SEMIPRO CYCLING

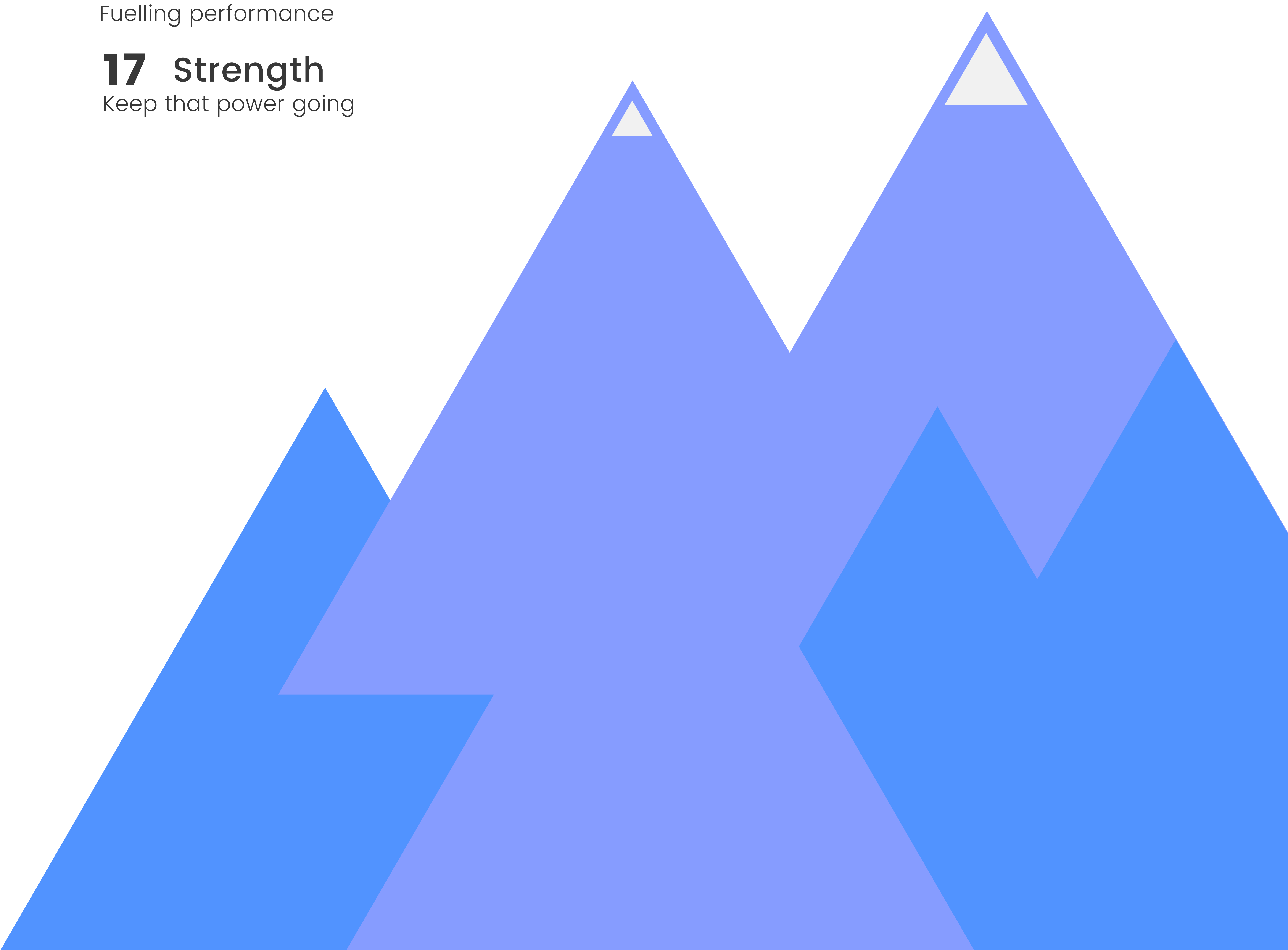
MAY 2021 | ISSUE #05

CYCLING SCIENCE

DIGEST

A MONTHLY SUMMARY OF THE LATEST CYCLING PERFORMANCE RESEARCH

Contents



How to read the digest

Page number

Classic

Section

Abstract

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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

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.

Practical takeaways from 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

Reviewers comments on the study

Want to learn more?
Check these out...

Related links to learn more about the topic

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. This month we decided to add some 'classic' studies into the mix. The goal of the Digest is not only to inform it's to educate - or at least remind you of some studies that made an impact in the world of sports science. Keep an eye out for them throughout the Digest.

2. I'm curious about how you are finding the Digest. Are we hitting the spot or are we missing specific topics? Send me an email directly at damian@semiprocycling.com with any feedback or requests and I'll consider changes for next month's issue.

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.

Not a member of SEMIPRO+ yet?

Learn more

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.

Meet your experts

The Coach

Damian Ruse

Founder and Head Coach of SEMIPRO Cycling

Damian has a Batchelor of Psychology from the University of New England and 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.

The Scientist

Jason Boynton Ph.D

Sport Scientist & Cycling Coach

Jason Boynton has a PhD is Exercise and Sport Science and is a USA Cycling level 1 certified coach. Jason is also a published researcher in the area of cycling performance. Jason earned his Ph.D. at Edith Cowan University in Perth, Australia. His academic supervisors were Associate Professor Chris Abbiss, Dr. Paolo Menaspà (Cycling Australia), and Associate Professor Jeremiah Peiffer. His thesis research investigated the effects of environmental temperature on high-intensity interval training.

The Athlete

Cyrus Monk

FUll-time Athlete with a Bachelor of Exercise Science

Cyrus has a Bachelor of Science with a Physiology Major from the University of Melbourne and is now a full-time athlete with UCI Professional cycling team EvoPro Racing. As a former U23 Australian champion Cyrus knows how to get the best out of himself.

Performance

This month's top research on cycling performance

Effects of Long-Haul Travel on Recovery and Performance in Elite Athletes: A Systematic Review

Rossiter, A., et al. The Journal of Strength and Conditioning Research. Ahead of print, 2021.

