

January 2019 | Issue #27

# THE PERFORMANCE DIGEST

A review of the latest sports performance research



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# Research Reviewers



**Dr. Will Vickery**

PhD

**Chief Editor**

Will is a former Senior Lecturer of Sport Coaching at the University of Northumbria: Newcastle Upon Tyne. Prior to this he has worked with Cricket NSW and Cricket Australia in an array of roles ranging from a sport scientist, development coach and a strength and conditioning coach.



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**Fatigue & Recovery**

Fran is a strength and conditioning coach at the Glasgow Warriors, Scotland. He is also a PhD candidate at Waikato University, New Zealand, a performance consultant to the Portuguese Rugby Union, and a published author.



**Adam Nichol**

PhD Candidate

**The Science of Coaching**

Adam is an Associate Lecturer/PhD Researcher at Northumbria University: Newcastle upon Tyne. His research focuses on how athletes receive, interpret, and are influenced by coaching practice. He is an experienced coach, operating within representative youth level cricket and with soccer referees. Adam also has experience in shaping national sport policy and delivering research-informed consultancy activity.



**Tom Green**

MSc UKAD Advisor

**Youth Development**

Tom is the Head of Athletic Development at St. Peter's R.C High School in Gloucester, England. He has an MSc in Applied Strength and Conditioning from Hartpury College. He has also worked with Gloucester Rugby Club as an Academy S&C Assistant and in professional boxing, semi-professional football, and GB Equine.



**James de Lacey**

MSc

**Strength & Conditioning**

James is currently the Head Strength & Conditioning Coach for the Romanian Rugby Union. He has previously worked in America's professional rugby competition Major League Rugby with Austin Elite and the NZ Women's National Rugby League Team. He is a published author and has completed a MSc in Sport & Exercise Science from AUT, Auckland, NZ.



**James Morehen**

PhD Candidate

**Nutrition**

James is a SENr registered performance nutritionist, currently completing his PhD at Liverpool John Moores University. He is also a Performance Nutritionist for the English Football Association alongside the England national squads (men's and women's)



**Carl Valle**

BSc

**Technology & Monitoring**

Carl is currently the lead sport technologist for SpikesOnly.com, and focuses his time on testing elite athletes and using technology to maximise human performance. Carl has coached Track and Field at every level, and also has significant expertise in performance data, including the practical application of equipment and software.



**Dr. Stephanie Allen**

PT, DPT, OCS, CFSC

**Injury Prevention & Rehab**

Stephanie is a Physical Therapist who graduated from Ithaca College and is working at Boston PT & Wellness. She is passionate about strength & conditioning and how it plays into rehab, and is also a member of the Strength Faction program.



# Audio REVIEW

## Talent ID

A recap on what we know and hope to find out from future research.

*with Dr. Stephanie Allen*

### WHAT WE DISCUSS

In this episode of the "Audio Review", Stephanie discusses the psychology of ACL injuries.

### In this episode, you will learn:

- The role of psychology in ACL injuries
- The impact this has on patients and athletes
- Consideration of psychology in the rehabilitation process and how to return to play
- Future research needed to take the psychology of ACL injuries to the next-level

Episode length = 37 min



### A bit about **Stephanie**

Stephanie is a Physical Therapist who graduated from Ithaca College and is working at Boston PT & Wellness. She is passionate about strength & conditioning and how it plays into rehab, and is also a member of the Strength Faction program.



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# The Science of COACHING

## Do coaches' emotions influence athletes?

The influence of coaches' expressions of happiness and anger in predicting players' emotions, cognitions, and performance

[Abstract]

### INTRODUCTION

A large body of work has attempted to understand the effectiveness of coach behaviour (e.g. praise, questioning, feedback) and practice design (e.g. game-based approaches). By comparison though, little attention has been paid to coaches' emotions and how the expression of emotions may influence others such as athletes ([HERE](#)). Studies which have explored emotions in sport, to date, have typically looked at the influence of athletes' emotions on their own thoughts and actions, or on the thoughts and actions of other athletes. What remains a topic mostly unknown is how the emotions of coaches may be influential (or not) in shaping athletes' thoughts, feelings and actions (e.g. performance).

Given emotions have been highlighted to play a key role in supporting the effectiveness of practitioners in other domains, (e.g. policing, nursing, leadership), and given sport is often an emotionally charged endeavour, this is an important area for consideration within the coaching domain. As such, the present study sought to understand how coaches' expressions of happiness and anger might predict the emotive, cognitive, and performance-related responses of players.

### WHAT THEY FOUND

During the first stage of this study, coaches and athletes from baseball and softball teams completed questionnaires after a competitive match to assess their perceptions and experiences of emotions. Performance was also measured both subjectively (i.e., through ratings of the number of mistakes made and how players perceived coaches to report their performance) and objectively (i.e., by score line). The key findings included:

- ⇒ A positive association between coaches' expressions of happiness and players' experiences of happiness.
- ⇒ A positive association between coaches' expressions of happiness and players' perceptions of how coaches rated their performance.
- ⇒ A negative association between coaches' expressions of anger and players' perceptions of how coaches rated their performance.
- ⇒ Coaches' expressions of happiness were associated with fewer individual errors and better team performance, whereas expressions of anger were associated with a higher number of errors and worsened team performance.

The second part of the study followed a similar methodology, but instead included soccer players and coaches and included measurements at different time points (i.e., pre-match, half-time and full-time). Similar findings were reported when compared to the first stage of this study, although key differences included:

- ⇒ Coaches' expressions of happiness were not significantly associated with players' experiences of happiness at half-time.
- ⇒ Coaches' expressions of anger were not significantly associated with players' experiences of anger before the game.
- ⇒ Coach expressions of happiness at half-time did not predict team performance in the second-half.
- ⇒ Coaches' expressions of anger, at any time point, did not predict team performance.

### WHAT THIS MEANS

Within specific contexts, displays of happiness by the coaches predicted athlete experiences of happiness, and displays of anger by the coach were associated with athletes' experiences of anger. Coaches' expressions of happiness and anger were associated with player inferences of better and worsened team performance (in the eyes of the coach), respectively. Further, coaches' expressions of happiness predicted fewer perceived player errors and better overall (objective) team performance. Conversely, anger expressed by coaches was associated with more perceived player errors and worsened overall (objective) team performance. This demonstrates that for the athletes in this study, the way in which coaches express emotions may play a role in how they make sense of coach evaluations of their performance. However, based upon the evidence presented, all of these relationships between coaches' expressions of emotions and how athletes think, feel, and act are liable to change across varying time points within the activity, across different activities, or based upon other contextual factors. This points to the context-dependent nature of coaching, and how effectiveness can only be understood in light of how, when, why, and under which circumstances emotions are likely to be conducive.

## Practical Takeaways

Alongside the actions and behaviour of a coach, it is also important for coaches to become more aware of how and why they display emotions in their interactions, and how this may influence others. Useful associations have been highlighted suggesting that coaches' emotions are indeed likely to play a role in influencing athletes' thoughts, feelings and actions. However, this interaction appears to be complex.

Importantly, emotions can only be made sense of in relation to previous experiences and engagement with emotions; they are unlikely to influence athletes in a straightforward manner. Instead, their influence must be considered alongside interaction with other factors. For example, strength and conditioning coaches could consider how expressing happiness in their emotions may be likely to positively shape how players interpret evaluations of their performance. However, consideration of previous inter(action)s with an athlete, their individual interpretation, as well as wider factors (e.g. contextual circumstances) is crucial.



**Adam Nichol**

Adam is an Associate Lecturer/ PhD Researcher at Northumbria University: Newcastle upon Tyne.

# Strength & Conditioning

This month's top research in strength & conditioning.

## **POWER CLUSTER SETS FOR INCREASED VOLUME**

Tufano, J. et al. (2018) PLoS ONE.

## **IS BLOCK PERIODISATION SUPERIOR TO TRADITIONAL PERIODISATION FOR TEAM SPORTS?**

Rønnestad, B. R. et al. (2018) Scandinavian Journal of Medicine & Science in Sports.

## **CAN INTER-LIMB ASYMMETRIES BE USED MONITOR FATIGUE?**

Bromley, T. et al. (2018) The Journal of Strength and Conditioning Research.



[Abstract]

# Increased volume using power cluster sets

## OBJECTIVE

Performing multiple repetitions during resistance training with maximal concentric effort results in fatigue and a concurrent decrease in velocity and power output. To combat this, cluster sets which include short, intra-rest intervals, allow for subsequent performance to be better maintained. Therefore, the purpose of this study was to investigate the effects of cluster sets and traditional sets on velocity, power output, and training volume when using individualised loads at which mean power output is maximised.

## WHAT THEY DID

Ten university-aged males with various sporting backgrounds performed back squats with an increasing load to determine the individualised load at which mean power output was maximised. This load was used during the traditional set (TS) and cluster set (CS) protocols where subjects performed both protocols at 72 h apart.

### TS protocol:

- ⇒ 6 sets of squats with their individualised load with as many reps as possible until mean power output dropped below 90% of mean power output for two consecutive repetitions.
- ⇒ 2 min of inter set rest.

### CS protocol:

- ⇒ An undetermined number of clusters of 2 reps were performed.
- ⇒ 20 sec intra set rest until both reps in each cluster dropped below 90% of mean power output.

## WHAT THEY FOUND

The number of effective reps (NER – reps over 90% mean power) during CS was greater than TS but mean velocity and mean power were similar. The number of total reps (NTR) performed during CS was greater than TS but again, mean velocity and mean power were similar. Total work and eccentric depth were greater in TS than CS for both NER and NTR. A greater NTR during CS in the first two sets and a greater NEF during CS in the first set was also observed.

