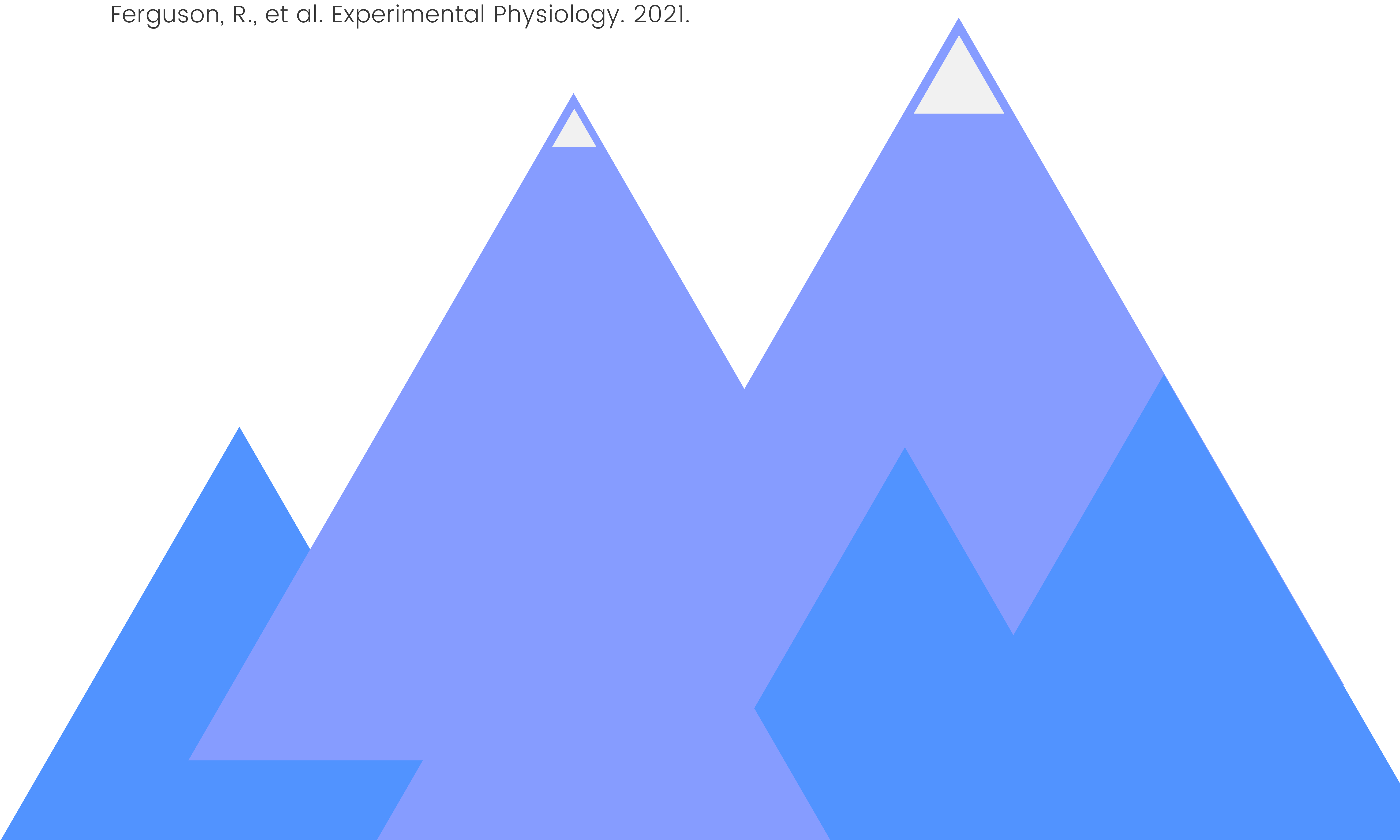
Baranauskas, Marissa N., et al. Information Exercise and Sport Sciences Reviews. 49(1), 2021.

The Effect of Upper-Body Positioning on the Aerodynamic–Physiological Economy of Time-Trial Cycling

Faulkner, S., et al. International Journal of Sports Physiology and Performance. 16 (1), 2021.

Blood-flow-restricted exercise: Strategies for enhancing muscle adaptation and performance in the endurance-trained athlete

Ferguson, R., et al. Experimental Physiology. 2021.



Abstract

Heat Versus Altitude Training for Endurance Performance at Sea Level

OBJECTIVE

If athletes have a choice of where to train before important events, which training intervention elicits better results?

Environmental stressors, such as heat or altitude, elicit dissimilar physiological adaptations to endurance training programs. This review evaluates heat and altitude interventions to assess the impact and ease of implementation when consdering which one to choose.

WHAT THEY DID

The authors reviewed data in support of their novel hypothesis, which proposed altitude as the preferred environmental training stimulus for elite endurance athletes preparing to compete in temperate, sea-level climates (5°C–18°C).

WHAT THEY FOUND

- Only three studies have demonstrated improvements in temperate endurance exercise performance after heat training practices. Moreover, despite a significant expansion in plasma volume, increases in $\dot{V}O_2max$ and improvements in temperate endurance exercise performance have not been consistently observed after long-term heat training practices. In contrast, an abundance of evidence supports an average improvement of 1%–4% in sea-level endurance performance after altitude training (either Live High Train Low or Live High Train High)
- Current evidence suggests that both altitude training and heat training hold the potential to improve temperate sea-level performance beyond traditional endurance training practices, work from the author's laboratories and others support altitude training as the choice with the clearest beneficial impact for endurance-trained athletes.

Practical Takeaways

Optimal recommendations for altitude and heat training camps:

- **Altitude training**
  Reside and perform usual training at an elevation of 2000–2500 metres for greater than or equal to 12 hours a day. Perform high-intensity sessions at an elevation less than 1250 metres. A natural environment is best and a minimum Training Camp Duration of 3 weeks is recommended.
- **Heat training**
  Perform usual training in temperate conditions (5°C–18°C). In addition to usual training, exercise for greater than or equal to 90 minutes at an intensity eliciting a core body temperature of greater than or equal to 38.5°C, e.g., fixed workload at 50%–55% $\dot{V}O_2max$ with ambient conditions of 35°C–40°C and 30%–70% relative humidity. A natural or artificial works here and a minimum training camp duration of 10 days is recommended.

Want to learn more?
Check this out...

Damian's Comments

"This article makes it clear that if you have time and means to choose either heat or altitude training - altitude training is a proven method to make gains at sea-level.

What is interesting to me is while the author's note that the "importance of executing a proper and optimally timed training camp...should not be overlooked". They go on to say that "Although at first glance training in hot ambient environments may seem more logistically feasible than training at altitude for most athletes, successful heat training practices may require the same meticulous execution as is required with altitude training."

So heat training is not the 'easy' alternative it may first seem."

Abstract

The Effect of Upper-Body Positioning on the Aerodynamic–Physiological Economy of Time-Trial Cycling

OBJECTIVE

Cycling time trials are characterized by riders adopting aerodynamic positions to lessen the impact of aerodynamic drag on velocity. The optimal performance requirements for TTs likely exist on a continuum of rider aerodynamics versus physiological optimization, yet there is little empirical evidence to inform riders and coaches.