Do We Need a Cool-Down After Exercise? A Narrative Review of the Psychophysiological Effects and the Effects on Performance, Injuries and the Long-Term Adaptive Response

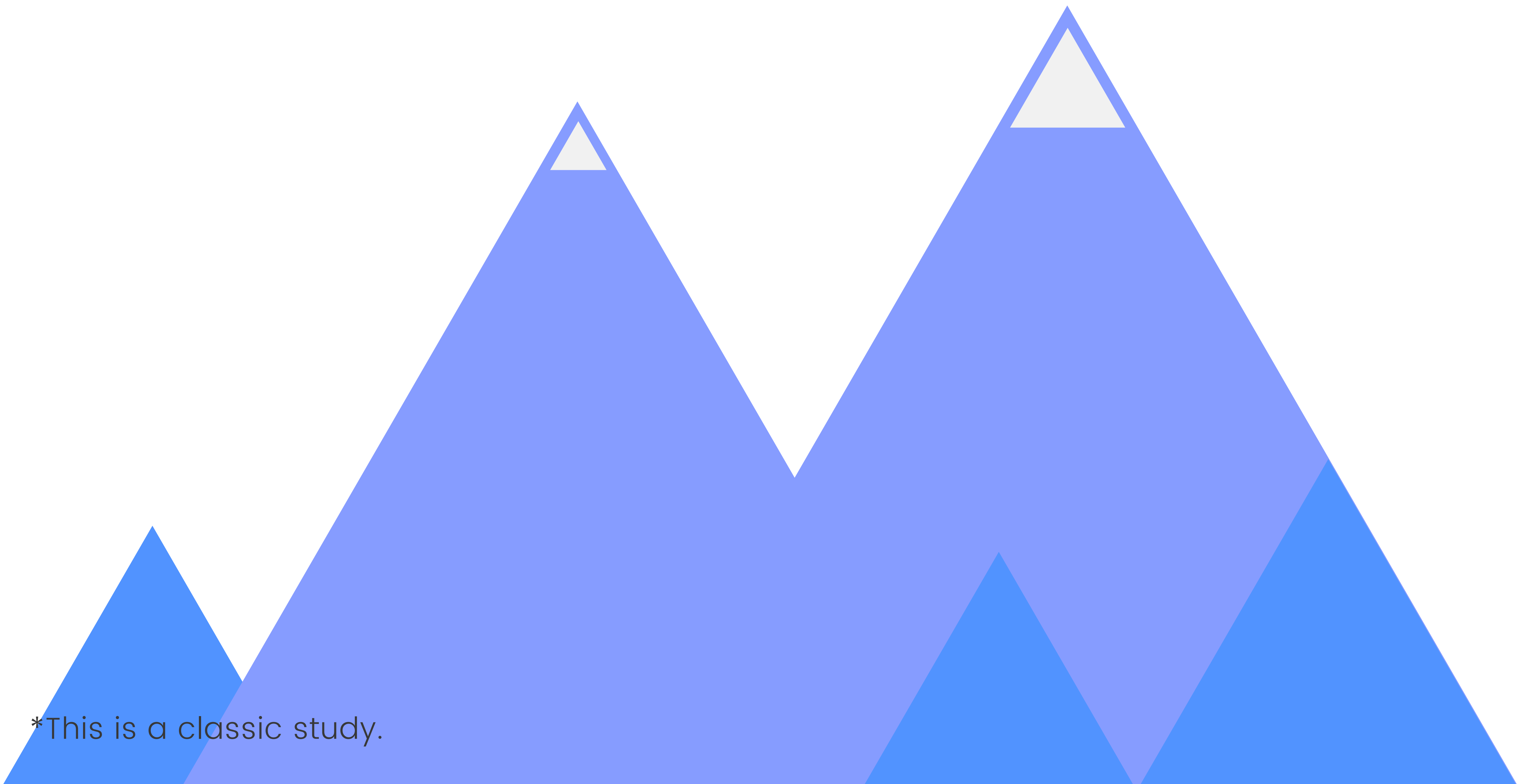
Van Hooren, B., Peake, Journal Sports Medicine. 48, 2018.

The dose-response relationship between interval-training and VO2max in well-trained endurance runners: A systematic review

Parmar, A., et al. Journal Sport Science. 1(18), 2021.

Effect of training on enzyme activity and fiber composition of human skeleta1 muscle*

Gollnick, P, D. Journal of Applied Physiology. 34 (1) 1973.



*This is a classic study.

Abstract

Effects of Long-Haul Travel on Recovery and Performance in Elite Athletes: A Systematic Review

OBJECTIVE

Elite athletes are often required to travel long-haul (LH) across numerous time zones for training or competition. However, the extent to which LH travel affects elite athlete performance remains largely unknown. The purpose of this systematic literature review was to critically evaluate available evidence on the effects of LH travel on elite athlete psychometric, physiological, sleep, and performance markers.

WHAT THEY DID

Electronic database searches of PubMed, SPORTDiscus, Scopus, and Web of Science were conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Studies were eligible for inclusion if subjects were identified as elite athletes who embarked on a LH flight (>6 hours) and used an outcome measurement of recovery or performance after the flight. Studies that were retrospective, used light therapy or pharmacological interventions were not included. Of 2,719 records assessed, 14 studies comprising a total of 197 athletes from 6 sports met the inclusion criteria.

WHAT THEY FOUND

- There was an increase in perceived jet lag and disturbance to various physiological markers after LH travel; however, there was minimal disturbance in other psychometric markers. Sleep was not negatively affected by LH travel. Of 10 studies that assessed performance, 3 found decrements in indirect markers of performance. Elite athletes perceived themselves to be jet-lagged and experienced disturbance to various physiological mechanisms after LH travel; however, the effect on performance was inconclusive.

Practical Takeaways

- From the limited studies that exist on this topic, it remains unclear whether LH travel affects elite athlete performance.

  However, elite athletes consistently perceive themselves to be jet lagged, and there is a disruption of physiological rhythm after LH transmeridian travel, and these effects are most severe after travel in an eastward direction. Recovery from jet lag in elite athletes occurs within 1 day for every time zone crossed. It is generally preceded by improved sleep and recovery of psychometric markers.