## » Practical Takeaways

In contrast to previous studies, this paper found CS and TS to have similar movement velocities and power outputs with statistical analyses showing a slight possible advantage for TS. It is ultimately believed that TS are arduous while cluster sets are fatigue resistant. Although this study showed TS and CS had similar velocities and power outputs, CS resulted in significantly greater NER and NTR indicating total training volume was significantly greater (approximately 1.6 x greater) without decreasing acute repetition performance. Based on this paper, CS may not be superior to TS unless TS are designed to induce large amounts of fatigue. This protocol could potentially be used in a couple of instances:

- ⇒ Adding an effective repetition limit to the cluster sets at individual load. This would, in theory, induce even less fatigue than a traditional set e.g.  $1 \times 2 + 2 + 2 + 2$  vs.  $1 \times 8$  reps.
- ⇒ Using this CS protocol during a high-volume phase. A maximal CS could be used where maximum reps of clusters are recorded over 90% mean power for each athlete at their individual load. Potentially taking 50% of that number to be performed each set may allow for more total volume over multiple sets versus only using a 90% mean power stop limit.



## James's Comments

"Using this method of CS may be a way to include more high-quality volume into an accumulation block rather than the inevitable slowing of reps through longer sets. As stated above, there was a large variability in reps performed for the CS protocol. Specifically, one subject who completed 21 NER during the first set of CS completed 7 and 2 NER during the second and third set, respectively. This greater volume in the first set may have affected subsequent set performance and may have resulted in greater fatigue throughout the session. As explained in the two articles linked below, cluster sets can also be used for strength and hypertrophy. It is further noted in these articles that a full performance benefit may take a year to surface."

Want to learn more?

Then check these out...



[Abstract]

# Is block periodisation superior to traditional periodisation for team sports?

## OBJECTIVE

Traditional training design generally constitutes an even distribution of targeting strength and endurance qualities, however,, such concurrent training with a high training volume leads to compromised development of strength and power. Block periodisation may lead to greater strength and power gains where shorter training periods are dedicated to improving a few abilities. The aim of this study was to investigate the effects of block periodisation on strength/power and endurance training versus a traditional periodisation approach.

## WHAT THEY DID

Sixteen U18 and U20 ice hockey players competing at the highest national level in Norway were randomly assigned to either a block periodisation group (BP) or a traditional periodisation group (TRAD).

### BP Group:

- ⇒ Weeks 1, 3, 4, and 6 focused on strength training (including plyometrics) with 6-7 weekly sessions + one weekly high-intensity training (HIT) session,
- ⇒ Weeks 2 and 5 focused on HIT aerobic training consisting of five weekly sessions, whilst performing one whole body strength session.

### TRAD Group:

- ⇒ Even distribution of 2-3 HIT sessions and 4-5 strength training sessions (including plyometrics) a week.

## WHAT THEY FOUND

Peak torque at 60°.sec tended to increase more in BP than TRAD with a moderate ES favouring BP (ES = 0.83). BP had a significantly larger increase in peak torque at 180°.sec than TRAD (ES = 1.18). Mean power output during the Wingate showed a tendency towards larger improvement in BP vs. TRAD (ES = 0.89). There was no difference in squat jump height improvements between the two groups but a small ES (0.34) favouring BP. BP had a larger increase in VO2max than TRAD (ES= 1.04).

## » Practical Takeaways

The main findings were that BP exhibited a greater effect size compared to TRAD for peak torque (fast and slow), mean power output and VO2max. These differences were evident despite the fact that the study protocol investigated the effect for only six weeks of training in already well-trained ice hockey players. It could be that the BP group maximised the power and strength training stimulus by concentrating on these variables in weeks 1, 3, 4, and 6, while simultaneously minimising endurance training. However, this study did not include a strength training only group so conclusions cannot be drawn as to whether an interference effect occurred. In the article links below, I've suggested how this block periodisation approach could be used in team and combat sports. Some key point examples:

- ⇒ During an 8-week preseason, weeks 1 and 5 may involve the five HIT sessions which frees up the remaining weeks for greater technical/tactical training along with other physical abilities. Maintenance of aerobic/anaerobic qualities can be kept through varying the duration/intensity of technical/tactical training.
- ⇒ During an 8-week fight camp, weeks 2 and 6 may involve five HIT sessions which frees up the remaining weeks for greater technical training along with other physical qualities. However, combat training is often performed at high intensities (% of maximum heart rate) so prior planning is important.

### Want to learn more?

Then check these out...



## James's Comments

"Block periodisation (see [HERE](#)) is an approach generally reserved for 'high level' athletes due to the greater stimulus needed for adaptation. It is suggested that concentrating the training stimulus on a few select abilities that have compatibility may be more effective for developing a range of physical qualities than training all qualities together. It is important to note that if you want to implement a block periodisation strategy, small doses of training for the qualities that are not emphasised are important to maintain that stimulus. One criticism of block periodisation is the rigid structure of the blocks. As stated in the infographic link below by John Kiely, perhaps a better way to look at periodisation is to "shift towards a philosophy of adaptive readiness to respond to emerging information." This way, if you identify a need for certain athletes that is different than the current block, they don't have to be stuck in the current cycle."

[Abstract]

# Can inter-limb asymmetries be used monitor fatigue?

## OBJECTIVE

With players consistently required to perform unilateral actions, asymmetrical loading is a natural consequence; thus, inter-limb asymmetries are likely a by-product of the sport. Chronic effects of neuromuscular fatigue have also been shown to remain up to 48 h post-match. At present, the association between side-to-side differences and fatigue in soccer is particularly scarce. Therefore, the aims of this study were to (1) quantify limb asymmetries in elite academy soccer players; (2) determine the effects that a competitive soccer match has on asymmetries; (3) monitor these asymmetries over a 72-h period.

## WHAT THEY DID

The acute effects of fourteen elite adolescent male soccer players (17-18 y) from a professional English category three academy were examined following a single 90 min soccer match on inter-limb asymmetries throughout a 72 h period. Asymmetries were measured using the single-leg countermovement jump (SLCMJ) performed on a force plate. Assessments were conducted at scheduled intervals: 2 h pre-match, 1 h after the match, and 24-, 48-, and 72 h after the match. Eccentric impulse, concentric impulse, peak force, jump height, and landing forces were measured.

## WHAT THEY FOUND

Group means:

- ⇒ Significant decrease from baseline at all time points for eccentric impulse, peak propulsive GRF, and landing impulse,
- ⇒ Significant increase in peak landing GRF,
- ⇒ Significant decreases also found from 1- 24-, 48-, and 72 h after the match for eccentric impulse and peak propulsive GRF,
- ⇒ Significant decreases were noted between 48- to 72 h on the left side only for eccentric impulse and propulsive peak GRF,
- ⇒ Jump height was only found to be significantly reduced on the left side between 1- to 24 h and increased between 24- to 72 h.

Asymmetries:

- ⇒ SLCMJ mean asymmetries significantly increased from before to after the match for concentric and eccentric impulse, peak propulsive GRF, and peak landing GRF with small to large effect size.
- ⇒ Significant reductions in asymmetry were shown from 1- after and 24-, 48-, and 72 h for eccentric impulse, peak propulsive GRF and peak landing GRF.

## » Practical Takeaways

The largest asymmetries were observed 1 h after the match. Inter-limb asymmetries returned to a similar level as pre-match values at the 48 h time point. However, jump performance for multiple metrics were still significantly reduced. There was a trend for test variability to be lower at baseline prior to the match which may have been exacerbated under fatigue for some metrics. It is important to highlight that concentric impulse and jump height showed the largest variability (CV = 18-30%). The results from this study showed concentric impulse and jump height were fully recovered on both limbs at the 48 h time point with the remaining metrics still exhibiting significant differences from baseline. Eccentric impulse and peak propulsive GRF showed the greatest mean reduction in means over the 24 h time period. A reduction in eccentric impulse may have been caused by altering the jump strategy allowing time to produce the necessary force.

Jump height was shown to have no significant decreases post-match. These results suggest that perhaps jump height isn't sensitive enough to detect significant immediate change as altered jump strategies were used to mask the fatigue. Landing impulse and peak landing GRF were both sensitive enough to show large significant increases at each time point. Practically, a relative strength index (RSI) measurement may be a better alternative to CMJ height for monitoring fatigue when on a budget. Due to the increased landing forces/impulses observed in this study, perhaps RSI would be sensitive to pick this up through increased contact time.

**Want to learn more?**

Then check these out...



## James's Comments

"Coaches should consider using the unilateral CMJ in addition to or in place of the bilateral CMJ. However, jump height does not seem like a reliable measure to indicate fatigue. The use of a force plate would allow a practitioner to quantitatively see whether an athlete altered their jump strategy to reach the height they jumped. However, force plates are expensive pieces of equipment. As stated above, RSI may be a more cost effective metric to monitor fatigue. Generally, fatigue monitoring is performed on game day +2 approximately 24-48 h after a match. Based on the fact that metrics such as peak landing GRF asymmetries still weren't recovered at 72 h post-match, it may be worth continuing a fatigue monitoring protocol the following days. In regards to baseline measures, make sure they correspond to the season you are currently in. This is further expanded on in the article linked below."

# Technology & Monitoring

This month's top research on technology and monitoring.

## **DOES CHRONOJUMP PROVIDE AN INEXPENSIVE WAY FOR COACHES TO MONITOR JUMP PERFORMANCE?**

Pueo, B. et al. (2018) Acta of Bioengineering and Biomechanics.

## **COMPLIANCE AND DATA VALUE WITH ATHLETE MONITORING SYSTEMS: HOW DO THEY FAIR IN COMBAT SPORT?**

Bromley, S. et al. (2018) JMIR Human Factors.

## **DO VERTICAL JUMPS HELP MONITOR REAL TIME HORIZONTAL SPRINT SPEED?**

Jimenez-Reyes, P. et al. (2018) Journal of Sports Sciences.



[Abstract]

# Does Chronojump provide an inexpensive way for coaches to monitor jump performance?

## OBJECTIVE

The popularity of tracking jump performance, specifically vertical height with athletes, is growing amongst sports performance coaches. Thus, using an open-source (or Do-It-Yourself equipment) product that allows for a budget-friendly and customizable solution may be worth exploring if the product is valid and reliable. The objective of this study was to see how the Chronojump (see [HERE](#) for more details) product fared against other commercially available contact mats.

## WHAT THEY DID

The reliability of the internal mechanisms and the accuracy of simulated jumping performance of three different systems (Globus Ergotester, Axon Jump, and the Chronojump) was examined by electronically simulating a jumping condition. Each simulated jump was measured 50 times for the three systems concurrently, for a total of 250 measurements for each jump system.

