April 2018 | Issue #18

# THE **PERFORMANCE** DIGEST

A review of the latest sports performance research





# Contents

Click a topic to jump straight there

**04** Welcome A word from the chief editor

**05** Reviewers The brains behind the brilliance

**o6** Audio Review A topic recap on all the research reviewed

**07** The Science of Coaching The doctors diagnosis

**08** Strength & Conditioning Performance-enhancing science

**12** Technology & Monitoring The tech revolution

**16** Fatigue & Recovery You can't adapt without recovery

# 21 Youth Development

Their future is in our hands

**25** Nutrition You are what you eat

**29** Injury Prevention & Rehab Minimising injury and maximising recovery

33 Infographics Our very latest infographics

**36** Offers Exclusive, members-only discounts



# YOU'RE INVITED



# MEMBERS ONLY GROUP CHAT WITH OUR EDITORS AND OTHER MEMBERS



# Welcome to the **PERFORMANCE DIGEST**

If you're reading this right now, then I am seriously honoured you decided to invest in yourself and join the Performance Digest. I am extremely thankful for every single member who chooses to join us on our relentless quest to improve this industry for the better. Without you, this would simply not be possible; so thank you.

## LATEST NEWS

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

**Changes to the research reviewers:** This month marks a new ear in the "Technology & Monitoring" section as we'd now like to welcome in our newest research reviewer: Carl Valle. Carl is a phenomenal academic and practitioner, with decades of high-profile experience in the world of sports performance and technology. Therefore, he will no doubt take this section to a whole new level; so expect great things from him. In that same breath, this means James de Lacey has moved up to become our new "Strength & Conditioning" research reviewer. James is now where he feels most comfortable and because he does this with such high-quality day-in day-out,, I know he'll do a fantastic job.

All of these moves have come about because our long-standing S&C reviewer Tim Rowland has decided to move on as his time commitments purely don't allow him to keep up with the reviews. As a result, we'd like to sincerely thank Tim for all of his great work since the launch of the Performance Digest in December 2016 and wish him all the very best in his future endeavors.

Thanks for reading, and for being a member :) Owen Walker



OWEN WALKER Founder and Director of Science for Sport



# **Research Reviewers**



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Owen Walker
MSc*D CSCS
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**Chief Editor** 

Owen is the founder and director of Science for Sport. He was formerly the Head of Academy Sports Science and Strength & Conditioning at Cardiff City Football Club, and an interim Sports Scientist for the Welsh FA.



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Dr. Will Vickery
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The Science of Coaching

Will is a 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.



**James de Lacey** MSc

Strength & Conditioning

Tim is the Head Strength and Conditioning Coach at the Sydney Rays Women's Rugby Sevens Team, and has assisted previously at the Australian Rugby Sevens. He has a Bachelor of Physiotherapy (1st Class Honours), Master of High Performance Sport and ASCA Level 2.



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. Francisco Tavares
PhD Candidate CSCS ASCA L2



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.

Fatigue & Recovery

**Tom Green** MSc UKAD Advisor

**Youth Development** 



Tom has an MSc in Applied Strength and Conditioning from Hartpury College. He is currently working at Gloucester Rugby Club as an Academy S&C Assistant and has experience in professional boxing, semi-professional football and GB Equine.

> 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)

> 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.









A 1-year recap on what we know and hope to find out from future research. *with Tom Green* 

## WHAT WE DICUSS

In this episode of the "Audio Review", Tom Green and myself (Owen) discuss the the importance of bone health for young athletes and how to improve it. We also cover what we currently know, and don't know, from the research.

In this episode, we discuss:

- Why bone health is important
- How it can be measured
- How you can go about improving the bone health of your athletes
- Recommendations for non-load bearding sport athletes (e.g. swimmers and cyclists)
- What research we hope to see in the near future

Episode length = 42 minutes





## Key Takeaways

- There's a critical period for developing bone mineral density around the age of peak height velocity
  - Low bone mineral density significantly increases fracture risk
    - Genetics, nutrition, medication, sun exposure all contribute to bone mineral density
  - <50% of children around the age of peak height velocity don't get enough vitamin D
  - Non-load bearing sport athletes are at a higher risk of bone fractures
    - DEXA scans are the gold-standard for measuring bone mineral density
- We'd like to see more practical, down-toearth research which practitioners can apply right away

# The Science of **COACHING**

# Strict vs. open training environments for technical development

How does the training environment imposed by a coach affect the learning and development of athletes in the short– and long-term?

### INTRODUCTION

In the current era of professional sport, a significant amount of time and money is spent on developing young athletes on the premise that they will one day represent a professional club. Some, however, have suggested that the coaching practices adopted within these systems are much less about providing junior athletes with an opportunity to develop a range of qualities (e.g. physical conditioning, technical skills, and tactical awareness), but more about the coaches moulding these athletes into replicas of previous or current professional athletes by using traditional coaching methods. This typically involves highly-structured sessions where coaches provide direct instructions and information to athletes with a large focus on technique modification.

The use of structured and technically-focused practices has been criticised in recent times, mainly due to the focus on replication of "text-book" movement patterns and not allowing players a sense of freedom or cognitive thought. A more updated approach to coaching practice is based on the concept of ecological dynamics (**HERE**), which views an athlete as a complex system who has the ability to examine and adapt to the environment they are in. Current research would suggest that this approach increases an athlete's opportunity to develop in a variety of areas. This study provided an insight into the training practices of pre-academy elite and subelite British rugby league players.

### WHAT THEY FOUND

Following semi-structured interviews with 16 players (8 domestic only, 8 domestic and international) a number of themes arose which highlighted the different practices these players were involved in from childhood to the present day:

- ⇒ A range of training methods and experiences were provided (drills through to small-sided games) during their amateur days and during their professional careers, regardless of the level they have played.
- ⇒ International players were more likely to take part in scenario-based practice tasks.
- ⇒ All players, regardless of the playing level, experienced positive experiences and supportive environments. However, the domestic-only playing group also reported negative practice experiences.
- Both playing groups engaged with a range of sports during childhood (e.g. football, athletics), rather than only playing rugby league.
- ⇒ International players appeared to be more likely to be involved in dynamic (frequently changing, autonomous) learning environments.

### WHAT THIS MEANS

Coaching practice that is based on an ecological dynamics framework appears to be a common environment for those players who have gone on to represent either at domestic or international level. As the authors state, this type of practice provides a greater opportunity for the development of physical, psychological, emotional, and social factors amongst players. What is noticeable, however, is that those players who have gone on to represent their country have had additional experiences and been involved in a range of other practice environments, including scenario-based and athlete-centred learning. These additional experiences and environments are likely to have shaped these athletes ability to identify relevant information within more match-replicable settings and adapt to these changing environments that are representative of professional sport. The negative experiences that were only reported by the domestic players are based on their perception that coaches prioritised physical conditioning instead of tactical and skill development. Something that does not fit within the ecological dynamics framework.

# **Practical** Takeaways

The coaching practices adopted during the early stages of an athlete's career has a significant impact on the player that they become. Although it is common practice within the strength and conditioning environment to focus much of the attention on technique and specific performance improvements, room should be made to allow athletes to explore their environments for themselves. This will hopefully provide more opportunities for athletes to develop match-specific movement patterns alongside a range of other factors, such as decision making ability which are sometimes neglected for the sake of physical improvement. Given the information presented from this study and previous work, coaches are encouraged to promote environments which allow their athletes to explore and adapt to their environment rather than simply provide specific, technical instructions.



Will is a Senior Lecturer of Sport Coaching at the University of Northumbria in Newcastle Upon Tyne, U.K. SPORT

# **Strength & Conditioning**

This month's top research in strength & conditioning.

## GYM-BASED PRIMER SESSIONS 1-2 DAYS BEFORE A GAME: DO THEY WORK?

Tsoukos, A. et al., (2018) Journal of Strength and Conditioning Research.

## THE NORDIC CURL VS. STIFF-LEG DEADLIFT: WHICH IS BEST FOR HAMSTRING MUSCLE ACTIVITY?

Hegyl, A. et al., (2018). Scandinavian Journal of Medicine and Science in Sports. (28): 992-1000.

## POST-ACTIVATION POTENTIATION (PAP) FOR ENDURANCE SPORTS: A HIDDEN PIECE OF GOLD?

Boullosa, D. et al., (2018). European Journal of Sport Science.



# Gym-based primer sessions 1-2 days before a game: Do they work?

### OBJECTIVE

It has been suggested that a resistance training (RT) session performed 24-48h before a competition/game or a highquality training session may enhance athletic performance. However, there is limited evidence regarding the effects of resistance training on subsequent explosive muscle performance. Hence, the purpose of this study was to investigate whether a low-volume, power-type RT session enhances neuromuscular performance of the legs in the following 24 to 48h.

### WHAT THEY DID

17 national-level male power- and team-sport athletes took part in 4 different sessions (2 experimental and 2 control). Subjects were first familiarised and then tested for baseline measures on 1RM half squat (90 degree knee angle), CMJ, drop jump (RSI), isometric maximum force (leg press 90-100deg knee angle), and rate of force development from the isometric leg press at 0-100, 0-200, and 0-300ms. After the baseline tests, the experimental group performed a warm-up of 1x6 @15% 1RM and 1x4 @30% 1RM jump squats. Once warm, subjects performed 5x4 jump squats with 40% 1RM (approx. 65kg) with a 90-100deg knee angle. Explosive performance was measured 24 or 48h after the intervention for each group. The control group also had explosive performance measured at 24 or 48h, but with no intervention.