- Sleep can potentially be more disturbed in the lead up or during travel in comparison with the days after LH travel. There is benefit in monitoring individual athlete response during and after LH travel, to assist in the development of individual travel and recovery strategies. It is recommended that a range of both subjective and objective markers are monitored; perceived jet lag and salivary cortisol may be a practical and cost-effective way to monitor resynchronization of the body clock in elite athletes.

Want to learn more?
Check this out...

Cyrus' Comments

"Anecdotally, I personally find LH travel to have a major short term effect on performance but this is largely due to the increased risk of illness - I've often experienced upper respiratory tract infections in the days after lengthy air travel. However, with the greater hygiene measures in place throughout the travel experience now hopefully this becomes less common..

I support the one day of recovery per time zone crossed recommendation. After flying from Melbourne to Barcelona (8hr difference) in early April of this year I had three days between landing in Spain and starting my first stage race. I certainly wasn't at my best for this race but managed to complete it without falling ill and at the tour the following week (11-14 days post travel) felt far more 'normal' and managed to achieve some good results."

Abstract

Do We Need a Cool-Down After Exercise? A Narrative Review of the Psychophysiological Effects and the Effects on Performance, Injuries and the Long-Term Adaptive Response

OBJECTIVE

It is widely believed that an active cool-down is more effective for promoting post-exercise recovery than a passive cool-down involving no activity. However, research on this topic has never been synthesized and it therefore remains largely unknown whether this belief is correct. This review compares the effects of various types of active cool-downs with passive cool-downs on sports performance, injuries, long-term adaptive responses, and psychophysiological markers of post-exercise recovery.
The findings of this review will be of primary interest to athletes and practitioners who regularly use an active cool-down to facilitate recovery between training sessions or competitions, but are interested in what evidence exists that supports the use of an active cool-down compared with a passive cool-down.

WHAT THEY DID

The authors only included studies that have compared an active cool-down with a passive cool-down that consists of sitting, lying, or standing (without walking). They have also restricted the review to studies that have investigated the effects of performing an active cool-down within approximately 1 h after exercise because findings from a recent survey suggest that this most closely replicates the cool-down procedure of many recreational and professional athletes. The primary focus is on how active cool-downs influence performance and psychophysiological variables during successive exercise sessions or competitions [i.e., approximately > 4 h after exercise, or during the next day(s)].
Relevant studies have been searched in the electronic databases of Google Scholar and Pubmed using combinations of keywords and Booleans that included (cool-down OR active recovery OR warm-down) AND (sports performance OR recover OR recovery OR physiological OR physiology OR psychological OR psychology OR injury OR injuries OR long-term adaptive response OR adaptation).

WHAT THEY FOUND

An active cool-down is largely ineffective with respect to enhancing same-day and next-day(s) sports performance, but some beneficial effects on next-day(s) performance have been reported. Active cool-downs do not appear to prevent injuries, and preliminary evidence suggests that performing an active cool-down on a regular basis does not attenuate the long-term adaptive response. Active cool-downs accelerate recovery of lactate in blood, but not necessarily in muscle tissue.

- Performing active cool-downs may partially prevent immune system depression and promote faster recovery of the cardiovascular and respiratory systems. However, it is unknown whether this reduces the likelihood of post-exercise illnesses, syncope, and cardiovascular complications. Most evidence indicates that active cool-downs do not significantly reduce muscle soreness, or improve the recovery of indirect markers of muscle damage, neuromuscular contractile properties, musculotendinous stiffness, range of motion, systemic hormonal concentrations, or measures of psychological recovery. It can also interfere with muscle glycogen resynthesis.

Practical Takeaways

- An active cool-down generally does not improve and may even negatively affect performance later during the same day when the time between successive training sessions or competitions is > 4 h. Similarly, an active cool-down has likely no substantial effects on next-day sports performance, but can potentially enhance next-day performance in some individuals. With regard to the long-term effects, a cool-down likely does not prevent injuries, and preliminary evidence suggests that an active cool-down after every training session does not attenuate and may even enhance the long-term adaptive response.

- If implemented, an active cool-down should: (1) involve dynamic activities performed at a low to moderate metabolic intensity to increase blood flow, but prevent development of substantial additional fatigue; (2) involve low to moderate mechanical impact to prevent the development of (additional) muscular damage and delayed-onset muscle soreness; (3) be shorter than approximately 30 min to prevent substantial interference with glycogen resynthesis; and (4) involve exercise that is preferred by the individual athlete.

Want to learn more?
Check this out...

Cyrus' Comments

"The majority of the studies included in this review investigated the effects of an active cooldown on untrained or recreationally trained individuals so it would be beneficial to see further work on this topic include elite athletes to assess whether effect sizes increase or decrease in these groups.
Personally, despite the inconclusive findings of this review, if given the choice I would almost always prefer a short active recovery immediately post competition. The majority of races end in some kind of sprint or effort above maximal aerobic power, resulting in accumulation of blood lactate. This review indicates that an active recovery assists in the more rapid removal of this blood lactate so I'd see this as beneficial before jumping in the team bus for the transfer to the next race.
An active recovery is not always logistically possible with the location or timing of certain race finishes and sometimes for athletes a passive recovery is the only option. It's therefore reassuring to see that a passive recovery in comparison does not negatively affect next day performance and the excess lactate will be cleared eventually regardless."

Abstract

The dose-response relationship between interval-training and VO2max in well-trained endurance runners: A systematic review

OBJECTIVE

The ability of interval training to improve cardiorespiratory and metabolic factors in sedentary and 'actively-fit' populations is well-established. However, surprisingly, the evidence for the physiological benefits of interval training for well-trained runners is inconclusive in the current literature. A better understanding of the dose-relationship between interval training, training load, and improvements in VO2max would potentially benefit well-trained athletes seeking to improve their aerobic ability. Therefore, the purpose of this review was to analyze volume and quality of the current literature addressing the effects of interval training on improving VO2max in well-trained runners. Additionally, researchers sought to analyze the dose-response relationship associated with the intensity and workload of the interval training and changes in VO2max.