## WHAT THEY FOUND

The results suggested that the three systems were not all as reliable and accurate as each other. The Chronojump performed the best in regard to accuracy and reliability, with the Globus system performing just well enough to be considered useful in the field but not lab grade. The Axon Jump was not considered robust enough to be used for elite performance. Variability of 3.5 cm with jump testing is not reliable enough within the field of performance sport. When using sports technology for jumping analysis, the precision needs to be very high.

## » Practical Takeaways

Coaches that are experienced with using contact mats should consider the Chronojump if their budgets are restrictive and there is a need to efficiently collect data with larger groups. Due to the inexpensive options of smartphone apps (see [HERE](#)), one could use a jump app if time is not a factor. The researchers also made a smart recommendation not to draw conclusions of the Axon product, as one device may not be representative of the entire line of equipment. Therefore, coaches should consider working with companies in advance to demand a certificate of analysis of the specific shipment they receive. When using this equipment, coaches should also consider factors such as the type of equipment, brand and, the generation of the product, as variability can occur even between individual systems.

**Want to learn more?**

Then check these out...



## Carl's Comments

"The Chronojump system is not new, and due to the open-source nature of the software, coaches can do more than just collect flight times to estimate jump height (see [HERE](#)). Since it is possible to programme and integrate the Chronojump equipment without limitations of closed products, coaches may want to work with the open source community of programmers who are likely to want to contribute to local academies or teams who are budget restricted and understaffed."

[Abstract]

# Compliance and data value with athlete monitoring systems: how do they fair in combat sport?

## OBJECTIVE

Monitoring workload in sport requires a combination of direct input from athletes as well as data collected from support staff. The inclusion of an Athlete Management System (AMS) is a commonly used tool in a number of sports such as soccer and cricket which potentially offer an effective way to gather important data of injuries and illness directly. There is little evidence that in up-and-coming sport such as combat sports to suggest that this is also an appropriate method for monitoring workload. Therefore, the goal of this study was to evaluate the engagement of and the actual data collected from combat sports across Australia.

## WHAT THEY DID

Over a 12-week period, the health status 26 national and emerging elite athletes from 4 Olympic combat sports (boxing, judo, taekwondo, and wrestling) were tracked through the use of a smartphone solution and backend software package from a leading domestic AMS provider. After the 12-week period, the engagement levels of each athlete and the different measures of health included in the AMS were collated. Athlete engagement is the commitment to using the monitoring software consistently throughout the time period requested.

## WHAT THEY FOUND

Due to the voluntary nature of the AMS software it appears that the athletes did not take advantage of the injury monitoring and activity tracking solution as compliance with the AMS was only 13%. Of those athletes that did engage with the AMS, one of the more significant findings was that nearly 97% of the opportunities to train were carried out by the athletes, regardless of their injury and illness state.

## » Practical Takeaways

This study highlights the difficulty in engaging athletes with workload monitoring tools. Within this study, the fact the study population were mainly Olympic sport competitors, only highlights the difficulty in monitoring modern athletes regardless of the convenience of smartphone integration due to their high levels of commitment. Fortunately, those athletes that leverage monitoring apps and other technologies benefit from having specific records over time, including details pertinent to supporting them in applied settings. If coaches and staff can improve engagement and reliance of the AMS solutions, the improvement in data collection can help practitioners learn why injuries and illnesses are occurring. This study really identifies the realities of athlete compliance (see [HERE](#)) being a limiting factor to sport science initiatives.



## Carl's Comments

"Athletes' involvement to sports monitoring (see [HERE](#)) is usually the limiting factor to coaches, medical professionals, and sport scientists. Thus, if simply collecting data is a barrier to success, more product development could be necessary to create a compelling and better user experience with athletes who tend to be fickle and sometimes difficult to work with. Overall, athletes are extremely sharp with their needs to succeed, and the right product and sport science education with athletes can improve outcomes with AMS engagement."

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[Abstract]

# Do vertical jumps help monitor real-time horizontal sprint speed?

## OBJECTIVE

Coaches design speed-training sessions using an estimated number of sprints based on modern training theory and previous experience. If a simple vertical jump test performed in advance of a sprint could detect a strong relationship with fatigue and possible velocity loss, then a countermovement jump score could be a novel way to manage athlete loading during the training session. The objective of this study was to see if the relationship between laboratory measures of fatigue and velocity with sprints were connected to a pattern in jump testing performance with sprint athletes.

## WHAT THEY DID

The 60 m sprint speed, as well as the concentration of ammonia and lactate of nine national level sprinters was measured. Before beginning the protocol and following each sprint, blood samples were taken from the athletes along with performing a countermovement jump. Data collection concluded when athletes dropped off by 3% in the 60 m total time. Statistical analysis of all of the athlete sprints (velocity) was compared to the fatigue biomarkers (ammonia and lactate concentration) and the countermovement height.

## WHAT THEY FOUND

Not surprisingly, a clear relationship existed between all of the variables and the fatigue pattern, meaning as more repetitions of maximal effort were performed the greater the decrement of speed and jump performance. In addition to the changes in neuromuscular performance, the physiological indices of fatigue were also parallel to the field tests. In summary, all measures of fatigue were correlated, specially the internal physiology and general speed and power performances on the track.

## » Practical Takeaways

The authors claimed that countermovement jump height might provide a more sensitive indicator of the metabolic demand of sprint training than actual sprint velocity. Also, having a fatigue index using jump height could potentially improve outcomes (see [HERE](#)) if personalised loads outperformed fixed prescriptions of speed training. Their belief was that a feedback approach to monitoring each rep completed could create a way to "interrupt" a session if the demand became a possible detriment to safe or effective sprint training. They also speculated that jump height could be a readiness test for sprint training, as a few jumps before training could determine if the athlete was fresh enough to sprint fast without residual fatigue. Obviously, the non-invasive benefits of simple jump testing could replace the need for invasive blood testing of either lactate or ammonia.



## Carl's Comments

"I have found that the reactive strength index (RSI) is also a great way to monitor sprints if the athletes are skilled with rebound jumping. A coach may want to test the RSI after the warm-up (see [HERE](#)), and when they suspect that fatigue may be manifesting during the session. Due to the longer sprint distance used in this study, sports like soccer may wish to reduce the distance of the sprints slightly. Research on short sprints (20 m) indicates that higher volumes respond differently than longer sprints, so a different fatigue index may be warranted."

**Want to learn more?**  
Then check these out...



# Fatigue & Recovery

This month's top research on fatigue and recovery.

## **DOES THE USE OF ELECTRONIC DEVICES IN THE EVENING AFFECT THE SLEEP PATTERNS OF WELL-TRAINED ATHLETES?**

Jones, M. J. et al. (2018) Journal of Sports Sciences.

## **A META-ANALYSIS ON THE INTERNAL AND EXTERNAL MEASURES OF TRAINING LOAD IN TEAM SPORTS**

McLaren, S. J. et al. (2018) Sports Medicine.

## **A REVIEW OF FATIGUE MARKERS FOLLOWING A SOCCER MATCH AND MATCH-SIMULATION PROTOCOLS**

Silva, J. R. et al. (2018) Sports Medicine.



[Abstract]

# Does the use of electronic devices in the evening effect sleep patterns of athletes?

## OBJECTIVE

It is well established that sleep is one of the pillars for good recovery from exercise. In order to enhance sleep quality and duration, different sleep hygiene strategies (e.g. removal of electronic devices prior to sleep time) are implemented by practitioners and sport scientists. However, limited research has investigated the effects of electronic devices use on sleep quality and quantity in athletes. This study investigated the effects of electronic device use on athlete's sleeping patterns.

## WHAT THEY DID

Seventy well-trained, Australian athletes (44 females and 26 males, 32 team-sports athletes and 38 individual-sports athletes) completed an online questionnaire, every day during 7 consecutive days to obtain information about their sleepiness (i.e. Epworth Sleepiness Scale), daytime behaviours (e.g. caffeine consumption, physical activity, napping), perceived sleep quality (e.g. how easily athletes fell asleep) and quantity (e.g. bedtime, estimated sleep onset latency (SOL), wake time), and if electronic devices were used in the 2 h before attempting to sleep. Time in bed (TIB) was calculated from the time the athlete went to bed until wake time.

## WHAT THEY FOUND

The main findings of this study were:

- ⇒ Well trained Australian athletes obtain adequate time in bed each night (~8:30 h:m)
- ⇒ Athletes used at least one electronic device per night (0-30 min) in the 2 h prior to bedtime;
- ⇒ Athletes fell asleep "fairly easily" and woke up "fairly refreshed";
- ⇒ Younger athletes spent longer in bed but generally felt sleepier than older athletes;
- ⇒ 21% of the athletes reported napping for  $73 \pm 48$  min;
- ⇒ 27% of the athletes reported completing exercise in the 6 h prior to bed time;
- ⇒ 40% of the athletes reported to exercise ( $4 \pm 1$  out of 5 intensity) in the 5 h prior to bed time;
- ⇒ 40% of the athletes reported sleep disturbances: uncomfortable temperature ( $13 \pm 6\%$ ), discomfort ( $13 \pm 3\%$ ) and outside noise ( $11 \pm 3\%$ );
- ⇒ The number of electronic devices used in the 2-h prior to bed was associated with an increased difficulty falling asleep.

## » Francisco's Comments

Athletes need to understand the role that sleep plays in recovery and performance. I recommend a group education approach with an individual or smaller group approach for the red flags. Practitioners can use simple sleep checklists to educate their athletes on good sleep hygiene habits ([HERE](#)).

The number of electronic devices used was associated with an increased difficulty in falling asleep. These findings may be related to the suppression of melatonin from the short-wavelength light emitted by electronic devices, as can be seen in the video below. Although no information was obtained in the current study, some athletes may have had access to light-filtering programs on their electronic devices. When possible, athletes are recommended to use a combination of light-filtering and a reduction in the brightness of the device screen as I recently reviewed in Issue #21 (July 2018) of The Performance Digest.