The aim of the present study was to investigate the relationship between aerodynamic optimization, energy expenditure, heat production, and performance.

A secondary aim is to develop a unit of measurement that is sensitive to changes in rider position with respect to their aerodynamic and physiological economy.

It was hypothesised that there would be a reduction in power output at lactate threshold as hip angle decreased. The secondary hypothesis was that changes to physiological parameters in response to hip angle manipulation would impact aerodynamic-physiological efficiency and thermoregulation.

WHAT THEY DID

Eleven trained cyclists (Age (yrs) 33±9, VO2max (ml kg min-1) 56.94±6.95, Power output at LT (Watts) 283±46, CdA (m2) 0.222 ± 0.018, Preferred hip angle (°) 15±3) with a history of competing in time trials and/or triathlons for more than five years, completed 5 submaximal exercise tests followed by a time trial.

Trials were completed at hip angles of 12° (more horizontal), 16°, 20°, 24° (more vertical), and their self-selected control position.

Submaximal Exercise Test: Participants cycled at their preferred cadence, starting at 95W, with a 35W increase in power output every three minutes until Lactate Threshold.

Time Trial: Following 30-minutes passive recovery, participants performed: 11-minute warm up prior to the TT. Following 5 minutes rest, the riders began the TT. Participants were given a set amount of work, equivalent to cycling for 20 minutes at 75% Wmax (321.4± 38.0 kJ) to complete in as fast a time as possible.

Target workload was calculated as: $Target\ Workload\ (kJ) = ((0.75 Wmax) / 1000) * 1200$

WHAT THEY FOUND

- The main finding is that with increasing hip angle (i.e less bending of the torso) there is an increase in both metabolic energy expenditure and metabolic heat production as power at LT increases. However, it appears that the reduction in power at lower hip angles is overcome by a reduction in aerodynamic drag and improved aero-physiological economy.
- The largest decrease in power output at anaerobic threshold compared with control occurred at 12° (-16 Watts P = .03; effect size = 0.8).
- There was no effect of hip angle on W .CdA.
- There was a linear relationship between upper-body position and heat production (R2 = .414, P = .04) but no change in mean body temperature, suggesting that, as upper-body position and hip angle increase, convective and evaporative cooling also rise.
- The highest aerodynamic–physiological economy occurred at 12° (384W·CdA-1·L-1·min-1, effect size = 0.4). The lowest occurred at 24° (338W·CdA-1·L-1·min-1, effect size = 0.7), Control (367W·CdA-1·L-1·min-1).

Practical Takeaways

- The application of these data relates to riders' position selection for time trial events. The author's data show that a focus on aerodynamic optimisation outweighs the physiological cost of reducing hip angle on power output at lactate threshold.

  Importantly, the use of aerodynamic physiological economy as a measure of overall efficiency, provides athletes and coaches with a direct way of assessing the optimal time trial position for a cyclist.

- These data show that for short duration time trials (<~20 minutes), riders should favour optimising their aerodynamics, as any physiological cost will be outweighed by the aerodynamic benefit.

- However, in longer duration events, where heat may become a limiting factor, adopting a less aerodynamic position may help to increase heat loss during cycling. From the power data obtained at 4mmol, a hip angle of approximately 16°appears optimal with respect to achieving the highest sustainable power. However, when you consider the relationship between aerodynamics and power output, a more aggressive position (12°) may outweigh the reduction in sustainable power at 4 mmol compared to more open hip angles.

  This may result in improved time trial performance in competition where aerodynamic drag is a significant issue. This means that even though there are potential reductions in sustainable power output, the improvement in aerodynamics may result in overall speed being sustained, at a lower metabolic cost.

Damian's Comments

"This paper addresses a common question and as the authors tell us, this paper is what they believe is the first time, that the aerodynamic gains outweigh potential physiological costs at intensities that are closer to true time trial efforts (~80-85% Wmax).

This is an important finding for any cyclists wanting to find the optimal time trial set up, regardless of distance.

It's great to get subjects, while not elite were able to produce a decent power output to test the hypotheses presented. I will say that the average CdA numbers were quite low which helps us transfer the results to elite level riders.

As they say, further work is needed to understand the relationship between time trial position, heat production and heat storage, in order to determine the thermal effects of position that may affect performance in long duration time trials, where performance may benefit from a less aerodynamic position, in order to help keep a rider cool by increasing airflow and evaporation of sweat.

Abstract

Blood-flow-restricted exercise: Strategies for enhancing muscle adaptation and performance in the endurance-trained athlete

OBJECTIVE

This review examined blood-flow-restricted (BFR) exercise as a strategy for potentially augmenting the adaptive response to training and improving performance in endurance trained individuals.

Focus is placed on the processes of capillary growth and mitochondrial biogenesis.

Recent evidence supports that BFR exercise presents an intensified training stimulus beyond that of performing the same exercise alone. The authors suggest this has the potential to induce enhanced physiological adaptations, including increases in capillary supply and mitochondrial function, which can contribute to improving endurance-exercise performance.

WHAT THEY FOUND

- Blood flow restricted (BFR) exercise represents an approach to potentially augment the adaptive response to training and improve performance in endurance trained individuals.
- When combined with low-load resistance exercise, low- and moderate-intensity endurance exercise, and sprint interval exercise, BFR can provide an augmented acute stimulus for angiogenesis and mitochondrial biogenesis.

There is, however, a lack of consensus as to the potency of BFR-training which is invariably due to the different modes, intensities, and durations of exercise and BFR methods. Further studies are needed to confirm its potential in the endurance-trained athlete.

Practical Takeaways

- It's important to note this is still in its early days and the safety element is still being worked out because there are some risks involved. The evidence base is still very small and the studies done on elite athletes are also very small.

  12 studies have addressed the endurance adaptations and the interventions conducted in these studies are all different. Take this and the fact that right now these are lab based interventions - it hasn't really been tested in the field - especially not for cyclists. It is not recommended to do any of this type of training.

- We can get an idea of what the interventions may look like in the future once science can optimise the training. The interventions involve a cuff that slips onto the upper thigh of the athlete and is inflated with air. The optimal inflated pressure is still being debated.

- Sessions right now are 2 minutes on / 3 minutes off at an intensity below FTP. The cuff is inflated for the effort and released after the effort. Then inflated again to perform the next effort. Each session - 3 sets of 5 intervals with a total time between 20-30 minutes. Per week these sessions are being trialled at 2 or 3 days for 4-6 weeks. The researchers are still unsure if this is optimal.

  It's also important to note that the cuff results in burning sensations. This is due to everything being trapped during the effort. For example, lactate is trapped in the muscle.

Want to learn more?
Check these out...

Damian's Comments

Quoting from the review - "Blood flow restricted (BFR) exercise represents an approach to potentially augment the adaptive response to training and improve performance in endurance trained individuals. When combined with low-load resistance exercise, low- and moderate-intensity endurance exercise, and sprint interval exercise, BFR can provide an augmented acute stimulus for angiogenesis and mitochondrial biogenesis."