WHAT THEY DID

Researchers conducted a systematic search of the major scientific literature databases. The inclusion criteria for retrieved studies were: participants were well-trained runners; the interval training intervention was at least 4 weeks in length; interventions consisted of running only; the intensity, volume, and duration of the work and rest intervals utilized were reported; the intensity of the work interval was greater than maximal lactate steady state; concurrent continuous training during the intervention was below the first ventilatory threshold; VO2max and at least one additional performance variable was reported. Following the researcher's search and selection process, 7 studies remained. From these studies researchers extracted participant characteristics, training intervention characteristics, percentage time spent in intensity domains vs. total training time, training load characteristics, average intervention training intensity, and response to training.

WHAT THEY FOUND

Seven studies, including 62 participants total, with interventions between 4-8 weeks, and sessions 2-3 times per week were analyzed for this review. Only one study of the seven increased VO2max in a significantly large manner (4.9%). Four studies reported trivial changes (< 0.7%). Two studies reported non-significant increases for VO2max of 5.9% and 4.2%. One study reported a non-significant, yet trivial decrease in VO2max (-0.9%). Based on these findings, the researchers suggested that the empirical evidence supporting the efficacy of interval-training as a modality to improve VO2max in well-trained runners is still inconclusive.

- Researchers found potential dose relationships between the individual session load and improvements in VO2max. Additionally, work interval training intensities up to, but not exceeding, the speed at VO2max (100% sVO2max) performed for greater than 2 minutes provided the greatest stimulus for VO2max.

Practical Takeaways

- The data analysis presented in this review suggests performing 2 to 3 interval sessions per week, at a work intensity approaching a speed of 100% sVO2max, during work intervals >2 min, accumulating >15 min of total work per session is the optimal manner of improving VO2max in well-trained runners. Additionally, these interval sessions work best when prescribed over a period of ~4 weeks. These recommendations are not too far off from those given by Buchheit & Laursen in their 2013 review on programming HIIT.

- However, there are a number of caveats that should be considered when interpreting these results. The obvious being these are runners, and this digest is focused towards an audience that trains cyclists. And while there is certainly a large amount of overlap between training cyclists and runners, they are not totally the same. For me, I see this review's findings more as supporting evidence for what I might already do with cyclists, but not literature that is going to influence a drastic change in how I prescribe interval training for them. Another caveat is, this is a tiny cohort of papers to draw any kind of absolute certainty from, even if you are training well-trained runners. However, I do not see that as a free license to train these athletes with whatever intervals we like. I see it more as we should attempt to incorporate what we think works best as much as we can.

Want to learn more?
Check these out...

Jason's Comments

"I included this paper because I think it is always good to have a look at systematic reviews that investigate dose-response relationships between different interventions and physiological and performance outcomes. Especially, when the subjects of the reviews are some category of well-trained endurance athlete.

I also included this paper because I wanted to demonstrate to an extent how little we often know about the most basic training components (e.g. interval training) when it comes to well-trained athletes- in 2021. It is not uncommon for popular training approaches to be based mostly on studies that utilized participants that were not highly trained athletes. This might be ok if the athletes you coach are weekend warriors, but realize, as an athlete gets fitter they might respond differently to the interventions you prescribe them.

Lastly, I'd like to make note of why so few training studies are completed with well-trained endurance athletes. One reason is due to the fact well-trained endurance athletes are a tiny portion of the current population. Currently, we have little control over this. However, another reason we do not have many studies on well-trained athletes is because they tend to be guarded when it comes to changing their training routines. This means the story of training studies and well-trained athletes becomes a kind of tragedy of the commons. Whereby, this cohort of athletes depends on science to bring them into peak condition, but at the same time, it is rare they participate in these types of studies. So the bottom line is, for the sake of all that is good in endurance sport, if you are well-trained please participate in research!"

Abstract

Effect of training on enzyme activity and fiber composition of human skeleta1 muscle*

OBJECTIVE

It is well recognised today that mammalian skeletal muscle has a remarkable potential to alter its phenotype. But it wasn't until Dr. Reggie Edgerton's famous 1969 study the question was addressed in response to exercise training in normal healthy mammals (in this case, mice). However, whether a stimulus such as exercise training could produce not only metabolic adaptations, but also transform fiber types in human skeletal muscle, is a question that had been long debated. This was the first prospective research study that addressed this question using a fiber type classification system based on histochemical staining of myosin ATPase activity.

WHAT THEY DID

Six healthy male subjects were studied. All were active in recreational sports but none had engaged in endurance training for at least 2 years prior to this study. Before training maximal oxygen consumption (VO2max) was determined and muscle samples were taken from two different sites in the lateral portion of the vastus muscle with the needle biopsy technique.

The training intervention lasted 5 months and consisted of pedaling a cycle ergometer 1 hour/day 4 days a week at a load requiring 75 % of their maximal aerobic power (MAP). Initially, the subjects could not tolerate this load for the full hour and it was reduced to about 65 % of VO2max during a portion of the exercise bout. After about 2 weeks all subjects were able to complete the hour.

WHAT THEY FOUND

VO2max increased an average of 13% during training ($P<0.05$). The largest increase in V02max was 1.1 litres min (25 %) and the smallest, 0.1 litre min(3.6 %).

- The percentage of slow-twitch (ST) and fast-twitch (FT) fibers in the muscle samples from the vastus lateralis was not significantly altered by the training program. In four of the six subjects, the pre- and post training fiber compositions of this muscle were nearly identical. In the other two subjects, there were about 9% more ST fibers in the post training samples.

There was no clear pattern of higher glycogen in one or the other of the two fiber types either before or after training.

Practical Takeaways

- While many details remain unresolved a general consensus exists among scientists who actually work in this area regarding fiber type changes with exercise:

1. All fiber types change with training, and it happens quickly.
2. Most sedentary people have ~20-40% of their fibers at hybrids. Active people are usually in the 10-20% range. Very highly trained athletes may have little to no hybrids.
3. Typically hybrids convert to pure types (i.e., MHC IIa/IIx convert to MHC IIa, and MHC I/IIa convert to MHC I or MHC IIa – depending on training style) when any type of training occurs, particularly the MHC IIa/IIx fibers (32). The reverse happens with disuse.
4. Extremely plasticity exists (i.e., it's easy to change) between all fiber types, though pure MHC I appear more rigid (but they still do change).
5. The amount of change is controlled by exposure time and intensity; training more often = more change. For example, a 10% or more change in FT% would be reasonable after a few months of training.