**Want to learn more?**

Then check these out...



## Practical Takeaways

"The findings from this study demonstrate that well trained athletes spent adequate time in bed during each night. However, younger athletes spent more time in bed and felt sleepier in comparison to their older counterparts, indicating that younger athletes may have a sub-optimal sleep quality. These findings highlight the need for sleep hygiene education and sleep monitoring in younger athletes.

In this study, one in five athletes reported to nap. Napping is a strategy frequently implemented by athletes to extend sleep duration and short duration naps are recommended during the day (e.g. 30 min nap during lunch time) to enhance alertness. When dealing with amateur and semi-professional athletes that do not have time to nap during the day, practitioners are encouraged to focus on sleep hygiene education."

[Abstract]

# A meta-analysis on the internal and external measures of training load in team sports

## OBJECTIVE

When developing a training session, a training stimulus is prescribed to target a physiological response. Measuring physiological responses though is not always feasible due to factors such as time and/or equipment constraints and, high-degree of technical knowledge required. Therefore, understanding the associations between internal and external measures of training loads is crucial for the training process in order to monitor training responses. This study compared several internal and external measures of load typically obtained within team sports environment to provide guidance to practitioners regarding the association between different measures.

## WHAT THEY DID

A meta-analytical analysis was completed that included studies which focused on measures used to determine internal and external load of team-sports athletes. Studies published until September 2017 were included for analysis and the final data sample included 13 studies, 295 athletes and 10,418 individual session observations. The following measures were included within the analysis:

- ⇒ Internal measures included: Session ratings of perceived exertion (sRPE), sRPE training load (sRPE-TL), and heart-rate-derived training impulse (TRIMP).
- ⇒ External measures included: Total distance (TD), the distance covered at high speed (HS) and very high speeds (VHS) (13.1–15.0 km/h and 16.9–19.8 km/h, respectively), accelerometer load (AL), and the number of sustained impacts. Additionally, the authors investigated if the internal–external load relationships were dependent of the training mode: mixed (reference condition), skills, metabolic, or neuromuscular.

## WHAT THEY FOUND

The following relationships between internal and external measures of load were observed, with the remaining results being deemed unclear or not possible:

- ⇒ sRPE-TL and TD (possibly very large), number of sustained impacts (possibly large), AL (likely large) and HS (likely moderate).
- ⇒ TRIMP and AL (possibly large).

In addition, TD was demonstrated to have the strongest relationship with internal load and intensity indicators; and internal–external load relationships differ depending on the mode of training.

## » Francisco's Comments

A variety of external load measures are often collected by sport scientists in order to quantify the training load of their athletes. The findings from this study demonstrate that care must be taken when assuming the strength of the relationship between internal and external measures of load. Practitioners are recommended to conduct in-house research to better understand the associations between internal and external load measures amongst their own athletes.

Practitioners need to be aware that the sensitivity of the measures commonly used to determine the internal load (e.g. sRPE-TL and TRIMP) in the applied setting can be questioned. For example, a low-density session with a high number of accelerations, decelerations and/or high intensity speed action will likely have a lower sRPE-TL score in comparison to a high-density session. However, such a session can lead to remarkable levels of muscle damage and prolonged fatigue. Therefore, my suggestion is to collect a variety of internal and external measures of load: a measure of total volume (TD), density (distance/min), high-intensity actions (high-speed running metres and number of accelerations) and, internal load (TRIMP and sRPE-TL).

### Want to learn more?

Then check these out...



## Practical Takeaways

"Although the association between internal and external load measures were mostly positive, the strength of these associations are dependent of the measures used and are strongly influenced by the training mode. For example, TD was highly related to sRPE-TL (possibly very large) for mixed training, but for skills and neuromuscular training, this relationship was lower.

TD has the strongest associations with internal load measures reinforcing the need to include TD as one of the markers to monitor training load. sRPE-TL was associated with various external load measures; therefore, sRPE-TL can be considered as a valid indicator of internal load in team-sport athletes. The diverse associations found between internal and external load measures reinforces the need for practitioners to collect multiple measures to accurately quantify internal and external training loads."

[Abstract]

# Markers of fatigue following a soccer match and match-simulation protocols

## OBJECTIVE

Understanding the demands of a particular sport (such as soccer) is of utmost importance in order to design specific and individualised training programs (e.g. daily training load within a training week) as well as an effective recovery protocol. The authors of this review investigated how a soccer match and various match-simulation protocols influence different measures of fatigue.

## WHAT THEY DID

Following a thorough review of the literature, 77 studies (n = 1105 soccer players over 18 y) were used for analysis. The results allowed the authors to analyse different fatigue markers at half-time and after the match (0-, 24-, 48- and 72 h after a match or match-simulation validated protocol). These fatigue markers included:

- ⇒ Metabolic alterations (e.g. glycogen depletion)
- ⇒ Biochemical parameters (e.g. endocrinal responses)
- ⇒ Physical performance markers (e.g. jumping performance)
- ⇒ Technical performance (e.g. passing precision)
- ⇒ Perceptual responses (e.g. muscle soreness)

Independent variables that were observed within the reviewed literature included methodological variables (e.g. playing surface, environmental temperature, and type of protocol) and players characteristics (e.g. gender and players' training status).

## WHAT THEY FOUND

The main findings of the study were:

- ⇒ Changes in metabolic markers were observed both at half-time and after a football match;
- ⇒ Markers of muscle damage, inflammation, endocrine response, and immunology function remained elevated until 72 h after a match;
- ⇒ Redox-related markers returned to near baseline 72 h after a match;
- ⇒ Increased fatigue levels were observed in knee extensors and flexors for up to 72 h after a match, with fatigue being greater in knee flexors in comparison to knee extensors;
- ⇒ Sprint performance is affected for up to 48 h after a match and change of direction ability for up to 24 h after a match;
- ⇒ Jumping performance is affected for up to 72 h after a match;
- ⇒ Repeated sprint ability is impaired at half-time and after a match but this does not differ from baseline at 48 h and 72 h;
- ⇒ Perceptual muscle soreness, fatigue, well-being, and sleep were elevated from baseline for up to 72 h after a match.

## » Francisco's Comments

This study provides information on how different fatigue markers are affected during and after a soccer match. Sensitivity of the measures that are to be used is an important consideration when deciding what markers to include in a fatigue-monitoring protocol. Practitioners should also be aware of the applicability and the relevance of each measure before including it in the protocol. I recommend the reader to go back to Issue #22 (August, 2018) of the Performance Digest where I have summarised a study that reviewed different methods which were used to monitor fatigue during soccer and their applicability to a real-world soccer environment.

In order to monitor levels of fatigue or readiness to train, different measures should be obtained (e.g. perceptual and performance-related measures). When time and applicability is a constraint, practitioners can rely on other measures (i.e. perceptual) as an overall indicator of fatigue.



## Practical Takeaways

"Soccer training and competition lead to a fatigue status that can affect performance for up to 72 h following a match or match-simulation. There seems to be some specificity regarding the recovery status of different fatigue markers. For example, whilst jumping performance is affected for up to 72 h after a soccer match, sprint performance appears to return to baseline by 48 h after a match.

Hamstring muscle function, countermovement jump performance, muscle soreness, and creatine kinase are the most sensitive markers (i.e. were the fatigue markers that were more affected by soccer and those that remain elevated for a longer period of time).

Practitioners are recommended to implement a fatigue monitoring protocol that involves different markers of fatigue in order to increase the sensitivity of the protocol to detect fatigue."

**Want to learn more?**

Then check these out...



# Youth Development

This month's top research on youth development.

## **FUNDAMENTAL MOVEMENT PROFICIENCY: THE IMPACT OF GENDER, THE ENVIRONMENT AND BODY WEIGHT**

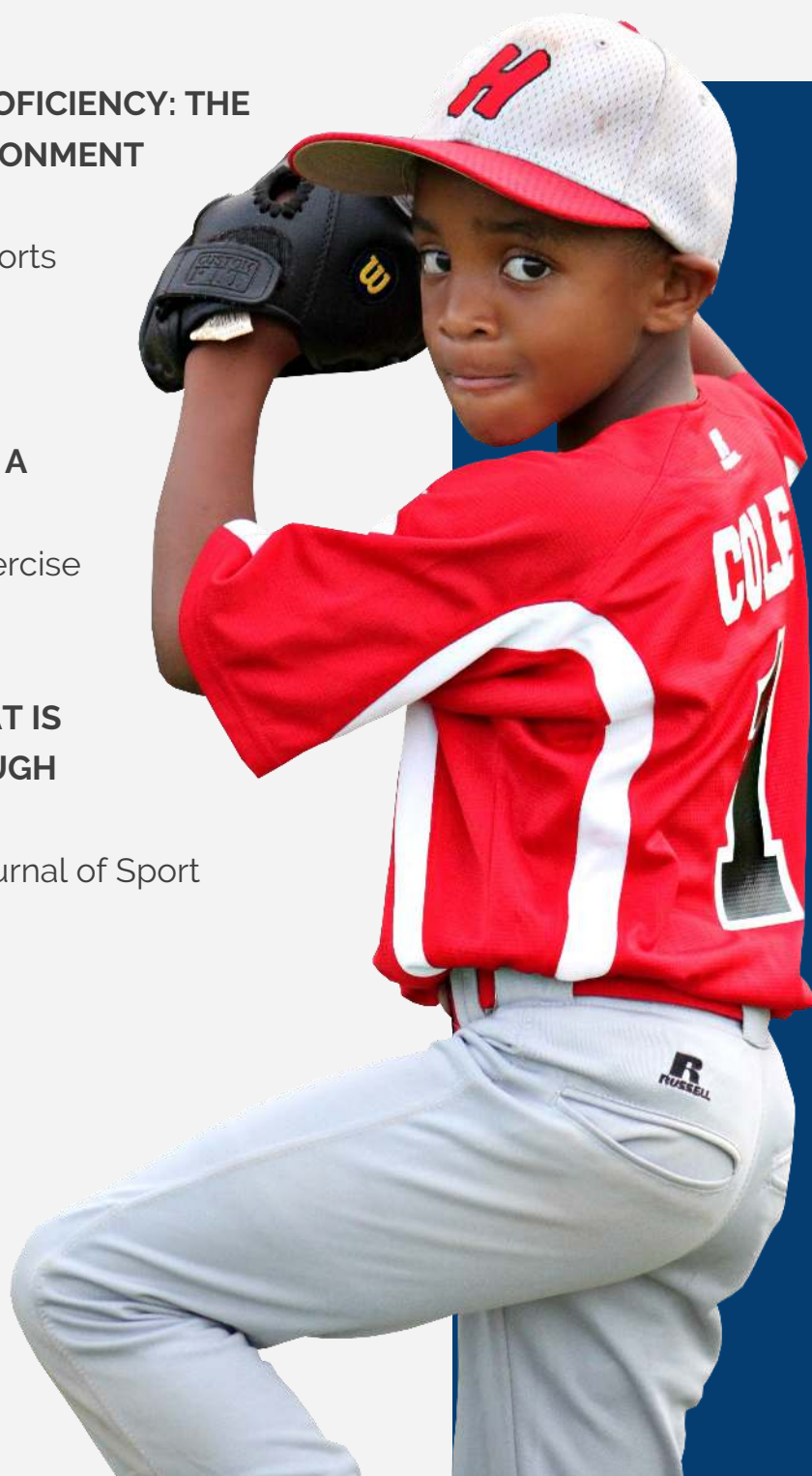
Kelly, L. et al. (2018) Journal of Sports Sciences.