### WHAT THEY FOUND

CMJ in the 24h condition was greater than baseline ( $5.1 \pm 1.0\%$ ) as well as in the 48h condition ( $3.0 \pm 0.7\%$ ) in the experimental trial, while there was no difference in the control trials. RSI in the 24h condition was greater than baseline ( $10.7 \pm 2.1\%$ ), while scores in the 48h condition were not statistically different. No significant interactions were found between conditions or time to maximum isometric force. However, RFD 0-100, 200, and 300ms were significantly greater in the 24h condition compared to baseline ( $18.3 \pm 4.1\%$ ;  $10.2 \pm 3.3\%$ ;  $9.7 \pm 3.4\%$ , respectively). Only RFD 0-100ms was greater than baseline in the 48h condition ( $9.8 \pm 3.1\%$ ).

# >> Practical Takeaways

This paper shows that a low-volume, power-type resistance training session results in moderate to large improvements in explosive performance 1 and 2 days later. In particular, CMJ, RSI, and RFD all experience significant improvements, however, no improvements in peak force were observed. The improvement in explosive exercises, but not peak force, could be due to the exercises performed in the intervention. Hence, 24-48h enhancements may be velocity specific, where the jump squat closely mimics the CMJ and DJ.

Based on this study, the use of the jump squat can be used as a "primer" 1 or 2 days out from competition to enhance neuromuscular performance. Other velocity-based movements could also potentially be used to enhance performance, such as sprinting or varying medicine ball throws. Since subsequent performance seems to be velocity specific, strength-based "primers" may be useful for sports that require high forces rather than high velocities; an example may be working up to a 90% 1RM squat or bench press.

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



# James's Comments

"This performance enhancement effect lasted up to 48h in this study. However, performance enhancements can be seen in as little as 4-6 hours after training (see article linked below). This provides a large window where a "primer" could be used before competition and may depend on the individual athlete as to how they respond. Performance enhancements seem to be dependent on the exercises chosen during the "primer", so for velocity -based exercises. In contrast, for forcespecific improvements, choose forcebased exercises.

A tip taken from Nic Gill (New Zealand All Blacks S&C Coach) at a conference in New Zealand, is that primers should always remain the same from week-toweek as you don't want to create unnecessary muscle soreness each week."



# The Nordic Curl vs. Stiff-Leg Deadlift: Which is best for hamstring muscle activity?

### OBJECTIVE

Hamstring injuries are the most common injury in sports involving high-speed running. Low eccentric strength is thought to be one of the most significant but modifiable risk factors. Bi-articular components of the hamstrings (those which contribute to both hip extension and knee flexion) may require complex within-muscle co-ordination. The aim of this study was to examine the eccentric-only Nordic hamstring exercise (NHE) and the eccentric phase of the stiff-leg deadlift (SDL).

### WHAT THEY DID

12 recreationally active young males with weightlifting experience participated. A familiarisation session involved a 1RM SDL and practice of the NHE and maximum voluntary isometric contractions (MVICs). The main testing session consisted of MVICs of hip extension and knee flexion with the trunk and hips fixed on a dynamometer bench. Activity of the biceps femoris long head (BFlh) and semitendinosus (ST) were recorded using HD-EMG arrays (a more detailed EMG that can differentiate proximal vs. distal activity in muscle). NHE was performed with force transducers attached above the ankles for 5 reps and with 2-mins rest in between. Lowering was performed at a constant speed and controlled with a metronome. SDL was performed with a 2-sec tempo at 80% 1RM for 5 reps and with 2-mins rest between.

### WHAT THEY FOUND

During the NHE, ST muscle activity was highest in the middle region of the exercise and with substantial differences between regions. Meanwhile, BFlh activity was highest in the distal region and lowest in the proximal region during the NHE.

In the SDL, ST activity was highest in the middle region with small to moderate differences between regions. BFlh activity was lowest in the proximal region with differences between middle and distal regions being trivial. ST presented substantially higher overall activity than BFlh during NHE, but in the SDL, the difference between muscles was negligible.

# >> Practical Takeaways

The "region effect" was larger with the NHE than in the SDL in the BFlh. In both exercises, the distal region was activated the most. The ST had the most activity in the thickest upper-mid region in both exercises. In comparison, the BFlh distal region showed the most activity. However, BFlh distal muscle thickness is lower compared to the middle and proximal regions. The increased activity in the distal region, however, could come down to the architecture of the different regions. This may be the case as there are short fascicles and larger pennation angles in the distal region compared to proximal region, therefore, the distal region seems to be more suited for force production.

In regards to injury prevention, the NHE is generally seen as a predominantly "lower-hamstring" exercise, whilst the SDL is often thought of as a "higher-hamstring" dominant exercise. However, this study showed that there was higher muscle activity in the ST and the BFlh in the NHE exercise, in all regions. This supports the idea of positive architectural changes (fascicle elongation) within the BFlh in response to NHE. In the SDL, absolute muscle activity was substantially lower than in the NHE, which is potentially due to load not being matched for both exercises. Instead, the load selected is what is generally used in training. In summary, this study suggests that the SDL alone may not be as effective as the NHE for hamstring injury prevention.

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



# James's Comments

"One thing that was not discussed in this study regarding the differences in EMG activity, was the length-tension relationship. The NHE isolates the hamstrings due to removing any movement of the hips (i.e. hips stayed fixed). Furthermore, the hamstrings start in a shortened position putting them at a more advantageous position to produce force going from flexed to normal length. In contrast, the SDL starts with the hamstrings placed in a typical standing length position before being stretched, this potentially lessens the force production capabilities. In addition to this, the SDL potentially has large contributions from stronger or larger muscles such as the glutes and spinal erectors.

For overall hamstring health, it's important to use a variety of exercises with different loads and a mixture of speeds. This means not fixing your training programme to only performing sloweccentric hamstring exercises (e.g. the NHE). Using movements that have a faster eccentric component would be a good way to progress through eccentric hamstring training; but be warned, eccentric exercise can induce a fair amount of muscle soreness. Regardless, a good example of this would be the single-leg drop catch back extension (see video link). Isometric exercises, on the other hand, act as a great link/ bridge between training with high forces but with very little muscle damage and soreness."



# Post-activation potentiation (PAP) for endurance sports: A hidden piece of gold?

### OBJECTIVE

Post-activation potentiation (PAP) has been defined as the phenomena by which muscular performance characteristics are acutely enhanced by previous exercise. PAP has been traditionally focused on power exercises, however, PAP responses have also been observed in endurance-trained athletes after maximal voluntary contractions. Therefore, the aim of this study was to present the current evidence of PAP in endurance athletes, and to discuss the physiological basis and methodological aspects of this ergogenic mechanism for better practice.

### WHAT THEY DID

Activities were considered as endurance-based if they lasted for longer than 1-min. The inclusion criteria for this review were: 1) participants should be endurance-trained athletes, 2) an endurance exercise should be present, and 3) pre- and post-exercise measures of muscle or motor performance. A total of 22 articles were included in this review. 2 articles used MVC as a conditioning activity, one used sub-maximal intermittent contractions, one compared different warm-up protocols, two assessed the effects of warm-up on subsequent simulated trial, 10 studied PAP using different exercise set-ups, and 8 studies looked at race simulations and competitions. Most output measures for assessing PAP were voluntary peak torque or evoked twitch peak torque and the countermovement jump (CMJ).

### WHAT THEY FOUND

A couple of positive outcomes were found for PAP for warm-ups. National-level rowers that added 5x5-sec isometric contractions to individualised warm-up routines significantly improved mean power and performance time over the first 500m of a 1000m rowing ergometer time-trial. Despite this, their performance time did not significantly improve over the whole trial. Another paper found a 6% time reduction (i.e. positive improvement) in a 20km cycling time-trial after adding 4 sets of 5RM leg press to a 5-min sub-maximal cycling warm-up routine. This improvement showed a trend towards higher mean power output during the first 10% of the trial. PAP during training and competition has shown that a conditioning activity consisting of 10-mins of sub-maximal (50% MVC) intermittent contractions of knee extension can significantly improve the peak torque in endurance-trained athletes when they perform an entire endurance-based protocol. On the contrary, power-trained athletes experienced a significant reduction in peak torque through the 2nd half of the protocol.

# >> Practical Takeaways

The concept of using PAP after specific warm-up protocols for endurance performance has been an under-explored area. From the literature reviewed within this study, a key take-home message would be that caution should be taken when using this training method given the fact that a PAP effect is typically shortlived (i.e. PAP conditioning activities used during warm-ups only seem to last <12-mins). As a result, the positive influence of PAP may only be expected during the first minutes of the subsequent exercise (as shown above), with limited application in longduration competitive settings. Having said that, the acute effects of PAP would therefore be more important in efforts of a shorter duration (e.g. 1500m race).

The authors also suggest that higher exercise intensities could induce more fatigue than potentiation on subsequent exercise (i.e. more bad than good), in comparison to prolonged endurance activities. This potentially means that the type of "primer" used may depend on the individual or the sport being prepared for (e.g. endurance sports using an endurance-primer or power sports a power-primer). Future research should investigate the influence of different modes of exercise (e.g. cycling and running) on PAP given the variability of PAP responses and their effect on subsequent exercise.

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



# James's Comments

"This current review suggests that endurance athletes can experience the existence of PAP during and after endurance performances; though the benefits may be short-lived (<12mins). The priming exercise used for longlasting endurance sports should be different than a typical primer used for team- or power-based sports. Based on the research reviewed, an endurance primer may involve submaximal intermittent isometric contractions as to keep the potentiation/fatigue balance in favour of PAP. While jump potentiation has been observed after long-duration endurance exercise, performing longduration exercise as a primer isn't practical before a competition. Future research is needed to verify the effectiveness of different training interventions in both PAP responses and endurance performance."