- What should you do to ensure your training optimises your FT%? We don't really know. The best guess: if you want to make more FT fibers, train fast and heavy. Better endurance? Practice getting tired. Maximize growth? Do a combination of high volume/low intensity with low volume/high intensity lifting. At least, this is the best we know as of now.

So while there are more questions than answers at this point, it can be comfortably said that not only do human skeletal muscle fiber types change, but it happens often, quickly, and in response to just about everything you do.

Damian's Comments

"This may be the first study to document the distribution of slow- and fast-twitch fibers in skeletal muscles from trained athletes from a variety of sporting disciplines (e.g., cycling, running, swimming, weight lifting).

There are a few things of note regarding this study. Starting with the duration and intensity of exercise training are amazing for a human research study. Six subjects on an ergo for 1 hour per day, 4 days per week, for 5 months! At the end of the study, most of the subjects were exercising for 1 hour at 85–90% of the maximal aerobic power.

Also, considering what we now know about this muscle fiber plasticity, it interesting that this study concluded that chronic exercise training does not significantly alter the distribution of fast- and slow-twitch fibers in human skeletal muscle. But, it should be noted that the magnitude of the mean change in the percent of slow-twitch fibers (32% to 36%) reported by Gollnick et al. has been consistent with numerous subsequent studies that have and have not reported statistically significant alterations in slow-twitch fiber distribution after exercise training. A small sample size (n 6) and relatively high sampling variance may have precluded Gollnick et al. from observing statistically significant changes.

Technology & Profiling

This month's top research on technology and profiling

Are the Assioma Favero Power Meter Pedals a Reliable Tool for Monitoring Cycling Power Output?

Rodríguez-Rielves, V., et al. Sensors. 21(8), 2021.

Discriminating performance profiles of cycling disciplines

Mostaert, M. et al. International Journal Sports Science Coa 16, 110–122 (2021).

Abstract

Are the Assioma Favero Power Meter Pedals a Reliable Tool for Monitoring Cycling Power Output?

OBJECTIVE

It is essential to determine the measurement error of devices used to monitor power output (PO) to guarantee that errors are narrow enough to determine the true PO achieved by the cyclists. Accordingly, if the error exceeds the expected changes, the device is rendered completely useless for its intended purpose. Hence, to be sure of the certainty of the outcomes, emerging power meter devices should be repeatedly tested across a variety of cycling conditions to determine how well they respond to changes in the cadence, the pedaling position (seated or stand), the PO, or the vibration.

This study aimed to examine the validity and reliability of the recently developed Assioma Favero pedals under laboratory cycling conditions.

WHAT THEY DID

12 well-trained male cyclists and triathletes (VO_{2max} = 65.7 ± 8.7 mL·kg-1·min-1) completed five cycling tests including graded exercises tests (GXT) at different cadences (70–100 revolutions per minute, rpm), workloads (100–650 Watts, W), pedaling positions (seated and standing), vibration stress (20–40 Hz), and an 8-s maximal sprint. Tests were completed using a calibrated direct drive indoor trainer for the standing, seated, and vibration GXTs, and a friction belt cycle ergometer for the high-workload step protocol. Power output (PO) and cadence were collected from three different brand new pedal units against the gold-standard SRM crankset.

WHAT THEY FOUND

- The three units of the Assioma Favero exhibited very high within-test reliability and
an extremely high agreement between 100 and 250 W, compared to the gold standard (Standard Error of Measurement, SEM from 2.3–6.4 W). Greater PO produced a significant underestimating trend ($p < 0.05$, Effect size, ES ≥ 0.22), with pedals showing systematically lower PO than SRM (1–3%) but producing low bias for all GXT tests and conditions (1.5–7.4 W). Furthermore, vibrations ≥ 30 Hz significantly increased the differences up to 4% ($p < 0.05$, ES ≥ 0.24), whereas peak and mean PO differed importantly between devices during the sprints ($p < 0.03$, ES ≥ 0.39).

Practical Takeaways

- These results demonstrate that the Assioma Favero power meter pedals provide trustworthy PO readings from 100 to 650W, in either seated or standing positions, with vibrations between 20 and 40 Hz at cadences of 70, 85, and 100 rpm, or even at a free chosen cadence. Importantly, the pedals slightly underestimated the PO compared with SRM readings, but errors are low enough to be handled in practice.

  In addition to the lower price in comparison with the SRM technology (>1.500 US), these pedal power meters have key advantages such as maintaining the usual riding position, the wheelset, and the crankset, as well as the reduced extra weight (microsensors attached to the pedals). Moreover, from a practical view, the ease installation of the Assioma Favero pedals allows athletes to use them interchangeably in different bicycles (e.g., track, road, and time trial).

- Despite the practical advantages they offer, the Assioma Favero Pedals are limited concerning their calibration. Static calibration is not possible because the pedals need a reading of the cadence. Thus, the slope of the power curve cannot be adjusted, meaning that they will always be limited by the factory calibration.

Cyrus' Comments

"The first thing I like to look for in a study of the validity of any measurement tool is these words at the end of the paper: “This research received no external funding”. I was happy to find this in this particular study as it's extremely important for independent, unbiased testing of measurement tools to be carried out as regularly as possible to ensure the consumer can rely on the accuracy of these products for their intended use.
I liked the inclusion of accuracy analysis with vibrations as this is something that can often be overlooked in the lab. Most cyclists aren't lucky enough to be riding on smooth, hot-mix roads the majority of the time so the reliability of a product on a rough road in the Pyrenees or the cobbles in Belgium is important.
One notable red flag of this study was the line “All tests were performed in the same facilities under standardized conditions (23.8 ± 2.4 ◦C; 39 ± 5% humidity).” Given that temperature change has been shown previously to significantly affect PO readings with some power meters it would be great to see how the pedals perform under varying temperatures in future studies.
"

Abstract

Discriminating performance profiles of cycling disciplines

OBJECTIVE

Insights into how general and sport-specific characteristics of youth cyclists relate to their high-performance adult cyclist counterparts are currently lacking. Yet, these insights would potentially be valuable to coaches when making decisions in regards to orientation, selection, and training. Therefore, the purpose of this cross-sectional study was to document to what extent different cycling disciplines can be discriminated from each other based on a generic battery of tests that were administered to both adolescent and young adult cyclists.