## **DIFFERENCES IN SOCCER LOAD: TRACKING THE CHANGES OVER A SEASON IN YOUTH**

Vahia, D. et al. (2018) Pediatric Exercise Science.

## **TO SHOE OR NOT TO SHOE, THAT IS THE QUESTION: A GUIDE THROUGH MATURATION**

John, C. et al. (2018) European Journal of Sport Science.



[Abstract]

# Fundamental movement proficiency: the impact of gender, the environment and body weight.

## OBJECTIVE

Currently, diseases such as obesity, cancer, and cardiovascular disease that could be prevented by physical activity are costing the Irish Healthcare System up to €1.16 billion each year. These problems usually manifest during childhood, placing an invested interest in fundamental movement skill (FMS) development from a young age due to the positive associations with good health. Few studies have investigated how gender, class, or weight could aid or detract from physical activity, which aims to be answered from this research.

## WHAT THEY DID

To support the objectives of this study, the researchers tested four-hundred and fourteen Irish school pupils (male = 216, female = 198) from the age of  $9 \pm 1.7$  y (year 5). FMS scores were examined using the Test of Gross Motor Development 3 (TGMD-3); which consists of 13 tests that are used to assess an individual's total athletic qualities. A vertical jump and single-leg stance assessment were also used to assess jump technique and postural and balance control. Participants were categorised into their gender (male or female) and class group. Further to this, participants' weight was measured and BMI was calculated and compared to international obesity cut-off points. The categories derived from this were overweight/obese, or non-overweight in-line with age and gender norms.

## WHAT THEY FOUND

Inadequate levels of FMS proficiency levels were present in Irish school children, with few achieving mastery (<50%), regardless of gender. Mastery was defined as having excellent body/object control, so the majority scored low on these predefined criteria. The largest improvements in FMS mean scores occurred between Year 2 (age 6-7 y) and Year 3 (age 7-8 y). After this, FMS scores began to plateau and decline, with a rapid drop after Year 5 (age 9-10 y). New insights suggest that males were more proficient than females in object-control subtest, and non-overweight children displayed far better locomotor and object control scores than overweight children.

## » Practical Takeaways

As coaches, teachers, and parents, it is important that we address any gaps in knowledge or a lack of resources before this becomes an excuse for lazy practice or a burden to overworked staff. This would be doing a disservice to our future champions, who have challenging times ahead. In light of this, the link below provides an excellent resource which will serve as an invaluable provider of knowledge for teachers in schools, and several include free PDF's of lesson plans that are both fun and developmental, and most importantly can be found in one place. Additionally, these resources contain ideas on how to alter a space (e.g. a playground), to assist in learning and promote physical exercise.

In a curriculum that can often constrain practice, it is important that teachers feel that they can have periods of unstructured and creative play. This study promotes the idea of exposure to new skills but suggests that more specialised teachers may be required. S&C coaches can provide insight for teachers here, for example, sharing ideas on lunge patterns, good squat mechanics, jumping/landing skills and the use of animal positions/superheroes to develop good fundamental movement habits. However, I do believe that teachers can do this with a rudimentary knowledge of these skills, as just "feeling" a movement can often lead to learning and self-correction over time.

**Want to learn more?**

Then check these out...



## Tom's Comments

"This study helps us to understand the relationship between quality physical education sessions and fundamental movement skill proficiency. Indeed, it would appear that mastering these skills requires quality teaching, access to equipment, and appropriate session progression and differentiation. However, this study makes no attempt to explain the rapid decrease in FMS scores that occur after year 5, but does note that limited training, time spent teaching PE, and decreased confidence when teaching FMS's could be a contributing factor.

It is now important to think about how we as S&C coaches can support children in becoming more competent. In my opinion, one of the leading thinkers in this area is Jeremy Frisch, who has certainly challenged the "norms" of physical development. In this podcast below, we can hear some of Jeremy's opinions and can hopefully see how these could translate into physical education. The difficulty now is ensuring that school's buy -in to this way of teaching, which can only occur with quality and consistent practice."

[Abstract]

# Differences in soccer load: tracking the changes over a season

## OBJECTIVE

As a youth soccer coach, the roles and responsibilities require an individual who can manage the interactions between development, match exposure, and recovery. These are all interlinked, where too much, too little, or not enough of each factor can have a significant impact on performance. In a youth population, little has been done to clarify how/what this should look like. This study aimed to understand this, by reporting on the variation of load in adolescent soccer players over a season.

## WHAT THEY DID

A total of fifteen male youth players (age:  $16.7 \pm 1$  y) were monitored over a 7-month period from October 2016 to April 2017. These players had a large amount of contact time with their coach and managed to train for seven sessions a week with matches typically played on a Saturday. Players wore heart rate monitors during every session which allowed the researchers to monitor a percentage of heart rate (HR) (e.g. 70% of HRmax). Furthermore, players were asked to provide a rating of perceived exertion within 20 min of finishing the session (sRPE), which represented the whole session's difficulty.

## WHAT THEY FOUND

To the best of the authors' knowledge, this is the first study that has examined the internal training load using HR and sRPE in youth soccer players over an entire season. The findings of this study indicate that amongst youth soccer players a strong relationship existed between HR and sRPE, suggesting that both HR and sRPE when measured independent of each other can be a reliable measure of internal training load. This is further explained in the attached resource below.

## » Practical Takeaways

This study offers the reader some visible data that can be used for normative data. For example, sRPE and HR data has been gathered in arbitrary units over a monthly basis. This data can be analysed and compared with your own to assess how players are reacting to less or more training volume. To better support this, Will Abbot of Brighton and Hove Albion Football Club discusses the use of internal load and heart rate in the attached podcast, and delves into how he uses these measures to support recovery.

In the discussion, Vahia and colleagues refer to the participants as transitioning between the "training to train" phase which focuses on aerobic conditioning and fundamental movement skills (FMS), to the "training to compete" phase with highly structured training. When programming or observing this data, it is important to consider that youths at this age (16-17 y) are still undergoing physical and behavioural growth and physiological development. In consideration of this, heart rate may prove challenging to analyse. It is therefore recommended that sRPE is used given that it is reported as both reliable and valid. In the attached video, an alternative has been suggested where the athlete would aim to train at an RPE intensity (e.g. 100 kg @ level 8). This can then be progressed either through a weight increase (e.g. 102.5 kg @ level 8) or by increasing the sets/ reps to demonstrate improved tolerance. Both require adequate time and maturity from the participants, as they must become familiar with this scale.



## Tom's Comments

"Strength and conditioning coaches are continually challenged to work under large time and financial pressure. This study supports the modern practitioner by demonstrating that at times, the most basic of interventions such as asking a child how hard they felt the session was, can match other measures (HR) which are far more expensive and time consuming. Heart rate monitors do have their use when looking to work at a percentage of maximal heart rate, but for the most part, they may prove an unnecessary purchase with regards to measuring the internal response to a soccer stimulus or load. Furthermore, HR data would be far larger and more difficult to analyse when compared to RPE.

When collecting sRPE, it is important to remove any peer pressure created by the team or unconsciously by the coach. An example of this may be the coach saying *"well done, that was a really tough session"*. In reality, the players may not have found the session challenging, but feel inclined to say it was hard to impress the coach. To get around this, players could be asked to complete this away from the session or to complete an online sRPE form. As coaches, we may need to think about how and why we use certain words in this environment."

**Want to learn more?**  
Then check these out...



[Abstract]

# A guide through maturation: comparison of barefoot and shoe wearing children

## OBJECTIVE

During maturation, deficits in sensorimotor control are thought to be temporarily disrupted due to poor motor coordination and changes in limb-length associated with growth. Increasing evidence has suggested that motor and gait control is also influenced by the presence or absence of footwear, and that a potential training effect on strength and balance may be increasingly sensitive during certain phases of development. Therefore, the aim of this study was to analyse the influence of maturation in children who grew up barefoot versus those who wore shoes.

## WHAT THEY DID

Sixty-five German males (mean age  $13.3 \pm 0.8$  y) who were habitually shod and fifty-five South African males (mean age  $13.4 \pm 0.9$  y) completed a barefoot questionnaire. To be classified as habitually barefoot, most activities in school had to be performed without shoes.

Height, weight, and maturity offset were collected and physical measures (backwards walking, sprinting over 20 m, and a long-jump test) were used to assess dynamic postural control and coordination, speed, and power. All of the data was then compared (shod vs. barefoot) to report the differences.

## WHAT THEY FOUND

Maturity had positive influences on motor performance in all athletes independent of whether they were shod or barefoot. However, in barefoot athletes, backwards walking performance was significantly better than those who wore shoes. However, factors such as footwear condition played a large part, with poorer shoe quality showing worse balance scores. No differences were observed in other measures through maturation.