# **Technology & Monitoring**

This month's top research on technology and monitoring.

MEDICINE BALLS WITH BUILT-IN ACCELEROMETERS: ARE THEY ACCURATE AND WORTH THE INVESTMENT? Roe G, et al. (2018) J Strength Cond Res, 1.

## ARE TYPICAL MUSCULOSKELETAL SCREENING TESTS SENSITIVE TO CHANGES IN TRAINING LOAD?

Esmaeili A. et al., (2018) Frontiers in Physiology, 1.

## ARE WEARABLE SENSORS THE NEXT GENERATION IN SPRINT PERFORMANCE TESTING?

Setuain I. et al., (2018) Scandinavian Journal of Medical & Science in Sports, 1.



# Medicine balls with built-in accelerometers: Are they accurate and worth the investment?

### OBJECTIVE

Elite sport requires valid and reliable technologies to monitor training or track performance. The market of velocity-based training equipment recently expanded with new options, and the need to ensure the new products are properly assessed is essential for coaches and sport scientists. Medicine ball training is a popular modality, so naturally a technology that enables coaches to measure the performance of throws is a tool that could be both practical and useful in testing. The goal of this study was to validate the 'Ballistic Ball' - specifically the 8 kg option - for chest throws compared to a research grade motion capture system.

### WHAT THEY DID

Researchers focused on the reliability of the device with professional rugby athletes and the criterion validity with Qualysis, an optioelectronic system. Researchers recruited ten young professional rugby players (19.7 ± 1.1 years), roughly 100 kg body mass and approximately 186 cm in height. Those athletes performed 2 x 3 throws maximally while lying supine on the ground. The best throw of each athlete was collected and compared to a separate evaluation of the criterion measurement. Three subjects (unknown population) performed 25 throws with 5 reflective markers on the sensor-enhanced medicine ball.

### WHAT THEY FOUND

Researchers found that the accelerometer-equipped medicine ball was reliable for chest throw velocity readings. The findings demonstrated a small typical error of 2.8% (2.0 to 4.6) with regards to between-day reliability. The investigators also found an almost perfect relationship between the Ballistic Ball and the criterion measure, proving the equipment has excellent validity. The medicine ball did overestimate velocity by 7.9% (Peak Velocity) and had a moderate standard error of 4.9%.

# >> Practical Takeaways

Based on the reported data, the use of an accelerometer-embedded medicine ball is very practical way to track improvement in a chest throw. Due to the between-day assessment error being only small statistically, it's useful for applied environments needing to see significant improvements in upper-body performance. The sensitivity of the Ballistic Ball appears to be strong enough to see improvement of a training programme over long periods of time, but for weekly monitoring of the nervous system it may not be able to detect fatigue. Finally, the athletes were supine when they performed their throws to improve the repeatability of the throw, so coaches may want to consider using a wall if they are performing horizontal throws seated or standing.

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



# Carl's Comments

"Medicine ball training and testing still desperately needs hard quantification, and the Ballistic Ball offers a potentially useful approach to extracting data from common exercises. What is disappointing is that the researchers used an upper-body throw instead of a total-body throw vertically, as that exercise is far more common with speed and power athletes. The paradigm shift in medicine ball training and testing towards a velocity-based approach instead of a weight and estimated distance is a great idea, as instantaneous feedback is great for athletes. Future research validating other common throws would be invaluable to coaches."



# Are typical musculoskeletal screening tests sensitive to changes in training load?

### OBJECTIVE

The relationship between injury and training load is well researched, but is still not clear enough to predict injuries with certainty. Musculoskeletal screening is also unable to predict injury, but several tests are connected to risk factors that may increase the likelihood of specific sport injuries. Naturally, a combined approach of using screening and load monitoring is a good idea for reducing the number of injuries that athletes encounter.

## WHAT THEY DID

In this study, researchers tracked three screening tests, two range of motion tests, and one local muscle strength test over the course of an entire AFL season. Researchers tested 44 athletes, with mean age of 22.8 7 ± 4 years, 14 times over the season, including the pre-season. Training load was estimated by using session rating of perceived exertion multiplied by the length of the training session (session RPE \* total minutes). After the data was collected, they did conventional statistical analysis with an SAS software package.

### WHAT THEY FOUND

The data collected found that all of the measures of training load (cumulative, smoothed, Acute:Chronic, Monotony, and strain) had a trivial effect on the screening scores. The only trend that appeared "substantial" was a very likely small increase in the adductor squeeze test over the in-season period. It should be noted that the players had small to moderate variability for all tests during both pre-season and in-season time frames. Based on their findings, the authors concluded that the three screening tests are not sensitive to training load.

# >> Practical Takeaways

Individual variability with screening scores is a factor that must be considered when flagging athletes for change. The three tests, dorsiflexion of the ankle joint, sit-and-reach of the spine and hips, as well as an adductor squeeze test are commonly done in elite and amateur sport. In addition to screening, using session RPE is also commonly integrated into monitoring programmes as well because it's quick and inexpensive. What can be learned from this study is that the influence of bodyload and fatigue with screening isn't a clear one, and only using subjective internal load monitoring and musculoskeletal testing may not be effective for reducing specific injuries.

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



# Carl's Comments

"Most coaches will want a research study to employ new training techniques or better monitoring options, but sometimes a study that informs us to the limitations of what we do is just as valuable. What I liked about this study was it tracked tests and found that context and individual variability matters, and using oversimplified flagging methods aren't appropriate. While I wanted to see tests like the ankle dorsiflexion lunge test be proven to have great sensitivity to training load, mechanical external load was not measured, so it may still have promise; but for that, we'll have to wait for future research."



# Are wearable sensors the next generation in sprint performance testing?

### OBJECTIVE

Advances in technology, specifically the improvement of smaller and more accurate wearable devices, could improve load management and performance testing with athletes. In the past, inertial measurement units (IMU) were suitable for coaches for estimating jump performance, but sprint performance was limited with these devices. The ability to collect speed and estimations of force could be a valuable tool for coaches trying to track large groups of athletes concurrently.

## WHAT THEY DID

To validate the device (Human Orientation Tracker from Xsens), the researchers used a customised 10m force platform and compared the measurements to the wearable sensor. Using 16 recreational athletes, the wearable device was placed on the lumbar spine to mimic the centre of mass (COM). In addition to the force platform, the researchers collected the horizontal velocity with three photocell timing gates and compared those measures to model force-velocity parameters.

### WHAT THEY FOUND

The two key findings of the study were that the sensor was both valid and reliable, but the data was not accurate enough to replace direct measures of force. While the absolute data was not interchangeable, the pattern of force and inter-trial reliable was statistically strong enough to be used in a coaching setting. Finally, the error of force estimation increased as the velocity increased, thus it was limited to low acceleration values. Also, the researchers noted limitations of the placement of the sensor and recommend other areas to explore; such as the ankle.

# >> Practical Takeaways

What can be concluded from this validation study is that a compromise still exists from direct measurements of force and speed and indirect calculations of sprint performance. Wearable sensors have a great cost benefit, but due to the limitations, they are not research grade with many applications such as high-speed running. Also, the concept of using the centre of mass is a limited approach, because variables such as lateral forces and the interaction of force transmission through the foot is not equated in the calculations. The researchers did recommend further investigation into IMU options in hamstring return-to-play scenarios.

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



# Carl's Comments

"The practical benefit of a single IMU sensor, specifically a magnetic device (MIMU), is interesting but not compelling enough for coaches to get excited. With the rise of inexpensive timing systems and force measurement tools, the major question is: "will a direct measure cost catch up to indirect measures such as IMUs in testing?" at least in my opinion. What is important to know is that monitoring of practices, not performance tests, is where IMU and MIMU options have the most potential for performance staff and medical professionals."



# **Fatigue & Recovery**

This month's top research on fatigue and recovery.

## INTERMITTENT COLD WATER IMMERSION: 8°C VS. 15°C

Kodejska J, Balas J, Draper N. (2018) Int J Sport Nutr Exerc Metab.

## PRACTICAL APPLICATIONS OF WATER IMMERSION RECOVERY MODALITIES FOR TEAM SPORTS

Tavares F, Walker O, Healey P, Smith TB, Driller M. (2018) Strength Cond J.

## HOW LONG DOES IT TAKE TO FULLY RECOVER AFTER A COMPETITIVE MATCH?

Doeven SH. et al., (2018). BMJ Open Sport Exerc Med. 4.





# Intermittent cold water immersion: 8°C vs. 15°C

### OBJECTIVE

Cold water immersion (CWI) is widely implemented within the athletic population in order to enhance recovery. In the Olympics, rock climbing will be structured in a triathlon-style format, therefore requiring athletes to speed-up recovery by maintaining hand-grip performance. This study aimed to investigate the effects of intermittent CWI at two different temperatures (8 and 15°C) on hand-grip performance.

### WHAT THEY DID

This study used a crossover design, where 32 rock climbers randomly completed three recovery interventions during three visits to the laboratory: CWI at 8°C, CWI at 15°C, and passive recovery (PAS).

On each session, athletes performed three trials consisting of an intermittent hand-grip exercise performed on a climbing-specific dynamometer and force-time integral (FTI; total time of contraction multiplied by the force of contraction) was recorded. The intermittent hand-grip exercise consisted of 8-second contractions at 60% of MVC followed by 2-seconds of recovery. If the applied force was 10% below the target force, the trial was terminated and recovery commenced. After trials one and two, CWI was implemented intermittently (3 x 4 mins immersed, with 2-mins between the immersions).