Sprint interval training is the next step. Big gains have been seen in v02max of elite athletes - 5% improvement in 2 separate studies. The intervention used was 30 seconds on / 4.5 minutes off. Post-exercise blood flow restriction. Off the bike and put the cuff on after effort - leave it on for 2 minutes, then remove it for another 2 minutes of rest. Then jump on the bike. Current interventions include doing the work 2 times per week for 4 weeks but it's a hard session.No improvement in the control - with just sprint interval training. This type of training enhanced the signals for capillary growth. Compared to sprint interval training alone. An acute switch of the signals for capillary growth.

TT performance did not improve - not sure if it translates to importance - a 15 km tt time did not improve. Future directions. Understanding the mechanistic aspects - see if capillary growth can be induced. Want to follow up to see if signals translate to actual capillary growth. Try and manipulate the intervention to see if the changes can be induced and then translate those to performance. Try and find ways for a practical application of this type of training. Maybe a pair of knicks with an inbuilt pump.

Technology & Profiling

This month's top research on technology and profiling

Effects of the Turbine™ on Ventilatory and Sensory Responses to Incremental Cycling

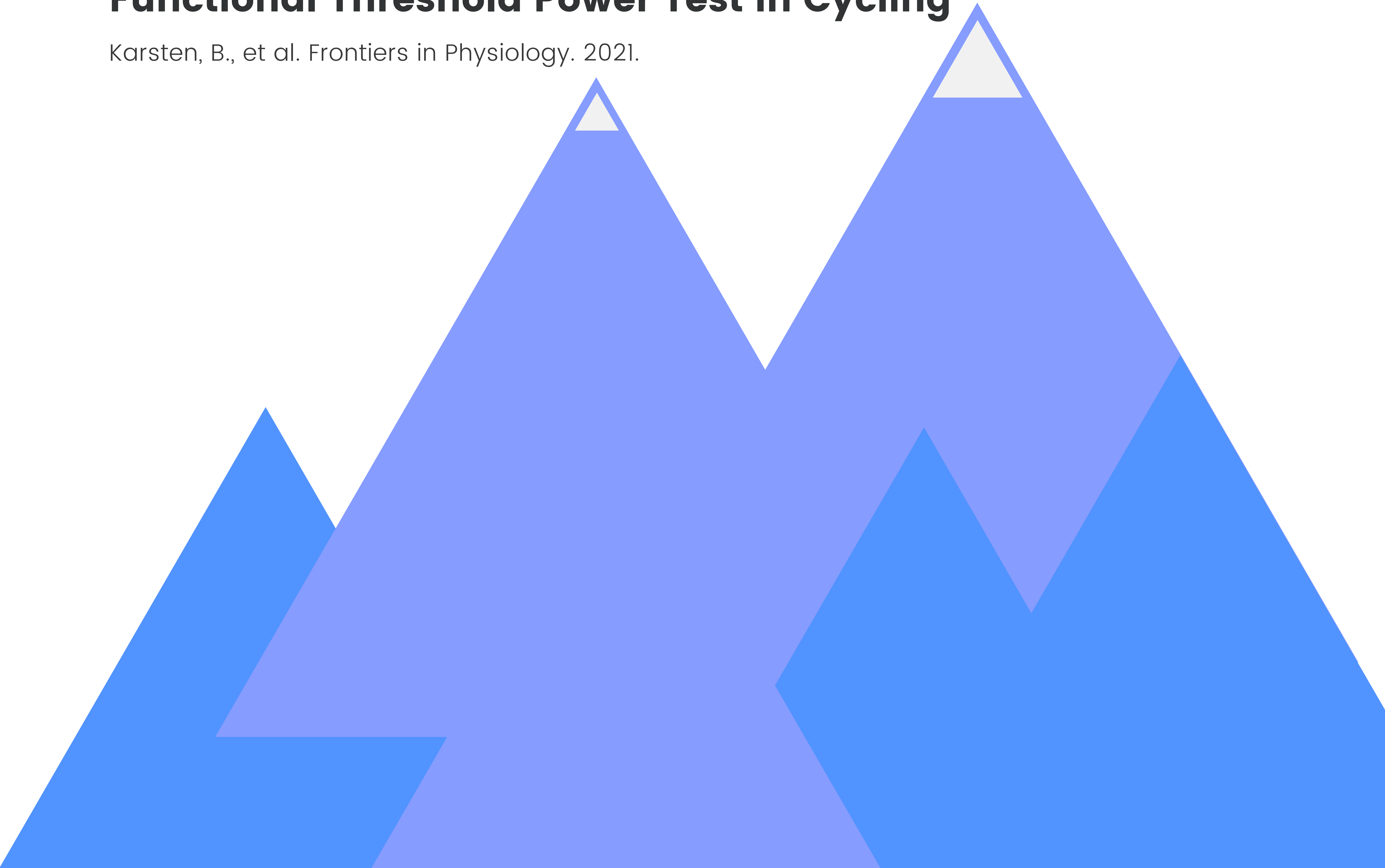
Schaeffer, M., et al. Medicine & Science in Sports & Exercise. 53 (1), 2021.

A New Detection Method Defining the Aerobic Threshold for Endurance Exercise and Training Prescription Based on Fractal Correlation Properties of Heart Rate Variability

Rogers, B., et al. Frontiers in Physiology. 2021.

Relationship Between the Critical Power Test and a 20-min Functional Threshold Power Test in Cycling

Karsten, B., et al. Frontiers in Physiology. 2021.



Abstract

Effects of the Turbine™ on Ventilatory and Sensory Responses to Incremental Cycling

OBJECTIVE

The Turbine™ is a nasal dilator marketed to athletes to increase airflow, which may serve to reduce dyspnea and improve exercise performance, presumably via reductions in the work of breathing (WOB). However, the unpublished data supporting these claims were collected in individuals at rest that were exclusively nasal breathing. These data are not indicative of how the device influences breathing during exercise at higher ventilations when a larger proportion of breathing is through the mouth. Accordingly, the purpose of this study was to empirically test the efficacy of the Turbine™ during exercise. The researchers hypothesized that the Turbine™ would modestly reduce the WOB at rest and very low exercise intensities but would have no effect on the WOB at moderate to high exercise intensities.

WHAT THEY DID

The researchers conducted a randomised crossover study in young, healthy individuals (7M:1F; age = 27 ± 5 yr) with normal lung function. Each participant performed two incremental cycle exercise tests to exhaustion with the Turbine™ device or under a sham control condition. For the sham control condition, participants were told they were breathing a low-density gas to reduce the WOB, but they were actually breathing room air. The WOB was determined through the integration of ensemble averaged esophageal pressure–volume loops. Standard cardiorespiratory measures were recorded using a commercially available metabolic cart. Dyspnea was assessed throughout exercise using the 0–10 Borg scale.

WHAT THEY FOUND

Peak $\dot{V}O_2$ and work rate were not different between conditions ($P = 0.70$ and $P = 0.35$, respectively). In addition, there was no interaction or main effect of condition on dyspnea, ventilation, or WOB throughout the exercise (all $P > 0.05$).

These findings suggest that the Turbine™ does not reduce the work of breathing and has no effect on dyspnea or exercise capacity.