## » Practical Takeaways

The results of this study highlight the differences in movement patterns and performance between youth with different experiences in wearing shoes during their developmental years. In the video below, Shaktar FC offer us a comprehensive look at the ankle and foot rehabilitation strategies used in their professional team. As coaches, we may wish to change some of the activities we see to a barefoot variation due to the additional benefits on balance and that certain conditions (e.g. health and safety, hygiene, adequate flooring) are met to improve vestibular and sensorimotor control. In turn, this may speed up the return-to-play process and allow players to become stronger and faster. However, this is quite a big jump from the findings of this study, where a further intervention study could be required to assess its effectiveness.

To implement this, coaches must develop the knowledge to justify this to the player and coach to ensure buy-in. To support the Performance Digest reader, Dr. Mike Mortino has offered a resource (see below) to help to explain why and how barefoot training can impact performance. This may serve as an invaluable presentation to look through and support your 'why' when incorporating this.

**Want to learn more?**

Then check these out...



## Tom's Comments

"This study marks quite an interesting concept for S&C coaches, where barefoot training may be advantageous, particularly as a tool for injury prevention or to train balance as demonstrated in the podcast. Such skills are key to improving our practice and could be further developed by adding foam pads, sand pits, or hard surfaces to improve ankle and foot proprioception. I believe that future studies should make a notable effort to assess the impact of footwear, particularly those with raised or "bouncy" soles/heels that are impacting ground contact and technique. I am forever looking at my athlete's footwear and asking to see a squat or deadlift with their shoes off. Amazingly, this can fix many of the problems such as knee valgus, collapsed arch, or poor trunk angles associated with poor technique."

# Nutrition

This month's top research on nutrition.

## **DOES CACAO JUICE SUPPLEMENTATION IMPROVE RECOVERY AFTER EXERCISE?**

Morgan, P. et al. (2018) Sports.

## **MILK: POUND-FOR-POUND ONE OF THE BETTER RECOVERY DRINKS FOLLOWING EXERCISE.**

James, L. J. et al. (2018) European Journal of Sport Science.

## **DOES CARBOHYDRATE FEEDING DURING A 10 KM SWIM IMPROVE PERFORMANCE?**

Baldassarre, R. et al. (2018) European Sports.



[Abstract]

# Does cacao juice supplementation improve recovery after exercise?

## OBJECTIVE

Cacao beans are used for cocoa production and are rich in both flavanols and proanthocyanidins. The potential antioxidant and anti-inflammatory qualities of cocoa polyphenols suggest an improved recovery when consuming a cocoa supplementation. To the authors knowledge, no research has attempted to investigate the potential of cocoa juice (CJ) on recovery from intensive exercise. As such, this study aimed to investigate whether consumption of CJ enhanced muscle function following a muscle damaging protocol.

## WHAT THEY DID

Ten healthy recreationally active males completed two trials (10 sets x 10 repetitions) of unilateral knee extensions at 80% of 1RM and ingested either a supplement (ZumoCacao® juice) or placebo (dextrose drink) for 7 days before and 48 h after exercise.

Knee extensions maximum voluntary contraction (MVC) and countermovement jump (CMJ) were performed at baseline, immediately after, and 24 h and 48 h after exercise. Venous blood samples were collected at each time point and analysed for indices of inflammation, oxidative damage, and muscle damage.

## WHAT THEY FOUND

The study found that the consumption of 330 mL of CJ 7 days before and 48 h after intensive exercise had no effect on the recovery of MVC force, self-reported muscle soreness, creatine kinase concentration, inflammation, or oxidative stress. However, the consumption of CJ was associated with improved recovery of explosive power (CMJ) compared to placebo.

## » Practical Takeaways

Performing exercise inevitably means a contraction of muscles. Depending on intensity and load applied, this may result in muscle damage and soreness. Alternative polyphenol-rich options (fruit juices such as cherry juice, blueberry, and pomegranate) to reduce oxidative damage and inflammation have shown greater effects than cocoa flavanol (for a review, see [HERE](#)).

With this in mind, athletes may want to consider combining polyphenol rich food sources together in an attempt to aid recovery during intensified training of fixture windows. An example may be:

- ⇒ A handful of mixed berries
- ⇒ 4-6 x 80%+ dark chocolate squares
- ⇒ Whole milk 200ml
- ⇒ Blitz together in a smoothie and consume

**Want to learn more?**

Then check these out...



## James's Comments

"The precise mechanisms by which CJ might have accelerated recovery is unknown, and CMJ improvements may have been purely coincidental. However, there are certainly no negative side effects to ingesting these food types within a normal diet if it is planned around heavy training sessions or competition. Therefore, practitioners should look to design quick and easy recipes that include flavanols for athletes to follow. The video and article links below provide some explanation of the mechanisms of cocoa flavanols and a more in-depth review of cocoa flavanol supplementation.

A logical next step for this line of work would be to understand the effects of cocoa flavanols in the real-world setting following training or competition demands that place trauma on muscle fibres.

Although not directly cocoa, a quick and easy option I have used with athletes for years is chocolate flavoured milk to aid the recovery process following exercise. I discuss this below in the next nutrition article and have also included a podcast that explains why milk is beneficial after exercise."

[Abstract]

# Milk: pound-for-pound one of the better recovery drinks following exercise

## OBJECTIVE

Milk provides a cheap and easily accessible strategy for athletes to facilitate recovery after exercise given the nutritional properties of high-quality protein, carbohydrate, water, and micronutrients (particularly sodium). Considering the low cost and ease of access to milk worldwide, many practitioners can utilise this food source with their athletes. This review evaluated the impact of post-exercise milk ingestion on recovery process and highlighted the areas where exercise and milk ingestion might interact to influence health outcomes.

## WHAT THEY DID

The focus of the review included:

The goals of post-exercise recovery from a nutritional perspective.

- ⇒ The impact of milk ingestion on different aspects of recovery after exercise.
- ⇒ An overview of the nutritional composition of different dairy milk (in particular the leucine content of dairy milk) and alternative sport specific beverages for comparisons to be made.
- ⇒ A discussion about how milk may be a favourable food source for positive body composition changes.

## WHAT THEY FOUND

The consumption of milk following exercise has the potential to have a beneficial influence on both acute recovery and chronic training adaptation. In addition, milk consumption following exercise has also shown to reduce subsequent food intake and, therefore, may lead to favourable body composition changes with exercise training. As such, athletes and exercisers focused on body composition manipulation or weight control may find it beneficial to consume milk after exercise to help maintain low energy intakes.

## » Practical Takeaways

Skimmed milk has been shown to increase the rate of muscle building, compared to a macronutrient matched soy milk drink (i.e. plant protein). Chocolate milk is a commercial beverage which also provides benefits after exercise, specifically after endurance exercise given the sugar content, compared with carbohydrate only beverage (see video below). Those who exercise for weight-management and aesthetic purposes such as combat sport athletes, jockeys, light-weight rowers, and physique competitors might be able to facilitate post-exercise recovery without negatively influence the energy balance, when consuming skimmed milk. Optimal protein intake would be between 1.5-2.5g/kg/BW and readers are directed [HERE](#) for some more guidance.

Considering milk is an affordable, easily accessible, and effective beverage naturally enriched with leucine that provides a number of benefits to the human body, it is ideal as a recovery drink after exercise. Practically, recommending milk consumption to athletes will help with:

- ⇒ Repair of damaged muscle and facilitation of new muscle growth
- ⇒ Increase intake of carbohydrate to help restore muscle glycogen
- ⇒ Rehydration
- ⇒ Reduction of subsequent energy intake and lead to favourable body composition changes with exercise training.

**Want to learn more?**

Then check these out...



## James's Comments

"This review provides an easy-to-read comprehensive overview of the implications of consuming milk for the recreational exerciser and athlete.

Considering the whey content in milk compared to other milk beverages (i.e., soy milk, coconut milk), low-fat milk appears to be an effective nutritional strategy following exercise, especially for the weight-making athletes or the exercisers who strive for weight loss, for health or aesthetic purposes. The authors of the study suggest further work should evaluate the chronic effects of post-exercise milk-ingestion on energy balance in response to exercise training."

[Abstract]

# Does carbohydrate feeding during a 10 km swim improve performance?

## OBJECTIVE

It is well established that high carbohydrate availability improves both endurance and high-intensity intermittent exercise performance. However, research in swimming athletes and the effects of carbohydrates is limited. The aim of the present study was to test the effectiveness of carbohydrate feeding supplemented every 2.5 km on the performance, perceptual (RPE), and glucose concentration amongst open-water swimmers.

## WHAT THEY DID

The study attempted to use traditional feeding strategies according to the guidelines for endurance exercise with ten elite open-water swimmers (six males and four females). They completed two 10 km intermittent training swimming sessions (20 x 500 m), each separated by 2 days of rest, in a randomised order. On each trial, participants were asked to ingest either 1 L of tap water (WAT, 0.50 L/h) or a 120 g carbohydrate beverage in the form of 8% solution (CHO: 60 g/h). During the trials, swimmers drank three times every 2.5 km in order to simulate feeding zones during the race. The first 9.5 km was completed at 80% - 90% of swimmers individual maximum 500m time and the last 500 m as fast as possible, replicating a typical open-water swimming race strategy.

## WHAT THEY FOUND

The ingestion of 60 g/h of CHO during the swim did not significantly improve the relative velocity of each 500 m or reduce RPE in open-water swimmers during a 10 km intermittent training. During the last 500 m, however, the presence of glucose in the blood was significantly higher when consuming the CHO beverage due to the ingestion of more carbohydrates in comparison to the consumption of WAT.