### WHAT THEY FOUND

No significant differences were observed between recovery modalities on trial 1. However, during trials 2 and 3, athletes exposed to CWI (8 and 15°C) were able to produce higher mean FTI during the intermittent trial to failure. Moreover, during the third trial, FTI was significantly higher after CWI performed at 15°C in comparison to 8°C.

# >> Practical Takeaways

The findings of this study suggest that intermittent CWI, particularly 15°C over 8°C, is an effective strategy to speed-up recovery during a rock climbing specific hand-grip exercise. Therefore, when athletes are competing in a rock climbing multiple-style format event, inclusion of intermittent CWI should be considered.

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



# Francisco's Comments

"I am particularly fond of studies like this one as they aim to solve "real-world" issues. While the effects of CWI for enhancing recovery have been previously demonstrated in rock climbing, this is the first study to compare CWI at different temperatures. It is important to mention that differences observed during the 3rd trial may be due to a greater decrease in muscle temperature after the athletes were exposed to CWI at 8°C. The higher reductions in muscle temperature may lead to a decreased nerve conduction velocity (see attached atticle #3) and therefore a reduced FTI.

The authors opted to use an intermittent CWI protocol that resulted in 12-minutes of CWI exposure. Perhaps it could be interesting to explore different protocols in order to optimise recovery, such as 2 x 5 minutes with 5 minutes of recovery between bouts. Moreover, the authors observed that responses from CWI are highly individual. As discussed in previous issues of the Performance Digest, temperature induced-changes by CWI are widely dependent by body composition (body fat, body mass, body area, etc.), gender, and other factors. When working with individual-sport athletes (e.g. rock climbers), practitioners should investigate the individual responses their athletes experience from CWI. You could do this by selecting a sport-specific test and measuring performance before and after, both with and without CWI."



# Practical applications of water immersion recovery modalities for team sports

### OBJECTIVE

Within an athletic population, cold therapies (e.g. cold water immersion) are the most popular forms of enhancing recovery. Although the general knowledge of cold modality protocols are widely described in the research (e.g. meta-analysis, systematic reviews, etc.), these manuscripts can, however, miss applications to real world. Therefore, the goal of this article was to provide a clear and practical article regarding the implementation of cold modalities for practitioners.

### DESIGNING THE PROTOCOL

We started this paper by reviewing the current knowledge on the different cold modalities protocol characteristics (e.g. duration, depth, etc.) and individual factors (e.g. body composition, age, etc.) which contribute to the effectiveness of cold modalities. My colleagues and I then provided practical recommendations based on external factors.

### The investigated protocol characteristics were:

- $\Rightarrow$  Duration (of exposure to cold);
- $\Rightarrow$  Type (contrast or cold water immersion);
- $\Rightarrow$  Immersion depth;
- ⇒ Temperature.

### Individual factors outlined were:

- $\Rightarrow$  Physique traits;
- $\Rightarrow$  Sex;
- ⇒ Age.

The external factors considered when designing the cold recovery programme were:

- $\Rightarrow$  Phase of the season;
- $\Rightarrow$  Density of the weekly schedule;
- ⇒ Goals of the athlete (short- and long-term).



# >> Designing the protocol

Our goal of reviewing the different protocol characteristics was to define different protocol intensities/severities which could be applied at various time-points in the training schedule. This was based on the assumption that different protocols (e.g. colder water or longer immersion durations) would have varying impacts on muscle temperature, and therefore, the enhancement of recovery. We also outlined the issue that eliciting greater decreases in muscle temperature may also lead to decreases in muscle protein synthesis, and therefore, adaptation/hypertrophy.

- ⇒ Water temperatures should range between 11-15°C, with lower temperatures having a greater potential to blunt adaptations without necessarily enhancing recovery due to reductions in muscle function.
- ⇒ Longer exposure to cold water increases the intensity/severity of the protocol. Importantly, deeper tissues (e.g. muscle) re-warm slower in comparison to superficial tissues (e.g. skin). Therefore, intermittent immersion protocols (e.g. 2 x 5 minutes) can be easily tolerated whilst deeper tissue temperatures remain somewhat similar.
- With regards to some markers of muscle damage, CWI may provide some small benefits in comparison to cold water therapy (CWT). Having said that, it's important to understand that the exposure to cold is lower in CWT protocols, and therefore, may reduce the harmful/blunting effects on muscle protein synthesis.
- ⇒ Immersing more of the body into cold water leads to a greater reduction in body temperature due to the increase in thermal strain.
- ⇒ Due to the hydrostatic pressure of the water, increases in venous and lymphatic compression, in addition to elevations in stroke volume and cardiac output are also observed concomitantly with increases in body surface area immersion.
- ⇒ Greater percentages of fat mass, body mass, body surface area (BSA), and other body composition characteristics all slow the reduction in body temperature during cold exposure. As a result, individualisation is warranted; especially in sports where body composition is exaggerated (e.g. American Football and Rugby).

### Go to the next page to continue reading this review...

# CONTINUED: Practical applications of water immersion recovery modalities for team sports

### PUTTING THE PROTOCOL IN PLACE

In addition to understanding the different protocol characteristics (e.g. duration, temperature, etc.), individual factors (e.g. body fat % and gender), and the significance of these on the protocol severity/intensity, practitioners should also consider the external factors (e.g. phase of the season and goals of the athlete) when designing a recovery programme using cold modalities.

Given that cold modalities can reduce muscle protein synthesis and therefore impact long-term adaptations (e.g. muscle hypertrophy), during non-competitive periods, if the goal is to increase muscle mass then implementations of these recovery modalities should be reconsidered. However, it is important to mention that even during non-competitive periods, some athletes main goal may not necessarily be further increases in muscle size. If accumulated fatigue throughout the training week/training phase is, however, reducing an athlete's "readiness" to train, then the practitioner should consider implementing cold modalities (e.g. low-intensity cold modalities). On the other hand, during competitive periods, an athlete that is not likely to make the squad and needs to make increases in muscle mass should probably avoid using cold recovery modalities.

The density of the training week should be seen as the main factor when deciding if cold modalities need to be implemented or not. Whenever an athlete can naturally recovery between training sessions, they should refrain from using them. Moreover, during the training week, the severity of cold protocols can be increased to ensure that athletes are fresh late in the week, especially for game day.



Day	Game -6	Game -5	Game -4	Game -3	Game -2	Game -1	Game
Field session	Day off	Low intensity and volume	High intensity and volume	Day off	High intensity and volume	High Intensity, Low volume	
Gym session	Day off	Upper body	Lower body strength and power	Day off	Full body power	None	
Cold recovery	None	None	None	None	Moderate- high	High	None
Example					CWT: 3x 2min cold + 1 min hot	CWI: 2x5 min cold	

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



# How long does it take to fully recover after a competitive match?

### OBJECTIVE

Team ball sports, such as football and rugby, are extremely demanding and can therefore lead to a remarkable level of fatigue. While different sports have been investigated, no previous research have systematically reviewed the differences in sports and markers of fatigue. Therefore, the goal of this study was to investigate post-match recovery of different performance and biochemical markers typically used to monitor fatigue/ readiness in team ball sports.

### WHAT THEY DID

Twenty-eight studies were included for analysis. The most common performance measures used were the countermovement jump (CMJ) and sprint tests, while creatine kinase (CK), cortisol (C), and testosterone (T) were the most frequently used biochemical markers, respectively.

### WHAT THEY FOUND

The CMJ was mostly affected for up to 12 and 24 hours after a match. In comparison to other sports, basketball appears to affect CMJ performance for a longer period of time. Sprint performance is mostly affected on the first measure after a match, and also being affected to a greater extent after a soccer match in comparison to other ball team sports.

Although in most cases these performance markers (i.e. CMJ and sprint performance) seem to return to baseline within 48 hours, longer periods were observed for CMJ (i.e. 72 hours) and sprint performance (i.e. 96 hours) after a match. Importantly, the time needed for these performance measures to return to baseline seems to be dependent on the competition level of the athlete, with lower competition level athletes demonstrating longer recovery periods in comparison to higher competition levels (e.g. amateur vs professional).

In some of the studies covered in this systematic review, CK did not return to baseline within the times of measurement, while in other studies, CK returned to baseline 42, 48, 72 or 120 hours after a match. Peak CK after exercise and time-to-return to baseline appears to be greater in soccer and rugby in comparison to other team ball sports. This is likely to be due to the greater number of high-intensity efforts performed during a match, such as accelerations/decelerations, sprints, collisions, and total running volume.

Cortisol seems to peak immediately after a match and return to baseline in different time-periods (i.e. 14-72 hours). For the same reasons to CK, the recovery times of cortisol are also longer in rugby and soccer. Different findings can be found in testosterone changes after a match. There seems to be a trend for testosterone to decrease after a match and then increase in the longer periods of recovery (i.e. 24-48 hours post-match).

# >> Practical Takeaways

The results from this study demonstrate that it takes approximately 48 hours after a match for an athlete to recover from a performance standpoint, and up to 72 hours for certain biochemical markers to recover (e.g. CK). These findings are important because they demonstrate that although athletes can regain performance (e.g. CMJ and sprint speed) 48 hours after a match, it does not mean that athletes are fully recovered from a muscle damage standpoint, for example.

Therefore, at certain periods within the season, athletes should be allowed to fully recovery, or at very least, strategies should be implemented to speed-up recovery in order to avoid accumulative fatigue. In addition, when working with sports where athletes are exposed to higher volumes during matches, such as rugby (i.e. 80 minutes) and soccer (i.e. 90 minutes), practitioners must be fully aware that the time needed to recover is longer, including how long it takes to fully recover.