Practical Takeaways

Instead of relying on this device, we might be better off asking if we can train our respiratory muscles to ride faster using inspiratory muscle training (IMT).

Many IMT studies have been conducted, so let's just pick a couple. Starting in 2002, Romer et al. found that IMT significantly reduced RPE (Rating of Perceived Exertion) and improved 20 km and 40km cycling time trial performance, relative to a placebo. In 2008, Edwards et al. set out to test whether IMT combined with cardiovascular training was more effective than cardiovascular training alone at improving 5000 m run performance. Interestingly, the researchers suggested that this was likely due to the fact that IMT significantly reduced the subject's RPE during the performance test.

So if you want to improve your performance through IMT, what's the most effective way to do it? To start with, you need to purchase some kind of inspiratory muscle training device. These devices provide resistance to load the inspiratory muscles when breathing. As your strength increases the load can be increased proportionally to facilitate progression.

Then try IMT while riding. In 2013, Hellyer et al. conducted a study involving 10 subjects carrying out IMT at 40% maximal inspiratory pressure whilst simultaneously cycling. Activity in the respiratory muscles significantly increased (measured with EMG) relative to performing IMT in isolation. These results suggest that combining IMT with cycling may significantly enhance its training effect.

Practically, this kind of training could be carried out by determining a '1-rep max' with a PowerBreathe, before carrying out the 30 breath protocol at 40% of this whilst riding on a trainer before heading out the door for your training session.

Want to learn more?
Check these out...

Damian's Comments

"This study is another nail in the coffin for another sports gadget.

This supports that it is a useless tool, especially during exercise at higher ventilations when a larger proportion of breathing is through the mouth. And more specifically, as this report suggests it does not improve performance or reduce the work of breathing.

So you may want to avoid purchasing the Turbine™."

Abstract

A New Detection Method Defining the Aerobic Threshold for Endurance Exercise and Training Prescription Based on Fractal Correlation Properties of Heart Rate Variability

OBJECTIVE

The purpose of this report is to validate a one nonlinear heart rate variability (HRV)index to identify the aerobic threshold in cyclists and runners.

Certain HRV indexes have been observed to change as exercise intensity rises, potentially providing information regarding an individual's physiologic status.

The short-term scaling exponent alpha1 of detrended fluctuation analysis (DFA a1), is a nonlinear index of heart rate variability (HRV) based on fractal correlation properties, has been shown to steadily change with increasing exercise intensity. To date, no study has specifically examined using the behavior of this index as a method for defining a low intensity exercise zone.

WHAT THEY DID

Seventeen healthy male volunteers, age (yrs) 20±10, training volume (hours/week)varied from 1 to >6 were tested.

Participants performed an incremental VO2MAX test on a motorized treadmill. The treadmill was set for the Bruce protocol with increases in speed and inclination from 2.7 km/h at ten percent grade, increasing by 1.3 km/h and two percent grade every 3 min until volitional exhaustion. A fan was used for cooling.

WHAT THEY FOUND

→ The results presented here appear to indicate that VT1 is reached at a midpoint between a fractal behavior of DFA a1 and a pattern of uncorrelated white noise with random behavior, corresponding to a DFA a1 of approximately 0.75.

Other cycling ramp studies in men of different fitness levels seemed to indicate that DFA a1 crossed the value of 0.75 at about 73–78% of VO2MAX (Hautala et al., 2003; Hottenrott and Hoos, 2017), within the approximate realm of VT1 for many individuals (Gaskill et al., 2001; Pallarés et al., 2016).

Practical Takeaways

If you want to test this - you are looking for DFA a1 value to cross 0.75 - use the power at this value as your aerobic threshold.

Here are three ways to determine LT1 through HRV DFA a1 analysis

→ Progressive ramp test past estimated LT1
- Ramp from 130w, then 5w/minute
- Don't need to go to max power, 1 or 2 stages past FTP
- Record RR intervals (HRV)
- Kubios for analysis

→ Steady-state with post-ride analysis
- 20-minute warm-up
- 5-8 minutes power intervals
- Record RR intervals (HRV)
- Kubios for analysis

→ Steady-state with in-ride (real-time) analysis
- 20-minute warm-up
- 6-8' power - get a value every 2 minutes
- HRV4T Data Logger

Want to learn more?
Check these out...

Damian's Comments

"This is a new way of getting a threshold number without a maxt test. As noted by the authors, "A significant advantage of DFA a1 over other HRV indexes for the determination of a low intensity threshold revolves around the nature of testing. With DFA a1, once the VT1 boundary area is reached, little additional increase in exercise intensity should be required. For athletes evaluating low intensity training limits, avoidance of exercise ramps to volitional failure may help avert undue stress in a polarized training model."

Use this test to find this first aerobic threshold, post-ride assessment to check you were under this threshold after endurance rides, real-time keep an eye on your a1, and make sure you're at 0.75 or better.

FYI - VT1 occurs at around 52% of Maximal Aerobic Power (MAP) (Cerezuela-Espejo et al., 2018), which would sit somewhere around ~65-70% of FTP"

Abstract

Relationship Between the Critical Power Test and a 20-min Functional Threshold Power Test in Cycling

OBJECTIVE

The present laboratory-based study was to compare CP as an index of "true" maximal metabolic steady state (MMSS) with FTP.

Over the past 40 years, the CP concept has been studied extensively within the scientific literature and it has emerged as a simple mathematical model which not only describes the relationship between sustainable power and the development of fatigue during high intensity exercise, but which also provides an estimate of the maximal sustainable metabolic rate.

More recently, practical methods of threshold assessments have emerged such as field-based CP testing, and the Functional Threshold Power (FTP). The FTP has become widely popular amongst recreational and competitive cyclists for the purpose of aerobic capacity assessment and training prescription. However, to-date there is controversy as to whether FTP is related to CP or parameters of other threshold concepts.

WHAT THEY DID

17 moderately trained cyclists and triathletes (mean ± SD: age 31 ± 9 years, body mass 80 ± 10 kg, maximal aerobic power 350 ± 56 W, peak oxygen consumption 51 ± 10 mL·min−1·kg−1) performed a maximal incremental ramp test, a single-visit CP test and a 20-min time trial (TT) test in randomized order on three different days.

CP was determined using a time-trial (TT) protocol of three durations (12, 7, and 3 min) interspersed by 30 min passive rest.

FTP was calculated as 95% of 20-min mean power achieved during the TT.

WHAT THEY FOUND

- The primary finding of this study was that for moderately trained cyclists, mean CP was non-significantly higher than FTP (i.e., 95% of 20MMP).

  Significant main effects and a large effect size were found between CP, FTP, and 20MMP ($F_{2,32} = 13.029$; $P < 0.001$; η2pηp2 = 0.45).

  Agreement between CP and FTP was assessed using the 95% limits of agreement (LoA) method and Pearson correlation coefficient. There was a 91.7% probability that CP (256 ± 50 W) was higher than FTP (249 ± 44 W).

Practical Takeaways

- If you want to conduct a Critical Power test as an alternative approach to an FTP, this test has the benefit that it will also provide information on the size of your anaerobic capacity.