## » Practical Takeaways

Despite no significant difference in performance variables throughout the 10 km trials, the variation of -1 % observed in the last 500 m between the CHO and WAT trials could still be the difference between winning a medal or not placing at all. Previously, Shaw et al., (2014) (see [HERE](#)) highlighted general competition nutrition strategies for the 10 km open-water athlete which include:

- ⇒ Consumption of 10-12 g/kg of CHO for 36-48 h before an event, combined with normal training to achieve a supercompensation in muscle glycogen stores.
- ⇒ Consumption of a pre-race meal of well-tolerated foods providing a carbohydrate target of 1-4 g/kg of body mass, 1-4 h before race start.
- ⇒ Consumption of sodium and cold beverages to optimise pre-race hydration status and enable a reduction in core temperature before competition.
- ⇒ Self-supplied fuel and fluid sources throughout the race (i.e. sources tucked into swimming suit), using feeding stations, only when tactically appropriate for a 10 km open-water event.

The duration of some open-water events involves physiological issues which are not typically seen in other endurance events such as cycling and running, and therefore, may affect the nutritional strategies used.

**Want to learn more?**

Then check these out...



## James's Comments

"The authors highlighted that this is the first study to monitor glycemia levels continuously through a swimming trial in elite open-water swimmers. Despite this novelty aspect, the protocol used may not have been appropriate. Firstly, the lack of a control trial with an artificially non-caloric sweetened placebo may result in a failure to demonstrate the efficacy of any potential performance benefits. The authors believed that there was no "placebo effect" as there was no increase in performance from the CHO trial.

Furthermore, the study used female participants, for whom the menstrual cycle was not recorded. Failure to consider the menstrual cycle may lead to a misinterpretation of measured performance variables given the utilisation of glycogen may be different between luteal and follicular phases. Thus, the menstrual cycle should be accounted for in both research and sporting settings (see podcast by Rothschild) to gain a greater insight into the effects of CHO consumption during open-water swimming. The study also utilised a swimming pool rather than open-water environment. As such, specific nutritional considerations may differ between the open-water and the swimming pool as they may be determined by the race duration, environmental conditions (unpredictable waves, tides and currents), and the opportunity to consume nutrients during the race."

# Injury Prevention & Rehab

This month's top research on injury prevention and rehabilitation.

## **PHYSICAL AND PSYCHOLOGICAL READINESS FOR SPORT IN ADOLESCENTS FOLLOWING ACLR**

Burland, J. P. et al. (2018) Journal of Athletic Training.

## **IS BLOOD FLOW RESTRICTION TRAINING BENEFICIAL FOR MUSCLE WEAKNESS DUE TO KNEE PATHOLOGY?**

Barber-Westin, S. et al. (2018) Sports Health.

## **IS MODERN MEDICINE TOO MUCH?**

Friedman, D. J. et al. (2018) British Journal of Sports Medicine.



[Abstract]

# Physical and psychological readiness for sport in adolescents following ACLR

## OBJECTIVE

Tears of the anterior cruciate ligament (ACL) and surgical reconstruction (ACLR) are on the rise in the paediatric population. Physical readiness criteria for young athletes may be different than those used for adults. Furthermore, psychological readiness is often not adequately addressed in rehabilitation at any age. The primary aim of this study was to investigate how strength measurements and self-reported outcomes related to timing of return-to-play (RTP) in adolescents who underwent ACLR.

## WHAT THEY DID

In this retrospective, cross-sectional study, the authors searched medical records for children and adolescents who underwent ACLR using a hamstring autograft between April 2014 and July 2015. Fifty patients were included, each of whom were either cleared to RTP or not cleared (NRTP) based on several criteria. The ACL Return to Sport Index (ACL-RSI) and the pediatric version of the International Knee Documentation Committee (Pedi- IKDC) were completed at the 3- and 6-month follow-up appointments. An isokinetic dynamometer was used to measure isometric and concentric hamstring and quadriceps strength (at 3 and 6 months following operation).

## WHAT THEY FOUND

Data were analysed to determine how well, if at all, limb symmetry indices (LSI's), self-report outcomes, and timing of RTP were correlated, and how accurately they predicted timing of RTP. The following findings were significant:

- ⇒ Higher ACL-RSI scores were associated with higher LSI's for isokinetic extension, and higher Pedi-IKDC scores.
- ⇒ At 3 months, the LSIs for both isometric extension and flexion were moderately associated with RTP timing.
- ⇒ The largest predictor of RTP was the Pedi-IKDC score at 6 months.
- ⇒ The 6 month LSI for isometric extension was highly accurate in predicting RTP following ACLR (a 6-month LSI isometric extension value of >87.35%).

## » Practical Takeaways

In general, patients with higher LSI's had better self-reported knee function and demonstrated an improved readiness for return to sport at their 6-month follow-up. Secondly, greater LSI's for isometric and isokinetic extension, along with higher self-reported knee function and readiness to return to functional activities, together predicted a quicker RTP after ACLR. Perhaps the most glaring and important finding was that those who had an isometric extension LSI of >87.35% at 6 months were 8 times more likely to return to play than those who had an LSI below this value.

This study was unique in that it investigated a strictly adolescent population. It also used a combination of self-report outcomes, functional and strength tests, and analysed the interactions between and among them. Previous research has focused mostly on one type of measurement or criteria for determining RTP, which we know does not explain the whole "picture." By using a combination of measures compared to looking at them separately, they were able to better understand the relationship between physical function and self-reported function and the readiness to return to sport or functional activity after ACLR.

However, there were several limitations to this study:

- ⇒ It only included those who had a hamstring autograft, and excluded those who had a bone-patellar-bone graft
- ⇒ No long-term follow-up or rehab analyses

**Want to learn more?**

Then check these out...



## Steph's Comments

"It was refreshing to come across a study that took into consideration both the psychological and physical readiness of athletes in the RTP decision making process. Much of the research has focused on either the psychological or the physical preparedness, which leaves the coach and clinician with some confusion about what is important to address.

This study shows that stronger, more mentally prepared athletes returned to higher level sport sooner. This helps us, as coaches and clinicians, direct our treatment and/or programming based on what the athlete is exhibiting. For example, an athlete may pass all physical tests but voice concerns about returning to "game speed" play. In this case, the coach or clinician can be confident that taking more time to set the athlete up for success during rehabilitation in order to promote self-efficacy and confidence will be most beneficial (see reference below). It's important to remember that each individual will be somewhere on this psychological to physical spectrum and may require different approaches at different times during rehabilitation."

[Abstract]

# Is blood flow restriction training beneficial for muscle weakness caused by knee injury?

## OBJECTIVE

Knee injury or pathology is often why individuals experience lower extremity (LE) muscle weakness and have difficulty gaining back strength. Blood flow restriction training (BFRT) has been proposed to help increase strength at lower, more tolerable loads. The purpose of this review was to determine if BFRT is effective in (1) increasing quadriceps and hamstring strength and cross-sectional area (CSA) for chronic knee-related LE muscle atrophy, and (2) preventing muscle atrophy after knee surgery.

## WHAT THEY DID

This was a systematic review in which all publications through 2017 were searched in PubMed using specific keywords. Strict inclusion and exclusion criteria were implemented, and of the 534 articles identified, 9 were kept for review. The following data were extracted from each article: study design, age, sex, diagnosis, number of training sessions, cuff pressure, occlusion protocol, exercise protocol, quadriceps and hamstrings strength measurements, CSA measurements for quadriceps and hamstrings from MRI or ultrasound, muscle biopsy results, results of outcome measures, and pain or discomfort reported during training.

## WHAT THEY FOUND

Six of the eight level 1 randomised controlled trials (RCT's) concluded that BFRT was effective and should be considered in rehab after ACL construction, after routine knee arthroscopy, in arthritic knees, and with patellofemoral pain. There were minimal adverse effects, the greatest being discomfort during training. In fact, Bryk et al. ([HERE](#)) found that the BFRT group in their study reported less anterior knee pain throughout training.

## » Practical Takeaways

What we know:

- ⇒ BFRT is safe and likely effective in increasing quadriceps strength in individuals with knee-related LE atrophy/weakness.
- ⇒ Low resistance loading (~30% of 1 RM) is sufficient to stimulate muscle strength and hypertrophy without eliciting anterior knee pain.
- ⇒ Including BFRT in rehab and/or training with the following populations should be considered: after ACL reconstruction or routine knee arthroscopy, with knee arthritis, and with patellofemoral pain cases.
- ⇒ The proposed mechanisms behind strengthening with BFRT are unknown, though it does not appear to induce any skeletal muscle damage.
- ⇒ With proper training/familiarisation, coaches and clinicians can utilise BFRT as an adjunct to current training and/or rehab.

What we need more information on:

- ⇒ Optimal cuff pressures/protocol.
- ⇒ Optimal frequency and duration of sessions.

Limitations of this study:

- ⇒ Small sample size.
- ⇒ No long-term follow-up.
- ⇒ Few studies measuring effect size or including power analysis.
- ⇒ Lack of consistency in muscle strength reporting.

Want to learn more?

Then check these out...



## Steph's Comments

"This review only included high-quality RCT's, reassuring the skeptical reader that, despite variation among the studies, we can be sure that opting to include BFRT in training or rehab with our patients or athletes is safe, potentially effective, and definitely not harmful. With that determined, the coach or clinician can properly educate their clients and patients and exude confidence, which can help with motivation and compliance in the rehab and training process.

What I would love to see in the research is a comparison of specific cuff protocols, assessment of the effects of longer duration and greater volume of BFRT training (greater than the 8 weeks included in the studies in this review), and more patient-reported outcomes and feelings on success using BFRT. With this added knowledge, perhaps training and rehab for those with significant muscle weakness and atrophy will be more targeted and effective."

# Is modern medicine too much?

## OBJECTIVE

This educational review, influenced by a recent review in the British Journal of Sports Medicine (BJSM) (see reference below), really brings attention to the concepts of "overdiagnosis" and "too much medicine". Overdiagnosis is the diagnosis of a medical problem that would never have caused symptoms or problems. The aim here was to keep the general public and the exercise and sports medicine reader up-to-date and well-informed on this topic.

## WHAT THEY DID

The authors identify specific problems as well as themes from both the Too Much Medicine Conference in Helsinki, Finland, and the Preventing Overdiagnosis conference in Copenhagen, Denmark. They offer advice and some actionable ways that healthcare professionals can begin to take action on and improve awareness of these concepts. They also introduce and shed light on "Choosing Wisely Canada", a campaign to reduce unnecessary tests and treatments in healthcare.