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





# Francisco's Comments

"This study aimed to investigate the recovery time of different markers of fatigue in different team-sports and rugby. Further research investigating the effects in other team ball sports are therefore warranted

When working with team-sport athletes, after a match, training week with a low-volume and low-intensity field session (see my second study review in this issue of the findings that athletes can still perform close to their maximum without being fully recovered (e.g. increased be highly dependent on the competition schedule. Some good options can be to rest an athlete for a game (e.g. full weekend off), a training week, or part of the training week (e.g. weekend and beginning of the professional sports and can be applied across the board to various levels of competition

training loads are needed to ensure periods where athletes are given the opportunity to recover and load (i.e. combination of field, gym, meetings, etc.) is can expect a reduction in accumulative fatigue (e.g. biochemical markers) and therefore an increase in recovery and "freshness"



# **Youth Development**

This month's top research on youth development.

## ACL INJURIES IN YOUNGSTERS: IS THERE A SPIKE AROUND THE AGE OF PEAK HEIGHT VELOCITY?

Shaw, L. and Finch, C.F. (2017). Int J Environ Res Public Health, 14(6).

## IS THE FUNDAMENTAL MOVEMENT SKILL MODEL FOR YOUNGSTERS OUTDATED?

Hulteen, R.M. et al., (2018). Sports Medicine, pp.1-8.

## BIO-BANDING IN YOUTH SPORT: WHAT DO THE ATHLETES THINK OF IT?

Cumming, S.P. et al., (2018). Journal of Sports Sciences, 36(7), pp.757-765.

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# ACL injuries in youngsters: Is there a spike around the age of peak height velocity?

### OBJECTIVE

Sports schedules have become more frequent, competitive, and intense over the last decade. This, in conjunction with a decrease in physical activity and motor skill, has heightened the need for youth-related injury research. The anterior cruciate ligament (ACL) is located in the knee and is at a particular risk during landing, cutting, and rotational tasks; such as running, evasion, and combat sports. However, few studies have formalised evidence based on trends in injury data to understand the incidence of ACL injuries in children. This study will look to reveal some of the trends, with the aim to support practitioners in lowering injury-risk and ensuring participation.

### WHAT THEY DID

This study analysed data collected from the public and private hospital database of Victoria, Australia between the years of 2005 and 2015. Inclusion criteria included reporting or being seen to as a result of an unintentional injury to the knee resulting in a hospital admission. Furthermore, all data collected was from a youth sample between the ages of 5-14.

### WHAT THEY FOUND

Between 2005 and 2015, 320 children aged between 5-14 received hospital treatment for an ACL injury. This study reported its findings in age brackets (5-9 and 10-14). In the first bracket (5-9 years old), only 10 diagnoses and treatments were administered for ACL injury in a hospital setting. However, in the second age bracket (10-14), there were 310 diagnoses with over half (54.7%) being males. The main diagnosis was a rupture to the ACL with 56.6% of these sustained whilst playing sport. The incidence of ACL injury in Victoria, Australia between 2005-2015 markedly increased by 147.8%.

# >> Practical Takeaways

Neuromuscular control of the knee and excessive landing forces have been shown to be significantly worse in females during the transition period before and during early puberty. As a result of this, it may be important that as coaches we monitor this through regular rate of perceived exertion (RPE) and conversations regarding health and wellbeing. These are cheap, time-effective, and can reveal any trends in feelings (i.e. fatigue) which may generate puzzle-pieces to lower the volume and/or intensity of a programme for an individual.

Practically, the authors of this study suggest that programmes that reinforce good technique, coupled with appropriate motor skill competence for their age are a necessity for reducing ACL injury. Additional recommendations include that a programme should contain adequate strengthening, plyometric, and balance training with concurrent feedback to modify technique. This study could therefore support you in justifying your position with a youth climate, by communicating the relationship between risk (poor fitness) and reward (appropriate conditioning).

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



# Tom's Comments

"To combat poor levels of fitness and motor skills, physical activity is one of the best time- and cost-effective ways to increase health and wellbeing. Naturally, an increase in physical activity will see an increase in sports-related injuries. Higher volume, frequency, intensity, coupled with poorer coordination and lower-levels of fitness will potentially see this problem continue. For the S&C coach or P.E teacher, this inadvertently strengthens our position and need for our profession, particularly in a school-setting.

It would be naive to assume that the above can happen overnight. It is apparent that schools and even sports scientists are unfamiliar with the role of the strength and conditioning coach in sport, let alone with youth. I believe that to move forward, current practitioners must continue to share their programmes, results and downfalls in order to create an aware and assertive profession that understands its own strengths and limitations better."



# Is the fundamental movement skill model for youngsters outdated?

### OBJECTIVE

Underpinning both excellence in sports performance and long-term participation is a solid-base of fundamental movement skills (FMS) (see attached article). These skills are often the building blocks of more specific sporting movements which consist of locomotor skills, object control, and stability. Whilst there have been many research reviews on FMS, there remains debate regarding which should be developed first, including which are the most important for performance. In light of this, an alternative model has been suggested that replaces the terms fundamental movement skills with foundational movement skills, believing that these more adequately describe the complexity and specifity of skills that can be used in a variety of settings. Additionally, this model suggests that where we are born, alongside one's social and cultural factors are a large contributor to which foundational movements we develop.

### WHAT THEY DID

Whilst the research and implementation of FMS has received a lot of attention with youth, it has been debated that 'fundamental movement skills' is a narrow term to describe the complexity and skills required to succeed in sport. A more contemporary view is introduced in the term 'foundational movement skills', which describes more specific and coordinative movement patterns that form complex task. These include:

- Bouncing/dribbling a ball
- Catching a ball
- Cycling
- Freestyle swimming stroke
- Galloping
- Hopping

- Horizontal jumping
- Kicking
- Leaping
- Lunge
- One-handed strike
- Overhand throw
- Overhead press
- Push-up
- Running
- Rolling a ballScootering
  - Skipping
- Sliding
- Squat
- Treading water
  - Two-handed strike
  - Underhand throw

### WHAT THEY FOUND

In summary, foundational movement skills believe that the typical FMS's (locomotor, object control and stability) are not adequate when describing other performance characteristics such as cycling; where the individual can use facets of this to support them in mountain biking, motor cross, or marathon cycling.

# >> Practical Takeaways

The lifelong physical activity model is a proposed model that examines the relationship between movement skill development and physical involvement in sport. The model is thought to be better than the typical FMS model by suggesting that FMS follows a pre-determined set of skills which are arguably not always needed for success in sport.

The model guides the reader through the rudimentary or "basic" movements required to develop more complex and sport-specific movements. In its description of the model, the authors discuss 'reflexes' that are present upon birth and how with practice, we can essentially "turn off" reflexes and become in control of our bodies. This progression is a very individual process and should be followed with caution.

An important aspect of this model lays in its consideration of the socio-cultural and geographic factors that impact learning. The authors acknowledge that birth place, age, and access to facilities (both man-made and natural) can significantly affect which skills are developed in a youth sample. For example, a child who has access to warm-weather and the ocean will develop different foundational movements than a child who is born in a cold and urban environment. These should be considered when working with new children, especially if they are from other areas with unique geography or cultural influences.

The long-term benefits may also be more evident, where a lack of competency in one skill may result in inactivity. However, with foundational movement skills which have a more performance-based criteria in which to evaluate children on, may support practitioners in giving children the confidence to continue participation in sport. In addition, the child may find strengths in other areas and build a more rounded-base of movement options to support enjoyment, participation, and health.

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





# Tom's Comments

"This model is a really interesting take on adapting the typical 'FMS' that is discussed in LTAD literature. By mapping the pathway of children, and guiding the reader through the transitional stages of development, this will prove an invaluable resource for those working with children. The authors take on geographical and socio-cultural and its influence on "selecting" foundational movement skills was fascinating and provided me with a lot to consider with regards to S&C.

For example, as a coach, we have the privilege of working with individuals from all over the world. When we screen these athletes based on a set criteria, we may miss many of the foundational movement skills they have developed based on their geographical location. To elaborate, a club may sign a player from a coastal town who has spent a large amount of their time surfing. As a result of this, they may have really good time to generating capacity, but may lack horizontal force production. In light of this, the programming would have to significantly change to develop this player, giving the Performance Digest reader an interesting way to think about new athletes."



# Bio-banding in youth sport: What do the athletes think of it?

### OBJECTIVE

Bio-banding is the process where players are grouped based on maturational qualities rather than chronological age and has become a popular and controversial topic in youth sport. The theory is that bio-banding results in a greater quality of practice and potentially a reduced risk of injury. However, like many research articles that are released, they forget to question the most important part of any intervention – the athlete. Luckily, the authors of this study have you covered, as the primary aim of this one was to investigate youth players within Premier League academies and their experiences of bio-banded tournaments.

### WHAT THEY DID

This study collected data from 66 academy soccer players (aged 11-14) that were measured to be at 85-90% of their predicted adult stature using the Khamis-Roche method (see attached article link). Four academies (Southampton, Stoke, Reading, and Norwich) entered a team with squad sizes of roughly 16-17 players drawn from the U12-U15 competing teams. Players competed in three 11 ys 11 games on a full-size pitch with two 25-min halves.

Of all these players, 16 (4 by each club) were invited to participate in a series of four semi-structured focus groups. These focus groups consisted of both written and spoken elements, with each participant being asked to make a note of any positive or negative experiences associated with participating in the tournament. This was also used to support group discussions and to identify shared experiences.