  In order to determine CP and W', you will need to complete 3-4 maximal efforts, each lasting between 3-mins and 20-mins. To get a good spread of durations, we recommend tests lasting 12, 7 and 3 min.

  Each maximal effort should be paced as consistently as possible. So, don't start too hard, and then fade towards the end. The tests should be performed on different days, with at least 24 hours rest between, so that your results aren't impacted by fatigue.

- It's important to warm up well before each maximal effort. This is important because one of the assumptions of the critical power model is that the aerobic systems kick in instantaneously to provide energy during each maximal effort. In practice this isn't true, and there's a lag between the effort starting, and the aerobic systems ramping up their energy contribution. However, this lag can be minimised by warming up well beforehand.

  Research looking at oxygen uptake after a warm-up (Jones et al., 2003) suggests a good warm-up should include: a gradual increase in exercise intensity from around a 2/10 to a 4/10 effort level or from around 45% to 75% FTP/CP, then some hard efforts above your expected FTP/CP/lactate threshold power, where you should feel lactate levels building somewhat, but these efforts these should only feel moderately hard, not all-out.then finally a short period (e.g. 4-5 mins) of gentle riding around a 2-3/10 effort level or between around 45-55% FTP to allow lactate levels to reduce.

Want to learn more?
Check these out...

Damian's Comments

""This is more evidence that there is no versus CP. This study adds to the idea that CP and FTP are strongly correlated, but not interchangeable.

This idea works because CP is almost exclusively aerobic in nature, whereas FTP is a performance measure involving complex interplay of multi-factorial fatigue mechanisms."

Nutrition

This month's top research on nutrition

International society of sports nutrition position stand: caffeine and exercise performance

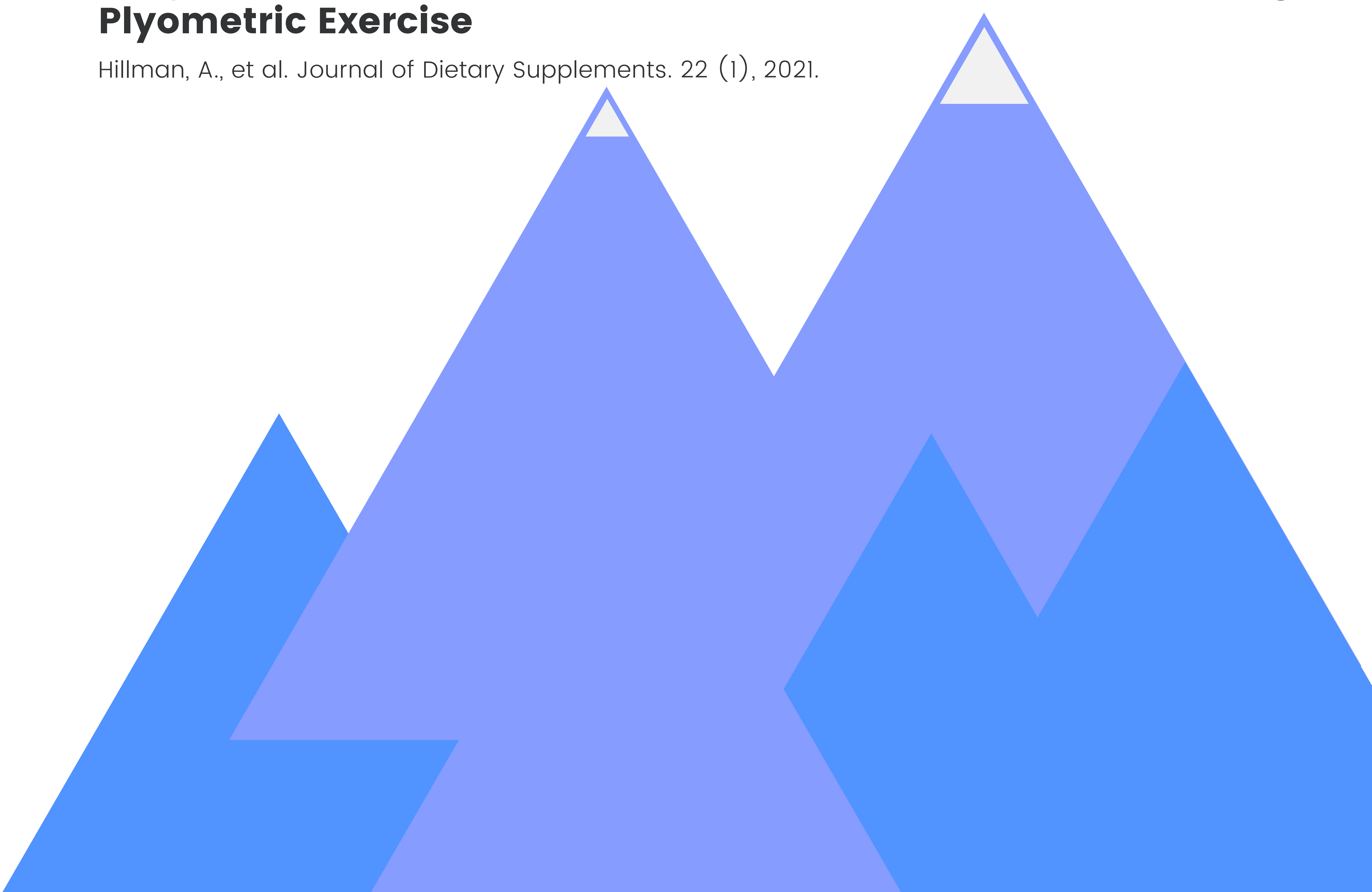
Guest, N., et al. Journal of the International Society of Sports Nutrition. 18(1), 2021.

The effect of β-alanine supplementation on high intensity cycling capacity in normoxia and hypoxia

Patel, K., et al. Journal of Sports Sciences. 2021.

Ten Days of Curcumin Supplementation Attenuates Subjective Soreness and Maintains Muscular Power Following Plyometric Exercise

Hillman, A., et al. Journal of Dietary Supplements. 22 (1), 2021.



Abstract

International society of sports nutrition position stand: caffeine and exercise performance

OBJECTIVE

This is a critical evaluation of the available literature to date, The International Society of Sports Nutrition (ISSN)position regarding caffeine intake will repeat some finds we already know but it is a good reminder of the current state of caffeine use for cycling performance.

WHAT THEY FOUND

- Caffeine has consistently been shown to improve endurance by 2–4% across dozens of studies using doses of 3–6 mg/kg body mass [13, 195, 205–207]. Accordingly, caffeine is one of the most prominent ergogenic aids and is used by athletes and active individuals in a wide variety of sports and activities involving aerobic endurance.

  Caffeine has been shown to benefit several endurance-type sports including cycling.

  A recent meta-analysis reporting on 56 endurance time trials in athletes (79% cycling), found the percent difference between the caffeine and placebo group ranged from - 3.0 to 15.9%

- In summary, caffeine has been consistently shown to be effective as an ergogenic aid when taken in moderate doses (3–6 mg/kg), during endurance-type exercise and sport. Dozens of endurance studies are highlighted through this review is various sections, showing consistent yet wide-ranging magnitudes of benefit for endurance performance under caffeine conditions.