## WHAT THEY FOUND

The major problems identified include: (1) that vested interests often take the place of patient/client interests, (2) clinical guidelines are causing misinformation, and (3) a lack of transparency with funding and outcomes hinders the ability to provide high-quality care. The themes derived from the conferences mentioned above were the following:

- ⇒ "You're sick, you just don't know it yet"
- ⇒ "If you're not sick, you just haven't had enough tests"
- ⇒ "A pill for every ill"

## » Practical Takeaways

The proposed drivers behind these identified themes are complex, though insightful. First, the fact that we do not have a clear definition of disease leaves us contemplating whether something as widespread as low back pain (LBP) is a disease or a symptom. Second, the wide variety and specificity of tests and screens available, though absolutely needed to determine risk of serious illnesses such as cancer, are often over-utilised in musculoskeletal disorders. Thus, resulting in incidental findings, a subsequent diagnosis, and the idea that tissue damage is the cause of pain. Thirdly, the vastness of technological advances, combined with the power to write prescriptions and/or operate tend to lead to medicine and surgery being used to "fix" problems. This is for sure a necessity when appropriate, except for when what is most appropriate is to utilise a conservative approach or, truthfully, to do nothing.

The bottom line is that society gravitates towards quick fixes and desires a tissue-based "cause" for symptoms or pain. This comes into play for coaches and physiotherapists when our athletes or patients have received imaging, medication, or treatment elsewhere prior to coming to us, and are now both hyperaware of symptoms as they relate to imaging findings and/or are dependent on said treatment or modality that they were told will "fix" their problem. This all feeds into feelings of discouragement, lack of confidence, and generally higher stress. Coaches and physios are in a great position to educate on the poor relationship between imaging and symptoms, and to support self-efficacy and confidence for these individuals and athletes.

**Want to learn more?**

Then check these out...



## Steph's Comments

"Perhaps the most important takeaway from this is that there are absolutely things that we can do to combat over-diagnosis. As Roy Moynihan states in the video below, "the package of modern medicine offers tremendous benefit... this is not about the problem with medicine itself, it's about the problem of too much medicine." The following are his suggestions regarding what we can start to do right now improve this:

- ⇒ Become more skeptical of diagnostic labels.
- ⇒ Seek out more information independently (outside of marketing).
- ⇒ Seek out more independent health professionals (not associated with drug reps or corporate companies).
- ⇒ Clinicians and coaches in management positions: be more independent; clean up corrupt relationships with drug and fitness reps.
- ⇒ Set up campaigns to criticise over-medicalization.

I realise this is a broad view of healthcare and fitness, though I truly believe that it is applicable to the S&C world as well. Coaches: this knowledge allows you to educate, empower, and to not necessarily jump to an intervention with every issue our athletes may have."

# Infographics

A round-up of our monthly research infographics.

## **DYNAMIC STRENGTH INDEX**

Solomon, M. (2018) Science for Sport.

## **FATIGUE MONITORING**

Solomon, M. (2018) Science for Sport.





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# DYNAMIC STRENGTH INDEX

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## What is it?

The dynamic strength index (DSI) is simply a ratio between an athlete's ballistic peak force and their dynamic or isometric peak force.



## Importance

The DSI provides information regarding how forceful the athlete is, and how much of that strength they can use during fast movements. The DSI can therefore be used to design individual training programs.



## Measurements

The isometric mid thigh pull (IMTP) or 1RM dynamic back squat is used to measure an athlete's maximal force capabilities, whilst the countermovement jump (CMJ), which is a ballistic movement, is used to determine how much of their total force capability can they produce in a very short timeframe.



## Our summary

The DSI can be used to identify whether the athlete may require maximal strength training, ballistic strength training, or concurrent training as a stimulus in their programme. It can also be used to reliably measure the performance capabilities in both the lower- and upper-body and in recreational, university, and elite athletes.



## Calculation

The equation below is used to calculate an athlete's DSI:

$$\text{Dynamic Strength Index (DSI)} = \frac{\text{Ballistic Peak Force}}{\text{Dynamic or Isometric Peak Force}}$$

Table 1: Test scores and DSI calculation.

Exercise	CMJ Peak Force (N)	IMTP Peak Force (N)	DSI
Athlete A	1,450	3,178	0.46 (46%)
Athlete B	2,500	3,000	0.83 (83%)
Athlete C	2,600	2,600	1 (100%)



## Application

A higher DSI means more time should be spent on developing maximal strength. A smaller DSI means more time should be spent developing the rate of force development, using ballistic strength training.

Table 2: DSI scores and training recommendation.

Score	DSI Score	Training Emphasis Recommendation
Low	<0.60	Ballistic Strength Training
Moderate	0.60-0.80	Concurrent Training
High	>0.80	Maximal Strength Training

For the full article check out the Science for Sport website

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# FATIGUE MONITORING



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## What is fatigue?

"Fatigue is an exercise- or non-exercise-induced loss in total performance due to various physiological factors, athlete reported psychological factors, or a combination of the two."



## Categories

Fatigue is often sub-divided into two forms:

### Central

Central fatigue is described as coming from the central nervous system and the transmission of signals from the brain to the muscle.



### Peripheral

Peripheral fatigue occurs within the muscle. Through either the depletion of glycogen, phosphate compounds, or acetylcholine, or, through an accumulation of lactate or other metabolites that are released during activity.



## Importance

Coaches who monitor fatigue can ensure an athlete's continual adaptation, prevent overtraining, and ultimately maximise performance.



## How to monitor

Fatigue can be monitored using either subjective or objective measurements.

### Subjective

Wellness questionnaires and the 'rating of fatigue scale' are subjective options, with the later capable of differentiating between perceived exertion during recovery and during exercise.



### Objective

Countermovement jumps, heart rate variability and salivary measures are objective options. Each assessing different elements of fatigue.



### Combination

A combination of subjective and objective measures may provide an optimal test battery for fatigue.



## Our summary

There are numerous subjective and objective practices that can be used to monitor each athlete. Coaches should consider which ones they have the capabilities of using, and which one is best suited to the athletes they are working with.

For the full article check out the Science for Sport website

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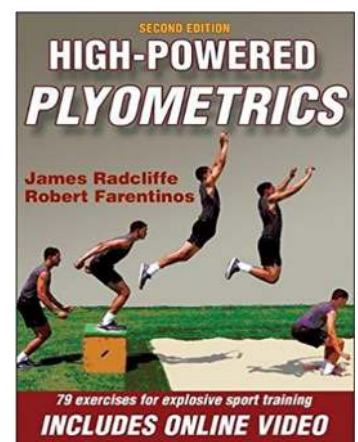
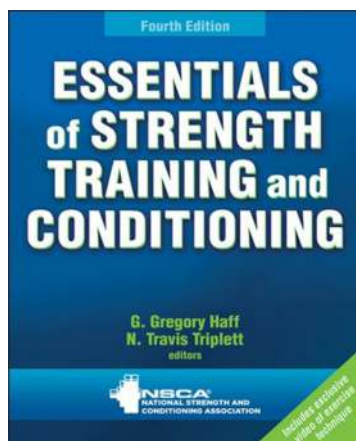
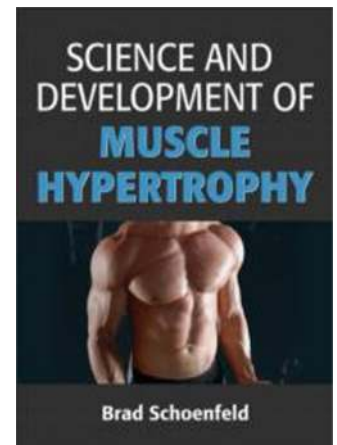
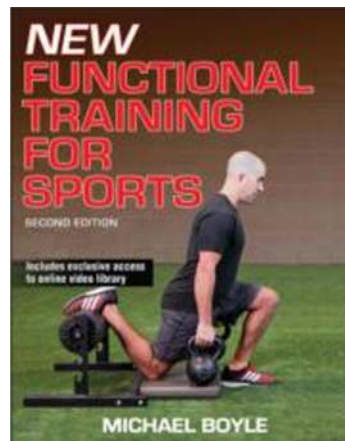
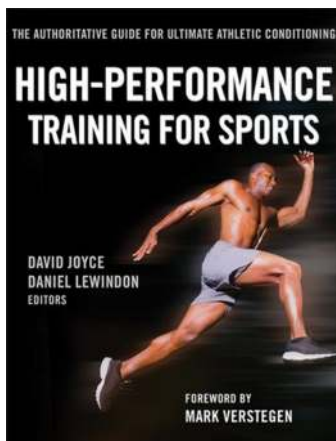
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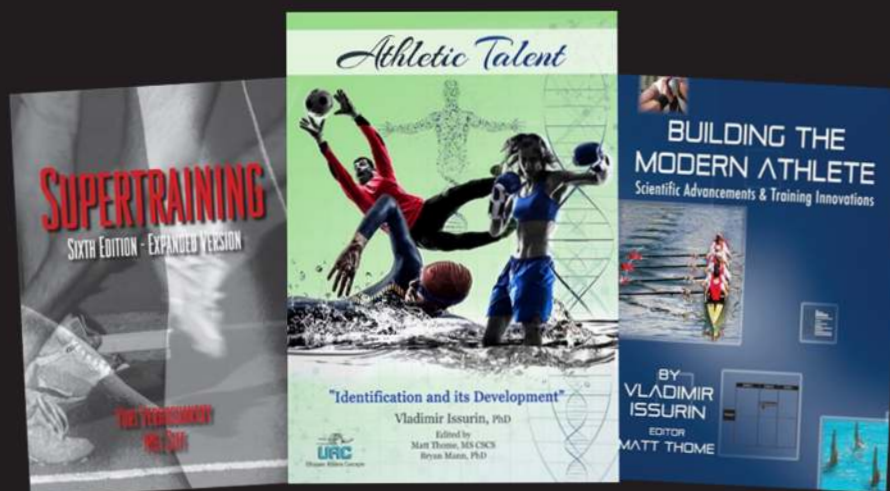
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knowledge with your friends and colleagues!

Warm Regards  
Science for Sport