WHAT THEY DID

A total of 243 adolescent cyclists (12 to 15.99 y/o) and 63 young adult cyclists (>= 16 y/o) participated in this study. All participants were male and competed in the road, track, cyclo-cross, and mountain bike (MTB) disciplines of cycling. All participants undertook anthropometric, physical, motor coordination, and cycling specific tests. Anthropometric measures included standing and sitting height, body weight, and BMI. Physical performance tests included standing broad jump, sit and reach, plank test, 30-meter sprint (running), and 20-meter endurance shuttle (running). Motor coordination testing included sideways movement on a wooden board for 20 seconds, two-legged jumping from side-to-side, and total number of steps walking backwards along a balance beam. Finally, the cycling specific tests were a shuttle bike test performed on a BMX bike, and a maximal cadence test.

WHAT THEY FOUND

- The researchers found that there was a high degree of discriminative power for the test battery in a group of young cyclists (16+ y/o), which correctly classified 80.7% of these high performance athletes with their cycling discipline. Contrary to these results with young adult cyclists, the discriminative power for the test battery in adolescent cyclists was substantially less. Whereby, an overlap approaching 50% existed across the four cycling disciplines for these junior athletes.

  In addition to what was observed with general profiling results, athletes from certain disciplines in cycling exceeded in specific tests compared to other disciplines. For example, in both the adolescent and young adult group, track cyclists were found to outperform the other disciplines in explosiveness. Young adult high-performance cyclo-cross athletes were characterized mostly by a different body composition, in that they were smaller and lighter than other disciplines. Additionally, from adolescence onward, performance on the shuttle bike test seemed to be distinctive for MTB and cyclo-cross racers. As cyclists of these two disciplines outperformed athletes from other disciplines, with MTB also outperforming cyclocross. Interestingly, the profile for road cyclists overlapped significantly with the profiles of track, MTB, and cyclo-cross cyclists.

Practical Takeaways

- This study presented objective reference test values for high-performance athletes competing in four major disciplines of cycling. Consequently, coaches are now provided with a collection of data that can help them evaluate the performances of their own adolescent and young adult cyclists. Admittedly, on the surface, it may appear that the lack of ability for this collection of tests to discriminate adolescent cyclists into their respective disciplines would reduce the usefulness of these findings. However, the utility of these tests and study findings are in monitoring individual adolescent cyclists as they develop and mature. In other words, as a cyclist develops, their individual testing profile will begin to fit better within the more distinct adult profile ranges of these four cycling disciplines. This will help coaches direct adolescent cyclists more effectively towards a discipline they will find success in at a potentially earlier age.

- Additionally, this battery of tests allows for athlete profiling without administering lab tests, such as blood lactate and VO2max testing. Which, while these types of lab tests are more of a gold standard and potentially better differentiators of cyclists, these tests are certainly more expensive and logistically more difficult to carry out on a large group of adolescent athletes.

Jason's Comments

When discussing specialization of athletes from an early age, as in this study, the value of a dynamic development pathway has to be clearly emphasized. Too often in sport it is the thinking of parents and coaches that early specialization of an athlete into a single sport will lead to their eventual success. Yet, there is plenty of evidence to demonstrate this is not the case. I'm of the opinion that adolescent athletes should participate in multiple disciplines of sports. Indeed, anecdotally, and as the authors of this paper pointed out, several cycling champions competed in multiple cycling disciplines during their youth careers- Peter Sagan, Cadel Evans, Mark Cavendish, Greg van Avermaet, just to name a few.

In relationship to this study, I think two points that should be considered when testing athletes: specificity and tests that are redundant or 'overlap' with other tests. Case in point, track cyclists performed better in the 30-meter running sprints than cyclists from other disciplines. However, in the case of cyclists who have power meters on their bikes, especially older and more elite cyclists, conducting sprint testing on the bike is going to be potentially more appropriate and valid. The addition of 30-meter running sprints into this level of athlete's training probably will not make sense in a cost benefit sense. Whereby, the running sprint does not add much more information than what the on the bike test would tell you, the running sprint is not as specific to the sport of cycling as a sprint on a bike is, and redundant testing potentially takes away from training (e.g. increases stress on the athlete, reduces the number of quality training sessions, and increases the risk of injury). However, contrary to this thinking, with very young cyclists who may not have the coordination to sprint on a bike, or lack access to a power meter, a 30-meter running sprint test might be the more desirable testing protocol.

Nutrition

This month's top research on nutrition

Muscle glycogen utilization during prolonged strenuous exercise when fed carbohydrate*

Coyle, E., et al. Journal of Applied Physiology. 61(1), 1986.

Pre-Exercise Carbohydrate or Protein Ingestion Influences Substrate Oxidation but Not Performance or Hunger Compared with Cycling in the Fasted State

Rothschild. J, A., Nutrients. 13 (4), 2021.

*This is a classic study.

Abstract

Muscle glycogen utilization during prolonged strenuous exercise when fed carbohydrate

OBJECTIVE

The purpose of this study was to directly measure muscle glycogen utilization during strenuous exercise with and without carbohydrate feedings to determine whether muscle glycogen sparing can explain the postponement of fatigue. The authors' first approach in the present study was simply to quantify glycogen utilization during 105 min of cycling when subjects were fed carbohydrates and when they fasted. After observing no difference in glycogen utilization during these non-fatiguing bouts of exercise, they proceeded to quantify glycogen utilization and carbohydrate oxidation during the latter stages of prolonged exercise performed to fatigue when subjects fasted and were fed carbohydrates.