Practical Takeaways

- Caffeine timing

The most common timing of caffeine supplementation is 60 min before exercise. This timing is used given that it is believed that 60 min post-ingestion, plasma levels of caffeine are at maximal values. However, caffeine appears to be most beneficial during times or in sports where there is an accumulation of fatigue, i.e., exercise over a longer continuous or intermittent duration.

A recent review reported that the effect size of caffeine benefits increase with the increasing duration of the time trial event, meaning that timing caffeine intake closer to a time of greater fatigue, i.e., later in the race, may be most beneficial. This supports the notion that endurance athletes (with longer races) may benefit most from caffeine for performance enhancement since they have the greatest likelihood of being fatigued. This also supports findings in other investigations that show ingesting caffeine at various time points including late in exercise may be most beneficial.

The optimal timing of caffeine ingestion may depend on the source of caffeine. Some of the alternate sources of caffeine such as caffeine chewing gums may absorb more quickly than caffeine ingested in caffeine-containing capsules. Therefore, individuals interested in supplementing with caffeine should consider that timing of caffeine ingestion will likely be influenced by the source of caffeine.

Damian's Comments

"One area that may be of interest is that caffeine at the recommended doses does not appear significantly influence hydration,
and the use of caffeine in conjunction with exercise in the heat and at altitude is also well supported.

Also, consider alternative sources of caffeine, such as caffeinated chewing gum, mouth rinses, and energy gels, which have also been shown to improve performance."

Abstract

The effect of β-alanine supplementation on high intensity cycling capacity in normoxia and hypoxia

OBJECTIVE

This study examined the effects of beta-alanine (BA) supplementation on high intensity cycling capacity in normoxia and hypoxia.

The availability of dietary BA is the limiting factor in carnosine synthesis within human muscle due to its low intramuscular concentration and substrate affinity. Carnosine can accept hydrogen ions (H+), making it an important intramuscular buffer against exercise-induced acidosis.

Metabolite accumulation rate increases when exercising in hypoxic conditions, thus an increased carnosine concentration could attenuate H+ build-up when exercising in hypoxic conditions.

WHAT THEY DID

In a double-blind design, nineteen males were matched into a BA group (n = 10; 6.4 g·d-1) or a placebo group (PLA; n = 9) and supplemented for 28 days, carrying out two pre- and two post-supplementation cycling capacity trials at 110% of powermax, one in normoxia and one in hypoxia (15.5% O2).

WHAT THEY FOUND

- Hypoxia led to a 9.1% reduction in exercise capacity, but BA supplementation had no significant effect on exercise capacity in normoxia or hypoxia ($P > 0.05$).

  Blood lactate accumulation showed a significant trial x time interaction post-supplementation ($P = 0.016$), although this was not significantly different between groups.

- BA supplementation did not increase high intensity cycling capacity in normoxia, nor did it improve cycling capacity in hypoxia even though exercise capacity was reduced under hypoxic conditions.

Practical Takeaways

- Proper Dosing of ß-Alanine

Dosing of ß-alanine 2g 2-4 times daily for a total of 4-8g. This should be done for a minimum of 2 weeks to improve muscle carnosine levels by 20-30%, but ideal supplementation time is 4-6 weeks with muscle carnosine levels shown to increase 40-60% compared to baseline (5). There have been no long-term studies done regarding long-term supplementation (>6 weeks) of ß-alanine, but the general consensus seems to be that it is safe and after the initial loading phase of the first 4-6 weeks, higher muscle carnosine levels can be maintained with a maintenance dose of 2-3 grams per day.So, can ß-alanine boost your cycling performance? YES!Ideally, ß-alanine should be loaded with 2g 2-4 times per day for a total dose of 6-8g for the first 4 weeks. This will increase muscle carnosine concentrations by 40-60% and can be maintained with a 2-3g dose once per day. The increase of muscle carnosine acts as a Hydrogen buffer and prevents acidosis as well as delaying neuromuscular fatigue for activities lasting 1-4 minutes especially, but has been shown to improve time to exhaustion for activities lasting >20 minutes. The long-term dosing of ß-alanine has not been studied, but is generally viewed as being safe. Remember to expect paraesthesia (tingling) when first supplementing with ß-alanine which will go away over time and with continued supplementation.

Want to learn more?
Here are two studies that show benefits for cycling...

Damian's Comments

Beta-alanine has been a supplement used by cyclists for a long time now. It has been reported to improve muscular strength, power output, as well as improve anaerobic and aerobic endurance.

Seeing

The effect of β-alanine supplementation on high intensity cycling capacity in normoxia and hypoxia.

BA did not increase high intensity cycling capacity in normoxia, or cycling capacity in hypoxia.

Abstract

Ten Days of Curcumin Supplementation Attenuates Subjective Soreness and Maintains Muscular Power Following Plyometric Exercise

OBJECTIVE

To determine the effects of curcumin supplementation on delayed onset muscle soreness and muscle power following plyometric exercise.

WHAT THEY DID

Participants (n = 22; five females, 17 males) consumed either curcumin (500 mg) or placebo twice daily for 10 days (6 days pre, day of and 3 days post exercise).

Participants completed 5 x 20 drop jumps on day 7.

Blood sampling and recovery tests were assessed at pre-supplementation, 24-hours and immediately pre-exercise, and immediately post-, 24, 48 and 72-hours post-exercise. Blood markers included serum creatine kinase (CK) and erythrocyte sedimentation rate (ESR), while soreness was measured during a squat and post vertical jump

WHAT THEY FOUND

- They found that curcumin supplementation decreased subjective ratings of soreness during a squat and after vertical jump performance and maintained muscular power performance better than placebo. This is despite no significant differences between curcumin and placebo on biomarkers of muscle damage and inflammation.
- Both groups experienced muscle damage post-exercise with elevated CK (403 ± 390 ul; $p < 0.01$), soreness with squatting (38 ± 29 mm; $p < 0.01$), and vertical jump (36 ± 30 mm; $p < 0.01$). Soreness was greater in placebo vs. curcumin 48 h and 72 h post-exercise ($p < 0.01$); however, CK was not significantly different between groups ($p = 0.28$) despite being >200 $IU \cdot L^{-1}$ greater 24 hr post exercise in placebo vs. curcumin.

These data suggest curcumin reduces soreness and maintains muscular power following plyometric exercise.

Practical Takeaways

- Supplementing with curcumin especially during times of heavy training or unaccustomed exercise (i.e. pre-season, short rest between competition, etc.) may help support training by decreasing perceived soreness and maintaining power.

We do not know the optimal amount to supplement with. A systematic review of the effects of curcumin supplementation on sport and physical exercise (linked below)The authors concluded there is a range of dosages, and some were taken in combination with other compounds such as Boswellia extract, which is an herbal supplement.

- In general, though, the most common dose was between 180mg to 500mg daily and the period of supplementation was short—often for just a few days, or only after intense exercise. But the fact that researchers saw benefits from that is promising, but they still have to be cautious about recommendations because curcumin is not yet considered a sports supplement with the highest degree of evidence.

More studies will need to be done to bring it to that level, but in general, the most promising results seem to be decreased muscle damage from training as well as reduced pain. Both are related to less exercise-related inflammation.