### WHAT THEY FOUND

This qualitative study split the results into four unique themes in which the players described their experiences of being involved in a bio-banded tournament. The four themes were:

### 1. Physical Development

Players suggested that this tournament encouraged a fairer playing field, with both early- and late-maturing players believing that bio-banding encouraged a style of play that was more tacticallyand technically-orientated. This may serve as a great way to reduce injury and ensure participation in children.

### 2. Technical and Tactical Development

Players reported that freedom and opportunity were greater than "normal" football games, with players feeling more able to demonstrate their technical and tactical strengths. In addition, players outlined that they altered their style of play to accommodate younger players in their "band".

### 3. Psychosocial Development

Based on chronological age, younger players felt a greater sense of confidence when playing with older players and was evident in their feelings of composure on the ball. However, older players felt that there was increased pressure on them to out-perform their younger banded players and adopt a higher level of "responsibility".

### 4. Overall experience

All participants in the focus groups described the tournament as a positive addition to their regular training. Early-maturing players suggested that they enjoyed the superior challenge that biobanding provided them with. The late-maturing players also enjoyed the banded tournaments, but for different reasons. The main reason for which was empowerment, specifically with regards to the effects of maturity on performance and how they may be at a disadvantage to their chronological peers because they are less mature. However, this bio-banded opportunity allowed them a chance to perform and get recognition from the coaches and staff.

# >> Practical Takeaways

Coaches and sports scientists should consider the benefits of bio-banding, such as increased confidence, a fairer representation of skill and ability, and the potential for players to develop tactical and technical skills. This may be a great way for coaches to use in a 'talent identification' scheme, so that players can really showoff what they can do. However, the frequency of biobanded sessions is a consideration for practitioners, who must consider how much they wish to use this, with few studies providing any solid recommendations.

Based on the limited evidence regarding its long-term impact and benefits to athletes, it is necessary for you, as the Performance Digest reader, to think about where this can fit into your schedule. Sean Cumming, the lead author of this study and the "Godfather" of bio-banding, suggests that this is an additional tool for the S&C coach to use and should form part of a multi-faceted programme.

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



# Tom's Comments

'Bio-banding is a relatively new intervention in the field of strength and conditioning, yet there are already some notable issues. Although bio-banding groups players based on 'physical' characteristics, it does not account for psychological maturity, which, as we know, can have numerous effects on group cohesion, enjoyment, and thus, participation. Furthermore, two athletes at 95% of their adult height can be completely different in stature, muscle mass, and therefore, performance characteristics, which can alter the dynamics of a game of football.

In terms of physicality, whilst a player may be limited when compared to their peers, an Ut3 player at 95% of their adult height, and an Ut3 player at 95% of their adult height, would have had completely different access to the tactical aspects of the game; which would still create a hypothetical proficiency barrier. This leads many to debate the validity of bio-banding as a model with some arguing that a natural "divide" in ability is required to develop a host of skills such as persverance, physicality, social skills, and group dynamics

Access to information can be a great thing, and although social networking, podcasts, and/or blogs are a great way of learning. I think that bio-banding has been misinterpreted in many resources that I ve read. For example, in my conversations with a Premier League football club, they suggested that a bio-banded tournament be used up to four times a year, with the rest of training being with peers of the same chronological age. I think a lot of people assume that this is a method used year-round, which simply isn't the case. However, I do agree that more research needs to be conducted to determine if bio-banding is a reliable and effective way at improving performance."



# **Nutrition**

This month's top research on nutrition.

## HOW DAMAGING IS UNDER-FUELLING ON MATCH-DAY PERFORMANCE?

Bonnici, D.C. et al., (2018). Research in Sports Medicine, 25, 1-10.

## CAFFEINE BEFORE AN EVENING GAME: DOES IT AFFECT SLEEP?

Dunican, I.C. et al., (2018). European Journal of Sport Science, 12, pp.1-11.

## ARE SOME ATHLETES GENETICALLY MORE SENSITIVE TO CAFFEINE THAN OTHERS?

Guest, N. et al., (2018). Medicine & Science in Sports & Exercise, 27 (3).





# How damaging is under-fuelling on matchday performance?

### OBJECTIVE

Football players can cover between 10-13km during a single 90-minute match which involves low- to moderate-intensity activities as well as high-intensity accelerations and decelerations. Low muscle glycogen concentrations are considered a key contributor to transient fatigue during match play, and as such, dietary intakes and habits of players becomes important to ensure correct fuelling strategies are employed. Therefore, the aim of this paper was to assess habitual intakes and quantify the effectiveness of an educational programme implemented with semi-professional players.

### WHAT THEY DID

Twenty-two semi-professional male soccer players (Malta BOV Premier League) filled in a food diary leading into the first soccer-specific exercise protocol having followed their normal eating behaviours from Monday-Thursday. They then completed the Ball Sport Endurance and Sprint Test (Friday) which was chosen for its validity in trying to replicate movement patterns and demands of a soccer match.

During the intervention, players consumed a nutritional intake of 10g.kg<sup>-1</sup> of carbohydrates and 1.7g.kg<sup>-1</sup> of protein with fat intakes not exceeding 30% of total energy intake (average nutritional ranges were carbohydrate 65%, protein 15% and fat 20%). This was consumed Monday-Thursday followed by 7g.kg<sup>-1</sup> and 1g.kg<sup>-1</sup> of carbohydrate and protein, respectively, on Friday morning before the commencement of the exercise protocol.

These nutritional intakes follow those outlined by FIFA in their Nutrition for Football: A practical guide in eating and drinking for strength and performance (**HERE**).

### WHAT THEY FOUND

Results show that after the post-dietary intervention, players ran significantly further when compared to the pre-dietary intervention. Additionally, more metres were covered in the second-half versus the first-half in both conditions, and this was supported with more metres being covered in the first-half of the post-dietary intervention when compared to the pre-dietary condition. Finally, the same was seen in the second-half, with more metres being covered following the post-dietary condition versus pre-dietary distances.

# >> Practical Takeaways

It is well-known within the sporting literature that carbohydrates, in particular glycogen, fuels winning performances. This is especially true when such exercise involves low-, moderate- and high-intensity activities with multiple muscle fibre recruitment. The main take-homes of this study are in support of this, and as such, clearly show that when players follow a dietary intervention which involves consuming optimal carbohydrate (and kcal), more distance was covered.

Although it appears players performed more work in the second -half (covering more distance) in this study, this contradicts typical match-play observations and should therefore be taken with caution. The authors elude to the many match play situations that can affect second-half performances in a competitive game, and considering players only performed a modified exercise protocol, further work in an actual game is warranted.

Nevertheless, it is clear to see that optimal intakes of nutrients results in increases with soccer-specific performances, and therefore, it is interesting to propose how this may transpire into similar results within competitive games.

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



# James's Comments

"Although this is a simple study performed only on semi-professional players from one club, the underlying messages are clear to see. Individual players or teams who underfuel their muscles will experience a reduction in soccer-specific performances; in particular, distances covered and potentially premature fatigue.

Athlete support personnel working with football players (e.g. nutritionist, S&C coach, etc.) should be encouraged to individually work with each athlete and understand current fuelling strategies to not only fuel to perform, but also fuel to recover from training and from matches. All too often, you hear stories of players shying away from consuming carbohydrates due to poor or lack of education and body composition concerns, either from the players themselves or other members of staff. Work from many different sports supports the notion that an under-fuelled muscle runs the risk of premature fatigue, and as a result, players and staff should always remember that carbohydrates fuel winning performances."



# Caffeine before an evening game: Does it affect sleep?

### OBJECTIVE

A super Rugby team will often play 15 games in a season and generally play them at night between the hours of 18:00-22:00. Before a game, some athletes will often ingest caffeine for an ergogenic effect, but despite the beneficial effects, previous research has also drawn attention to decreased sleep duration and sleep efficiency as a result of the caffeine supplementation. Caffeine consumed shortly before bedtime becomes a concern since fatigue, staleness, and soreness is associated with insufficient recovery. Resultantly, insufficient recovery could therefore contribute to decreased performance in subsequent competitions.

Despite this, no studies have assessed the impact of caffeine consumption on sleep patterns in rugby or other team sports following evening or night-time competitions. Therefore, the aims of this study were two-fold. Firstly, the authors aimed to quantify the caffeine concentration levels of professional rugby union players before and after an evening Super Rugby game. Secondly, they wanted to determine any associations between caffeine concentration levels and post-game sleep.

### WHAT THEY DID

Twenty players from a single professional Super Rugby team based in Australia took part in the study. Wrist-activity monitors were continually worn on each of the three days before and after a Saturday evening game (19:00-21:00h). Saliva samples were collected 3 hours before the game and within 30 minutes after the game to measure caffeine concentration. Players consumed caffeine as they would normally (i.e. before and sometimes during the game). Furthermore, players completed a sleep and training diary throughout the seven days of the game week with questions relating to their sleep patterns and training effort.

### WHAT THEY FOUND

The study showed an increase in salivary caffeine concentrations both before and after the match, suggesting that caffeine consumption was a common behaviour before and/or during the game in most players. Moreover, the increased caffeine levels were moderately associated with an increase in sleep latency, a decrease in sleep efficiency, and a tendency toward decreased sleep duration.

# >> Practical Takeaways

Sleep is an essential component of recovery in athletes, primarily due high-intensity training regimes and competitive events. As team sports are often played at night, this alone can contribute to sleep difficulties after competition. Couple this with the fact that caffeine is often consumed before matches in order to improve cognitive and physical performance, and there may be further concerns regarding sleep quality and quantity. Despite this, when it comes to supplementing with caffeine, the effects of post-game recovery sleep are often overlooked.