WHAT THEY DID

Seven endurance-trained cyclists exercised at 71% of maximal O2 consumption (VO2), to fatigue. During the first experimental trial, fasted subjects ingested 4 ml/kg body wt of a cold aspartame-sweetened and lemon-flavored solution at 2O-min intervals throughout the exercise period (i.e., placebo). After completing 2 h of exercise a muscle biopsy was performed. The subjects then continued exercising until fatigue, as defined by their inability to maintain the required work rate. At this time (~3 h) another muscle biopsy was performed within 5 min of the cessation of exercise.

The carbohydrate feeding trial was performed 1 wk later. The subjects ingested 2 g/kg body wt of a glucose polymer in a 50% solution during the 20th min of exercise and 0.4 g/kg body wt in a 10% solution every 20 min thereafter. Muscle biopsies were performed prior to exercise, after 2 h of exercise, at the time that subjects fatigued during the placebo trial (i.e., ~3 h), and at the time of fatigue during the carbohydrate feeding trial (i.e., ~4 h).

WHAT THEY FOUND

- Fatigue during the placebo trial occurred after 3.02 hours of exercise and was preceded by a decline ($P < 0.01$) in plasma glucose to 2.5 ± 0.5 mM and by a decline in the respiratory exchange ratio (i.e., R; from 0.85 to 0.80; $P < 0.05$). Glycogen within the vastus lateralis muscle declined at an average rate of 51.5 mmol glucosyl units (GU) kg-l h-1 during the first 2 h of exercise and at a slower rate ($P < 0.01$) of 23.0 ± 14.3 mmol GU kg-l h-1 during the third and final hour. When fed carbohydrate, which maintained plasma glucose concentration (4.2-5.2mM), the subjects exercised for an additional hour before fatiguing (4.02 ± 0.33 h; $P < 0.01$) and maintained their initial R (i.e., 0.86) and rate of carbohydrate oxidation throughout exercise.
- The pattern of muscle glycogen utilization, however, was not different during the first 3 h of exercise with the placebo or the carbohydrate feedings. The additional hour of exercise performed when fed carbohydrate was accomplished with little reliance on muscle glycogen (i.e., 5 mmol GU kg-l h-1) and without compromising carbohydrate oxidation.

Practical Takeaways

- The authors observed that carbohydrate feedings during prolonged exercise delay the development of fatigue during steady state, intense aerobic exercise, in this case by 1 h (i.e., from 3 to 4 h).

  The maintenance of carbohydrate oxidation and work rate for an additional hour when subjects were fed compared with when they fasted was accomplished with little reliance on muscle glycogen and presumably due to a sufficiently high rate of blood glucose oxidation.

  Lowering of blood glucose during the latter stages of prolonged strenuous exercise plays a major role in the development of fatigue by not allowing leg glucose uptake to increase sufficiently in order to offset reduced glycogen availability.

  The author's suggestion that hypoglycemia causes muscular fatigue when muscle glycogen is low is different from previous suggestions that hypoglycemia causes fatigue due to central nervous system dysfunction.

- This study demonstrates that by providing adequate blood glucose supplementation, exercise at 70% of VO2max and the concomitant high rate of carbohydrate oxidation can be maintained during the later stages of prolonged continuous exercise, with little reliance on muscle glycogen.

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Cyrus' Comments

"This study provided pivotal insight at the time into the cause of hypoglycemia-induced fatigue in endurance exercise. It was known that carbohydrate ingestion could prolong high-intensity aerobic exercise but the mechanisms were uncertain. Previous physiologists had hypothesised greater regulatory input from the central nervous system than actually exists; this study adhered to Occam's Razor by suggesting that once the fuel runs out the engine simply won't turn over.
Interestingly, Coyle et al. found that carbohydrate ingestion during exercise had no glycogen-sparing effect; a result contradictory to the literature of the time as well as many subsequent studies. They also made regular notes throughout the discussion of their own results differing from previous studies due to their highly-trained participants, however did not conduct this present study on a group of untrained participants to establish the significance of training status on fuel utilization."

Abstract

Pre-Exercise Carbohydrate or Protein Ingestion Influences Substrate Oxidation but Not Performance or Hunger Compared with Cycling in the Fasted State

OBJECTIVE

Nutritional intake can influence exercise metabolism and performance, but there is a lack of research comparing protein-rich pre-exercise meals with endurance exercise performed both in the fasted state and following a carbohydrate-rich breakfast. The purpose of this study was to determine the effects of three pre-exercise nutrition strategies on metabolism and exercise capacity during cycling.

WHAT THEY DID

Seventeen trained cyclists and triathletes participated in this study (31.2 ± 12.4 years, 181.9 ± 6.4 cm, 74.8 ± 9.6 kg, VO_{2peak} 62.2 ± 5.8 mL·kg^{-1}·min^{-1}, peak aerobic power 425 ± 55 W/5.7 ± 0.6 W·kg^{-1}, average weekly training volume 13.6 ± 3.1 h).

In a randomized and counter-balanced order, participants received one of three meals to be consumed within a 5-min window. A CHO-rich meal (CARB; 1 g/kg CHO), a protein-rich meal (PROTEIN; 0.45 g/kg protein + 0.24 g/kg fat), or 500 mL water (FASTED).

Thirty minutes after ingestion of the meal, participants began the sub-maximal cycling portion of the testing which included 4 × 5-min stages at a power equivalent to 60%, 80%, and 100% of VT, and 20% of the difference between VT and Wmax, to measure substrate oxidation, energy expenditure, heart rate (HR), and perceived exertion (RPE). Following a 3-min static rest, participants performed 6 × 3-min cycling intervals with 3 min of active recovery (100 W) between each interval. The first three intervals were performed at 80% of W max, in a cadence-independent manner. Intervals 4–6 used the cadence-dependent linear mode set to produce a workload of 80% W max at their preferred cadence, with participants instructed to produce their maximal power output across intervals 4–6 by increasing the cycling cadence.