Want to learn more?
Here is one study and an article that show benefits for cycling...

Damian's Comments

This study adds to a growing body of science supporting the potential benefits of turmeric and curcumin for athletic performance.

The antioxidant qualities that are being researched regarding athletic performance. The dilemma with antioxidants generally (typically most commonly used are vitamins C and E) is that they seem to do their job while also restraining the adaptations from hard training that one is seeking. There is some emerging science to the effect that curcumin enhances recovery without also restraining positive adaptations.

Further research is warranted to elucidate the relationship of muscle damage and inflammation and the potential impact of curcumin both, particularly in sport-specific settings.

Strength

This month’s top research on nutrition

Traditional Versus Optimum Power Load Training in Professional Cyclists: A Randomized Controlled Trial

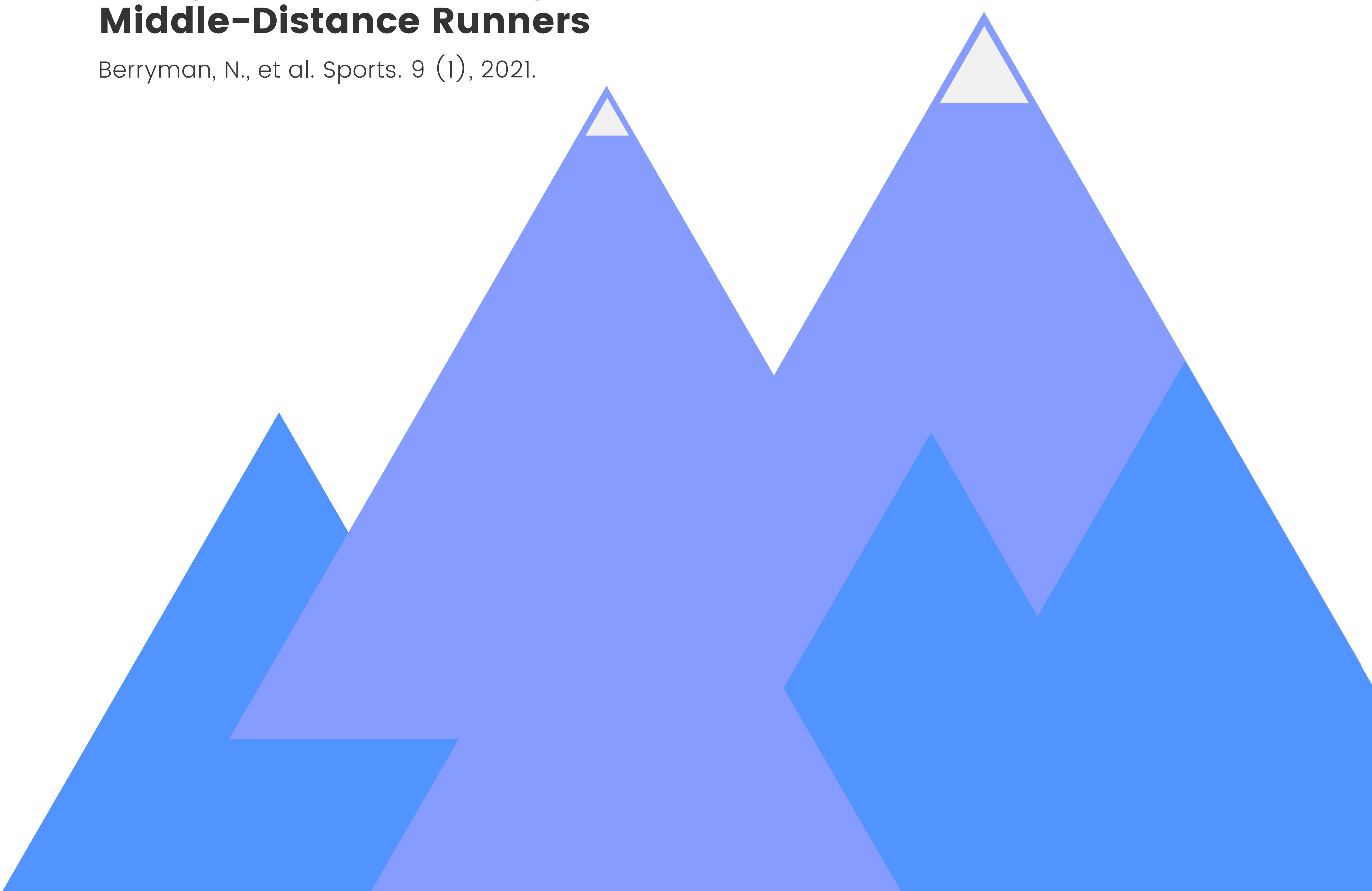
Gil-Cabrera, J., et al. International Journal of Sports Physiology and Performance. 1(8), 2021.

Traditional versus velocity-based resistance training in competitive female cyclists: a randomized controlled trial

Montalvo-Pérez, A., et al. Frontiers in Physiology. 2021.

Effects of Short-Term Concurrent Training Cessation on the Energy Cost of Running and Neuromuscular Performances in Middle-Distance Runners

Berryman, N., et al. Sports. 9 (1), 2021.



Abstract

Traditional Versus Optimum Power Load Training in Professional Cyclists: A Randomized Controlled Trial

OBJECTIVE

To compare the effectiveness of a commonly prescribed type of velocity-based resistance training called optimum power load training (OPT) with traditional resistance training (TRT) in professional cyclists.

OPT is a commonly prescribed type of velocity-based resistance that consists of prescribing training loads based on the individualised load maximizing muscle power watt output (usually corresponding to a mean velocity of ~1.0 m/s).

Traditional resistance training is the same number of repetitions and relative load for all individuals.

WHAT THEY DID

Participants (19y, V02max 75.5 mL/kg/min) were randomly assigned to 8 weeks (2 sessions per week) of

- TRT (n = 11)
- OPT (n = 9)

During which they maintained their usual cycle training schedule.

All participants performed 2 RT sessions per week (from Monday to Friday, and interspersed by a minimum of 48 h)

		Weeks 1-3		Weeks 4-6		Weeks 7-8	
Intervention	Variable	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
TRT	Exercise	Squat, hip thrust, and lunge					
	Training, set x reps	3x10	3x6	3x8	3x5	3x6	3x4
	Load, %RM	75%	85%	75%	85%	75%	85%
	Rest, s	120					
OPT	Exercises	Squat, hip thrust, and lunge					
	Training, set x reps	3 × maximum number of repetitions at >90% OPL (8 [3] reps)					
	Load, %RM	OPL (65% [10%])					
	Rest, s	120					

WHAT THEY FOUND

- OPT resulted in a lower average intensity (percentage of 1-repetition maximum) during resistance training sessions for all exercises ($P < .01$), but no differences were found for overall training loads during resistance or cycling sessions ($P > .05$).
- Both programs led to significant improvements in all strength/power-related parameters, muscle mass (with no changes in total body mass but a decreased fat mass), and time-trial performance (all Ps < .05).
- A trend toward increased power output at the respiratory compensation point was also found ($P = .056$ and .066 for TRT and OPT, respectively). No between-groups differences were noted for any outcome ($P > .05$).