The information presented from this study will help coaches and athletes understand that pre-game usage of caffeine may have negative effects on sleep onset, sleep time, and sleep quality. However, the responses and effects experienced by each athlete will depend upon the dose administered and their caffeine tolerance. Unfortunately, the researchers did not measure the total or type of the caffeine ingested before or after the match. Thus, athletes consuming a lower dosage of caffeine may find little or no impact on sleep quality, whilst higher doses of caffeine may impair sleep. Future work should focus on testing the dose-response relationship on sleep patterns following night-games.

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



# James's Comments

"This study used wrist-activity monitors to assess sleep patterns over a 7-day period, rather than the gold-standard method (e.g. polysomnography), as it was deemed more practical and appropriate to team-sports during the season. Self-reported information on the source and/or dose of caffeine consumed during the game was unknown, and therefore there could have been discrepancies in the sleep responses and saliva concentrations. Such information would have provided a better understanding of what type of caffeine has the largest effects on sleep disturbances. Additionally, it is important to highlight that there is a substantial inter-individual variability in response to caffeine indestion which should also be taken into consideration, but wasn't (see my next review for more information on this). Nevertheless, this study highlights that there is a need for educational programmes for players, coaches, and other sport professionals on caffeine consumption, timing, and its potential effects on sleep.

This is not only applicable to professional Rugby, but also relevant in other athletic populations. It also raises the question: "does an athlete, who is playing in front of thousands of people, really need an ergogenic aid to bolster performance?" this, though, will of course be highly-subjective."



# Are some athletes genetically more sensitive to caffeine than others?

### OBJECTIVE

Many studies have repeatedly demonstrated performance enhancement with caffeine use, however, there is also considerable inter-individual variability as to the magnitude of these effects, even with similar study designs, participants, and doses of caffeine.

Over 95% of caffeine is metabolised by the CYP1A2 enzyme, which is encoded by the CYP1A2 gene. A -163A>C (rs762551) single nucleotide polymorphism (SNP) within the CYP1A2 gene has been shown to affect the speed of caffeine metabolism and has been used to categorise individuals into "fast" and "slow" metabolisers of caffeine. For example, AA (homozygotes fast) tend to produce more of this enzyme and therefore metabolise caffeine more quickly. In contrast, AC (heterozygous slow) or CC (homozygous slow) genotypes tend to have slower caffeine clearance.

The objective of the study was therefore to determine the effects of low (2mg.kg<sup>-1</sup>) or moderate (4mg.kg<sup>-1</sup>) doses of caffeine supplementation on 10-km cycling time-trial, and whether variation in the CYP1A2 gene modifies these effects among different competitive male athletes.

### WHAT THEY DID

In a randomised, double-blinded, placebo-controlled study, 101 competitive male athletes from a variety of sports (e.g. endurance, power, or mixed) completed a 10-km cycling time-trial under three conditions: 0, 2 and 4mg.kg<sup>-1</sup> of caffeine. Resistance was set at 65%Wpower for all participants, which was calculated from a VO2peak test prior to the experimental trials. Participants were blinded to time, speed, and heart rate, but were able to see the distance they travelled. Saliva samples were collected on visit 1, and DNA was isolated from the saliva and genotyped for the DNA isolation A -163A>C polymorphism in the CYP1A2 gene (rs762551). Individuals were grouped into three different CYP1A2 genotypes: AA (fast), AC (heterozygous slow) and CC (homozygous slow) in line with salvia results.

### WHAT THEY FOUND

The overall findings of this study are consistent with previous research, caffeine is ergogenic to endurance cycling performance with a 3% improvement in the time-trial time at 4mg.kg<sup>-1</sup>, but not at a lower 2mg.kg<sup>-1</sup> caffeine dose. Interestingly, the authors observed a significant caffeine-gene interaction with improvements found in both 2mg.kg<sup>-1</sup> and 4mg.kg<sup>-1</sup> caffeine in only those athletes with AA genotype (e.g. fast in metabolising caffeine). Caffeine had no effect on those with the AC genotype and diminished performance at 4mg.kg<sup>-1</sup> in those with the CC genotype.

# >> Practical Takeaways

This study shows inter-individual variation in performance in to response to caffeine ingestion. It highlights the importance of considering genotype when deciding whether athletes should use caffeine as an ergogenic aid to improve endurance performance. Just to clarify, genotyping can be done by collecting saliva samples for DNA isolation, as used in this study. Whilst caffeine is ergogenic, the current generalised guidelines of 3-9mg.kg<sup>-1</sup>, consumed 60-minutes prior to competition/training are clearly not optimal for everyone.

Individualised guidelines would be beneficial given that caffeine use is prevalent in elite sports. It is important to consider that there are also a variety of different non-genetic factors that can impact caffeine effects, such as habitual use of caffeine, gender, medication use, training status, and expectancy effects. For example, habitual caffeine use itself has a genetic underpinning, and certain genotypes may appear more sensitive to the effects of placebo. Indeed, it is unclear whether these findings can be applied to female, non-athletic, and older populations. Furthermore, it is unknown whether there is similar genetic influence for other modes of exercise (e.g. high-intensity or shortduration) considering this study was performed during a 10km time -trial.

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





# James's Comments

"The study highlights the importance of considering genotype when deciding whether athletes should use caffeine as an ergogenic aid to improve endurance performance. The authors considered eliminating learning effects and caffeine-placebo effects, nevertheless, more questions are to be answered. Furthermore, similarly wellcontrolled studies should now be performed on female athletes to understand if gender can alter the modifying aspect of genotype on caffeine erogeneity. They should also look to determine whether habitual caffeine intakes occur differently across genotypes, and whether there are different optimal dosages and timing strategies for different genotypes in order to create best-practice guidelines for caffeine use in athletes

Finally, as the authors touch upon, practitioners should take care when extrapolating these results into their own populations of athletes that they work with. This study shows that there are differences between genes and subsequent interactions with caffeine, however, this area of work is only the beginning."



# **Injury Prevention & Rehab**

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

HOW TO IDENTIFY CONCUSSION AND THE USEFULNESS OF USING VIDEO FEEDBACK

Gardner, A. et al., (2018) Sports Medicine, 4(1), 5.

CAN A HIP-FOCUSED TRAINING PROGRAMME REDUCE THE OCCURRENCE OF FEMALE ACL INJURIES? Omi, Y. et al., (2018) Am. J. Sports Med.

DOES THE TYPE OF STRETCH PERFORMED BEFORE EXERCISE INFLUENCE HAMSTRING INJURY RISK? Chen, C.H. et al., (2018) PloS one, 13(2).



# How to identify concussion and the usefulness of using video feedback

### OBJECTIVE

Video review and analysis has become more enough the norm in many collegiate and professional sports leagues as part of an effort to identify possible concussion. Research on it's implementation thus far, however, has concluded that it is often difficult to interpret video findings. The purposes of this study were first, to determine the various observable signs of concussion in the National Rugby League (NRL) using video review. Secondly, to determine which combination of signs and match play characteristics were associated with a diagnosis of concussion when the Concussion Interchange Rule (CIR) was activated. The CIR allows for a player to be removed from the game and assessed without their team being penalised.

### WHAT THEY DID

A single reviewer analysed films of each instance that the CIR was activated during the 2014 NRL season, looking for the following 6 observable signs: 1) clutching or shaking the head, 2) unresponsiveness or loss of consciousness, 3) slowness to get up, 4) gait ataxia, 5) vacant stare, and 6) apparent seizure. Each case was also reviewed for a medically diagnosed concussion, for game and injury details, and for match characteristics (anticipating impact, tackler vs. ball carrier, tackle height, and the number of defenders involved). Sensitivity, specificity, and positive and negative predictive values were calculated for both the total number of signs observed and for each of the possible combinations of signs documented during the study.

### WHAT THEY FOUND

Ultimately, 156 videos were reviewed. Data analysis revealed a significantly greater number of total observable signs in both those that were subsequently diagnosed with a concussion, and in those that did not return to play in the same game. The most common combinations of signs were clutching/shaking the head and slowness in getting up (17.3%), clutching/shaking the head, slowness in getting up, and vacant stare (13.5%), and clutching/shaking the head, slowness in getting up and gait ataxia (10.9%). The match characteristics of anticipation of the hit, fewer number of tacklers involved, and vacant stare were each independently associated with a diagnosis of concussion.

# >> Practical Takeaways

Most notably, this study found that positive hit anticipation, a vacant stare, and fewer number of tacklers were predictive of a diagnosis of concussion in the NRL. Also of note, sensitivity decreased, while specificity increased as the number of total observable signs increased. This shows that most of the combinations of signs were specific to, but not sensitive to an eventual diagnosis of concussion.

For coaches, this means that when you see a number of these signs in an athlete, you are better able to rule in a concussion as the number of signs increases, and you are less able to rule it out when there are fewer observable signs. As video analysis software improves and as video recording of matches/games becomes required, standardised approaches - such as the one proposed in this study - will be instrumental in the effective care in the case of concussion.

Several limitations were acknowledged in this study. First, there was only one video reviewer who was only partially blinded to the use of the CIR. Second, their use of "operational definitions" for some of the match characteristics and signs inserted some level of subjectivity into the analysis, therefore, decreasing the reproducibility of a study like this. Lastly, this study involved men's professional rugby, and these results may not be highly relatable to other levels of match play.

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



# Steph's Comments

"Investigating these observable signs, and the relationship between them as they relate to medically diagnosed concussion, is definitely a great first step in increasing both the accuracy and consistency with which concussions are managed in sport. This is particularly important when video is either not available or is of lower quality; therefore, knowing to look for these groups of signs and what they can tell us about the athlete is incredibly helpful. Although this study assessed only professional male rugby players, it can be fairly well extrapolated to others sports with the same or similar levels of intensity and contact.