WHAT THEY FOUND

Submaximal Exercise

Contrasts between treatments at each intensity revealed HR, measured as a percentage of each individual's maximal HR, was lower for FASTED compared with both CARB and PROTEIN ($p < 0.05$). Gross cycling efficiency was higher ($p < 0.01$) for FASTED compared with PROTEIN at each intensity, while RPE was not different between treatments.

Fat oxidation was lower ($p < 0.05$) for CARB compared with FASTED at VT60, VT80, and VT100, and compared with PROTEIN at VT60. Carbohydrate oxidation was different ($p < 0.05$) between CARB and FASTED at VT60, VT80, and VT100.

High-Intensity Exercise

Intervals 1–3 were performed at 80%W max, corresponding to 340 ± 44 W. The subsequent three intervals were performed as maximal efforts, with no differences between treatments for average power ($p = 0.516$). Similarly, there were no differences in RPE or lactate between trials. However, contrasts between treatments showed HR was higher during PROTEIN compared with FASTED at each interval (all $p = 0.004$).

Practical Takeaways

Overall, exercising in the overnight-fasted state increased fat oxidation during submaximal exercise compared with exercise following a CHO-rich breakfast, and pre-exercise protein ingestion allowed similarly high levels of fat oxidation.

That would have been my overall guess, but it's nice to see it confirmed. The body prefers calories from carbs/fat, so when fed only protein it still needs to reach for stores. When fed nothing pre workout, an athletic individual can proceed to have a normal workout from energy stores without any discernible slow downs. When fed carbs/fat, the body takes advantage of the calories present so it doesn't have to reach for stores.

The size and timing of the nutrient ingestion was chosen to maximize ecological validity. Ingesting a small amount of CHO (e.g., 1 g/kg) just prior to exercise (e.g., 30 min) is similar to the day-to-day practices of endurance athletes and in contrast with previous studies using extremely large test meals provided up to 4 hours prior to exercise. No differences in performance have been observed when CHO was consumed 15, 45, or 75 min, 15 or 60 min, or 5 or 35 min before exercise.

There also appears to be no effect of meal size on substrate oxidation during exercise, as similar values were found with 45 and 156 g of CHO consumed 4 hours prior to exercise, and 25, 75, or 200 g of CHO consumed 45 min prior to exercise. Therefore, these findings should be generalisable to a range of pre-exercise meal sizes and timings.

Damian's Comments

"The total duration of the was just over 60 minutes. Which is a common prescription for fasted training rides. They are also usually done at submaximal intensities. So the addition of "3 × 3 min intervals at 80% peak aerobic power and 3 × 3 min intervals at maximal effort" adds more intensity into the mix. I wonder how this impacted the results 18 minutes at 80% of MAP or above is a high load. Especially as fat oxidation during submaximal exercise was highest in the overnight-fasted state and following pre-exercise protein ingestion.

It is an encouraging sign to see that there were no differences in work capacity, RPE, oxidative stress, or hunger between treatments. Also, consuming a low-CHO meal before submaximal exercise will not meaningfully impair fat oxidation and eating a high- or low-CHO meal does not confer additional performance benefit during HIIT compared with training in the overnight-fasted state. "Therefore, athletes who wish to increase fat oxidation but promote energy balance can use pre-exercise protein ingestion as a viable alternative to fasted training sessions. Conversely, for shorter duration higher intensity sessions, fasted training and protein ingestion are also viable choices as performance was not compromised, suggesting athletes can choose whether to eat based on personal preference. However, longer-term training studies are needed as the net adaptive responses of chronic CHO or protein ingestion prior to exercise is unknown."

Strength

This month's top research on strength training

Strength Training versus Stretching for Improving Range of Motion: A Systematic Review and Meta-Analysis

Afonso, J., et al. Healthcare. 9(4), 2021.

Abstract

Strength Training versus Stretching for Improving Range of Motion: A Systematic Review and Meta-Analysis

OBJECTIVE

Stretching is known to improve range of motion (ROM), and evidence has suggested that strength training (ST) is effective too. However, it is unclear whether its efficacy is comparable to stretching. The goal was to systematically review and meta-analyze randomized controlled trials (RCTs) assessing the effects of ST and stretching on ROM.

WHAT THEY DID

Cochrane Library, EBSCO, PubMed, Scielo, Scopus, and Web of Science were consulted in October 2020 and updated in March 2021, followed by search within reference lists and expert suggestions (no constraints on language or year). Eligibility criteria: (P) Humans of any condition; (I) ST interventions; (C) stretching (O) ROM; (S) supervised RCTs. Eleven articles (n = 452 participants) were included.

WHAT THEY FOUND

- Overall, ST and stretching were not statistically different in ROM improvements, both in short-term interventions, and in longer-term protocols, suggesting that a combination of neural and mechanical factors are at play. However, the heterogeneity of study designs and populations precludes any definite conclusions and invites researchers to delve deeper into this phenomenon. Notwithstanding this observation, the qualitative effects were quite similar across studies.

Practical Takeaways

- Insufficient reporting of training volume and intensity meant it was impossible to establish effective dose-response relationships, although, for ST, a minimum of five weeks of intervention, and two weekly sessions were sufficient to improve ROM.

ST with an eccentric focus demands the muscles to produce force on elongated positions, and a meta-analysis showed limited-to-moderate evidence that eccentric ST is associated with increases in fascicle length. However, ST with an emphasis in concentric training has also been shown to increase fascicle length when full ROM was required.

Some studies indicate that decreased pain sensitivity may be another mechanism by which ST promotes ROM gains.

Cyrus' Comments

"Before implementing any training intervention it's important for the coach and athlete to establish the goal and hence desired outcome of the intervention. In the case of cycling, improved ROM is likely to be most useful in either rehabilitation from injury or in enabling the athlete to adopt a more aerodynamic riding position without compromising force production.

For each of these goals, the findings of this review could be used to streamline a strength and conditioning program toward achieving them. Given ST is known to provide strength gains while stretching alone does not have the same effect, it may be more practical for athletes to prioritise ST over stretching. This review suggests they can do this without sacrificing improvements in ROM.

Prescription of stretching intensity is also complex, relying predominantly on scales of perceived exertion whereas ST is easily quantifiable, another reason it may be preferable for coaches and athletes."

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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