Conclusion: The addition of either TRT or OPT to an endurance training regimen of elite cyclists results in similar improvements of body composition, muscle strength/power, and endurance performance.

Practical Takeaways

- If you are able to access the technology this is how to find your optimal training load for an intervention. The first step is finding your mean propulsive power with an incremental loading test for the squat, lunge, and hip thrust exercises. In this study, these were performed on a Smith machine, and bar mean propulsive velocity and mean propulsive power (MPP) during the concentric phase were measured with a validated linear position transducer (T-Force System; Ergotech, Murcia, Spain).

  The initial weight was 20 kg (ie, only the bar), and the load was increased by 5 to 10 kg until a decrease in MPP was observed in 2 consecutive loads. Athletes performed 3 consecutive repetitions with each load, and a 3-minute rest was allowed between loads. The highest MPP registered for each exercise was used for analysis. Once the incremental test was ended and after a 10-minute rest, we assessed the number of repetitions that each participant could perform with their MPP associated load (ie, the optimum power load) before attaining <90% of their MPP during the sets, which was used for the guidance of training prescription

- Then when doing the work the optimum power load was determined during baseline tests and was also updated for the OPT group at week 4 during the study. The number of repetitions was also individualized for each participant and exercise, with each participant performing the number of repetitions that allowed them to maintain at least >90% of their MPP during the sets, which was also individually determined for each exercise during the tests performed at baseline and at week 4 during the study.

  Thus, the load lifted (65% [10%] of 1RM) and the number of repetitions per set (8 [3]) varied between participants and within the same participant from the first to the second half of the study.

Want to learn more?
Here are two studies that show benefits for cycling...

Damian's Comments

"This study shows the main advantage of VBT is that it could be a more efficient strategy for inducing the same improvements despite no evidence of differences in effectiveness between OPT and TRT.

Avoiding resistance training-induced fatigue (eg, muscle soreness, neural fatigue, glycogen depletion) is of major importance in endurance athletes, as it can impair the quality of endurance training sessions and thus limit the development of endurance capabilities.

In the present study, average training intensity was lower (less percentage of 1RM) in OPT compared with traditional resistance training for all exercises, and resistance training external loads were also lower (less total weight lifted) in the former during most of the intervention (ie, up to the 11th session of 16 performed). However, no differences were found for overall external resistance training loads during the whole intervention or for internal training loads during resistance training or cycling sessions. Thus, the present findings do not overall support the superiority of optimum power load training over traditional resistance training for reducing training loads.

Thus, both interventions might be equally recommended and their implementation could depend on individual preferences or methodological resources (eg, optimum power load training might require greater resources to monitor velocity which will be discussed in the practical takeaways section of this review)."

Abstract

Traditional versus velocity-based resistance training in competitive female cyclists: a randomized controlled trial

OBJECTIVE

The aim of the study was to assess the effects of a short-term velocity-based resistance training (VBRT, where exercise intensity is individualized based on the loads and repetitions that maximize power output) program compared with traditional resistance training (TRT, where the same number of repetitions and relative load are used for everyone) to improve body composition, strength and endurance performance in competitive female cyclists.

WHAT THEY DID

17 participants were randomly assigned to 6 weeks (2 sessions·week-1) of TRT (n=8) or VBRT (n=9), during which they maintained their normal endurance program. Both interventions included the squat, hip thrust and split squat exercises. Training loads were continuously registered, and outcomes included measures of muscle strength/power, body composition, and endurance performance (including an incremental test and an 8-minute time trial).

WHAT THEY FOUND

→ No between-group differences were found for overall training loads during RT or cycling sessions ($p>0.05$). Both interventions led to significant improvements in all strength/power-related parameters, but VBRT induced greater improvements for maximum strength and power as assessed with the hip thrust exercise ($p<0.05$). Significant increases in muscle mass were observed with VBRT ($p<0.05$) but not TRT. Both interventions led to significant improvements in the power output during the time trial, with no differences between groups.

Damian's Comments

"I have published this review before seeing the full article as it is yet to be published. I wanted to include it as it shares a similar result as the previous study. We may not have the details of the intervention but the results are encouraging to reinforce the idea that VBT might induce superior gains on body composition and strength."

Abstract

Effects of Short-Term Concurrent Training Cessation on the Energy Cost of Running and Neuromuscular Performances in Middle-Distance Runners

OBJECTIVE

Evidence supports the implementation of concurrent strength and running training, within the same mesocycle, to improve performances in middle- and long-distance events. However, very little is known about the effects of concurrent training cessation.

The purpose of this investigation was to describe the effects of 4 weeks of explosive strength training cessation after an 8-week concurrent training protocol.

WHAT THEY DID

Eight runners completed this study, which first included either plyometric (n = 4) or dynamic weight training (n = 4) in addition to the usual running regimen. Explosive strength training was thereafter interrupted for 4 weeks, during which running sessions were maintained.

Participants were tested at baseline, after concurrent training and after concurrent training cessation.

WHAT THEY FOUND

- The results suggest that the energy cost of running improvements observed after the intervention (-5.75%; 95% CI = -8.47 to -3.03) were maintained once explosive strength training was interrupted (-6.31%; 95% CI = -10.30 to -2.32). The results also suggest that neuromuscular performances were maintained after 4 weeks of concurrent training cessation, especially when tests were specific to the training intervention. Furthermore, a 3000m time trial revealed a similar pattern, with improvements after the concurrent mesocycle (-2.40%; 95% CI = -4.65 to -0.16) and after concurrent training cessation (-4.43%; 95% CI = -6.83 to -2.03). Overall, only trivial changes were observed for aerobic endurance and VO2 peak. Together, these results suggest that short-term explosive strength training cessation might be beneficial and could be considered as a taper strategy for middle-distance runners.

Practical Takeaways

- The best approach is a two week period when you gradually reduce volume by 40 to 60 percent but keep the number and intensity of the sessions the same.

The results suggest that if nothing else, you can err on the side of caution in backing off your strength routine fairly early.

The question that's left hanging is whether the extra boost in 3,000-meter performance after the taper (despite running economy staying the same and VO2 max getting worse) is real. There's simply not enough data here to draw conclusions, but there are some hints in previous studies that there might be an "overshoot" effect that supercharges your fast-twitch muscle fibers a week or two after you stop your strength training routine.

Future research is needed here—but even without an overshoot effect, these results add support to the idea that you can and probably should taper your strength training at least a week before a big event.

Damian's Comments

"This study helps answer the question of when should you stop strength training to taper before an important event.

The authors go out of their way to emphasize all the caveats here, particularly the small sample size of eight subjects. We also don't really know how things were changing during the four-week taper. Maybe the best performance of all was actually one or two weeks after the cessation of strength training.

Still, at least you have a starting point when it comes to stopping strength training before an important event. However, as the authors state "coaches and athletes must interpret these results cautiously considering the study's low sample size and the very limited available literature in this domain."

Thanks for reading

Next issue will be published on the first of next month.

If you liked all the great content, then make sure to share it and spread the knowledge to your friends and colleagues who you know will also find it useful!

Cheers!
Damian