Other research is demonstrating that it is not necessarily that concussion rates are increasing in incidence or severity, but that the overall management of concussion is lacking in standardisation and thoroughness. Studies such as these can help advance and standardise concussion management and better arm coaches, clinicians, and game staff with critical decision making tools that will result in better overall care for the athlete."



# Can a hip-focused training programme reduce the occurrence of female ACL injuries?

### OBJECTIVE

Female athletes are 2 to 8 times more likely to experience an ACL injury compared to males. The authors of this study aimed to find a group of preventative neuromuscular training exercises that appear to reduce ACL injury risk in female basketball players. The purpose of this prospective interventional study was to measure the effectiveness of a hip-focused injury prevention (HIP) protocol on ACL injury reduction in female basketball players.

### WHAT THEY DID

There were two periods in this study: a 4-year observation period in which number of ACL injuries and athletic exposures (AE's) were recorded for 309 female basketball players, followed by an 8-year intervention period that consisted of both education and HIP training (periods I and II). The following data were collected at completion of the 12-year process: the overall and non-contact injury incidence rates were compared between the observation and intervention periods. These rates were then compared separately between the observation period and each individual intervention period. Relative risk (RR), absolute risk reduction (ARR), number needed to treat (NNT), and compliance were all calculated as well.

### WHAT THEY FOUND

Analyses of data found a significant decrease in risk of both contact and non-contact ACL injury (RR reduction) between observation and both intervention periods. When comparing the observation period to intervention periods, overall ACL injury RR reduction was 62%, and non-contact ACL RR reduction was 61%. The specifics of NNT and ARR can be found in the full text, though it is worth mentioning that there was a significant ARR between observation and intervention periods (3.2%) and a low NNT (32 players), indicating that the HIP programme was successful. Also worth noting, is the number of ACL injuries per 1000 AE's: rates in intervention periods were 0.11 and 0.08, respectively, compared to 0.25 in the observation period and 0.22-0.28 reported in previous studies.

# >> Practical Takeaways

Although this study was not a randomised controlled trial and it only observed a single women's basketball team, there are several things that played into the success of its design and its developed exercise protocol. The first is that it utilised basketball-specific movements and multiple forms of exercise, including landing from a rebound, deceleration and cutting, and lateral jumping and catching. The second, is that it focused on improving overall hip joint function and strength, which has been shown in previous research to be compromised in females. In particular, they focused on hip abductor strength, hip and knee alignment during jump and land movements, and cueing to land softly in order to better attenuate ground reaction forces. Lastly, the compliance rate in this study was 89%, which is phenomenal.

This is owed mostly to the regular presence of athletic trainers and student trainers who encouraged all athletes to participate and who gave cueing and positive feedback throughout. Perhaps the most beneficial takeaway from this study is that such a protocol, in the right group or team setting, is entirely feasible for any training, coaching, or clinical staff to carry out. Although it cannot completely prevent an injury from occurring, it can substantially reduce the risk of injury and it will only benefit the athletes themselves.

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



# Steph's Comments

"The importance of neuromuscular control, lower-extremity alignment, and hip-joint strength are no secret in the world of ACL injury prevention and rehab. However, I agree with the authors that there is a far smaller amount of research investigating exact protocols and/or sports-specific exercises for basketball in particular. This sport requires many movements that are thought to put players at higher risk, such as quick deceleration with change of direction, rebounding and landing on one foot, cutting, and pivoting.

If we can demonstrate with confidence that a protocol such as the one proposed in this study, utilised with a high-risk population like female basketball players, can significantly reduce the incidence of ACL injuries, then why is this not more common? To me, one of the greatest attributes of this study is its simplicity. As coaches and clinicians, we can be fairly certain we are working in our athletes' best interest if we ensure 3 things: sports-specific exercises using different modes, a focus on hip joint function and dynamic control, and a high compliance rate. With a bit of organisation and planning ahead, it is more than feasible to implement a training system like this in any team or training group."



# Does the type of stretch performed before exercise influence hamstring injury risk?

### OBJECTIVE

Traditionally, static, ballistic, and/or proprioceptive neuromuscular facilitation (PNF) stretching is recommended prior to sports participation as a means of the reducing risk of a hamstring strain (HS). However, the research measuring their effect on range of motion and muscle stiffness, as well as suggested repetitions and sets, is abundant, yet conflicting. The intent of this study was to examine the effects of three different dynamic exercises on the following hamstring strain risk factors: flexibility, eccentric strength, peak torque, muscle stiffness, and knee joint proprioception/joint position sense. The three exercises investigated were jogging with dynamic open kinetic chain stretching (DS), jogging with dynamic closed kinetic chain stretching (LEC), and jogging only (CON).

### WHAT THEY DID

This was a randomised controlled trial using a between-group design. Subjects were 36 active male volunteers who had no history of lower-extremity injury, low-back pain, or neurological disorders. They were randomly assigned to 3 groups: jogging with DS (standing straight-leg swing), jogging with LEC (a modified single-leg deadlift), jogging only (CON). Intensity, duration, reps, and sets were all standardised. Pre- and post-exercise intervention, the following tests were measured (in this order): muscle flexibility, muscle stiffness, joint position sense, maximal voluntary eccentric strength, and angle of peak torque.

### WHAT THEY FOUND

Hamstring flexibility, measured via passive straight-leg raise (PSLR), significantly increased in the DS and LEC groups, and significantly decreased in the CON group. Muscle stiffness, however, decreased in the DS group, increased in the CON group, and did not change significantly in the LEC group. This indicates that, although open-chain stretching can improve hamstring ROM, this is not necessarily achieved by improving muscle compliance. There were significantly greater errors in joint position sense testing in the CON and DS groups compared to the LEC group. Results also showed that the LEC group exhibited significantly greater eccentric strength and smaller angle of peak torque compared to the DS and CON groups.

# >> Practical Takeaways

These data suggest that open- and closed-chain dynamic stretching can have very different outcomes that can affect sport performance. It appears that open-chain stretching, while increasing muscle compliance and hamstring ROM, may negatively affect eccentric strength and joint position sense, which is not advantageous for game-play situations. These findings support the use of closed-chain dynamic stretching prior to sport to improve eccentric strength and decrease the risk of hamstring strains.

There were several limitations within this study. First, the subjects were fairly homogenous, in that they were all untrained, active male volunteers. Second, it was not possible to precisely match exercise volume, considering the inherent differences in the two types that were used in this study. Lastly, these effects were measured acutely, before and after the intervention, without any long-term follow-up data. Therefore, these results cannot be confidently extrapolated to all sports or all individuals.

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





# Steph's Comments

"Here, as in most cases regarding proper warm-up, your intention matters. If you are simply aiming to increase hamstring ROM/flexibility, then an open-chain dynamic stretch is sufficient. If you are prepping for activities involving singleleg power production and/or unpredictable sports situations, this research suggests that you should opt for closed-chain dynamic stretching in order to optimise peak torque generation, eccentric strength, and to maintain joint position sense.

For the coach planning for their team, group, or clients, this information is helpful to use in order to set them up for success during training or play and to decrease their risk of injury. For the physical therapist or clinician, this information reiterates the importance of closed-chain single-leg training being built into therapeutic exercises within the plan of care."



# Infographics

A round-up of our monthly research infographics.

## NEUROPLASTICITY: EVERYTHING YOU NEED TO KNOW

Dobbs, I.J. (2018) Neuroplasticity, Science for Sport.

# IS THE NORDIC CURL OR SINGLE LEG ROMANIAN CHAIR HOLD MORE EFFECTIVE IN INCREASING STRENGTH ENDURANCE IN PREVIOUSLY INJURED ATHLETES?

MacDonald, B. et al., (2018) Journal Strength Cond Res.





# Neuroplasticity



Neuroplasticity refers to our brain remodelling, adapting, and organising after the practice of a motor skill



# What is it?

Neuroplasticity refers to the brains capacity to adapt and reorganise as we experience and learn different tasks.

# Why is it important?

To proficiently perform athletic movements the brain must coordinate with the necessary muscle groups to produce the action Training could be optimised using principles of neuroplasticity...





# Considerations

# Focus on Technique

Every time a skill is performed our brain refines that motor pathway, regardless of whether it was performed correctly or incorrectly.



# Learn Early

Neuroplasticity with regards to motor skill is available during a human's entire lifespan. However this appears to peak in prepubescent children.



# (2)

# Allow for Specificity

The acquisition of a skill is highly task-specific and relevant to the person [Figure 1]



[Figure 1] Changes in motor skill neuroplasticity are often divided into a "fast-stage" (short-term) and "slow-stage" (long-term).

The brain's plasticity appears to peak during childhood, and as such, professionals who coach young athletes should capitalise on this period of time by encouraging multi-skill development and educating correct movement, as this will likely have positive benefits that carry into adulthood.

For the full article check out the Science for Sport website







# **Authors View**

"This study demonstrated that Gaelic football players who completed a 6-week program of isometric hamstring strengthening had a substantial improvement in single leg hamstring bridge performance on both the previously injured and noninjured leg, whereas players performing 6week eccentric training did not demonstrate substantial improvements in either of the legs."

# Science for Sport Recommends



Considering the single leg Roman chair hold as part of a well rounded hamstring rehabilitation training program.

Macdonald, Ben, et al. "The Single-Leg Roman Chair Hold is More Effective than the Nordic Hamstring Curl in Improving Hamstring Strength-Endurance in Gaelic Footballers with Previous Hamstring Injury." *Journal of strength and conditioning research* (2018).

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