April 2019 | Issue #30

THE PERFORMANCE DIGEST

A review of the latest sports performance research

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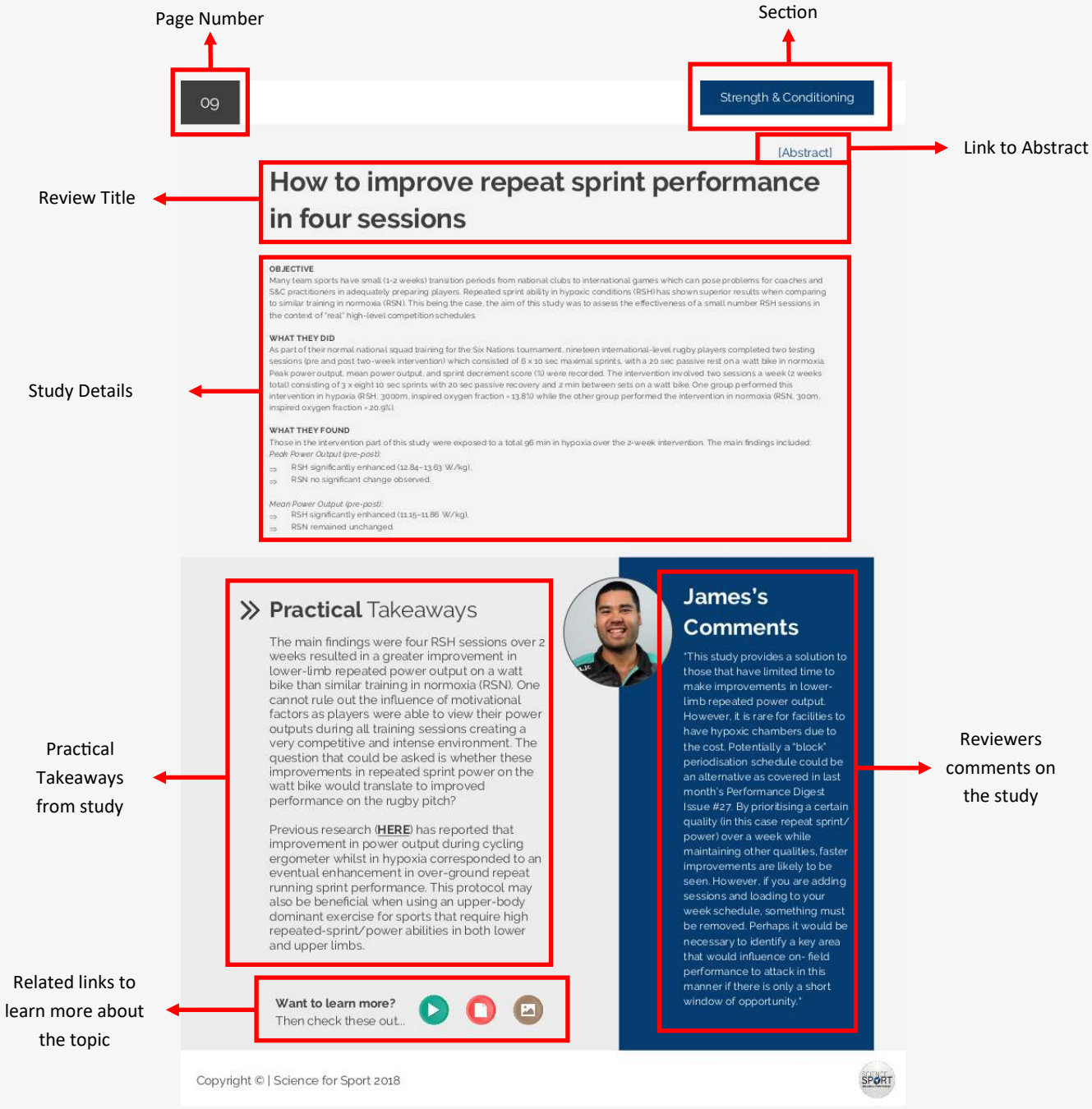

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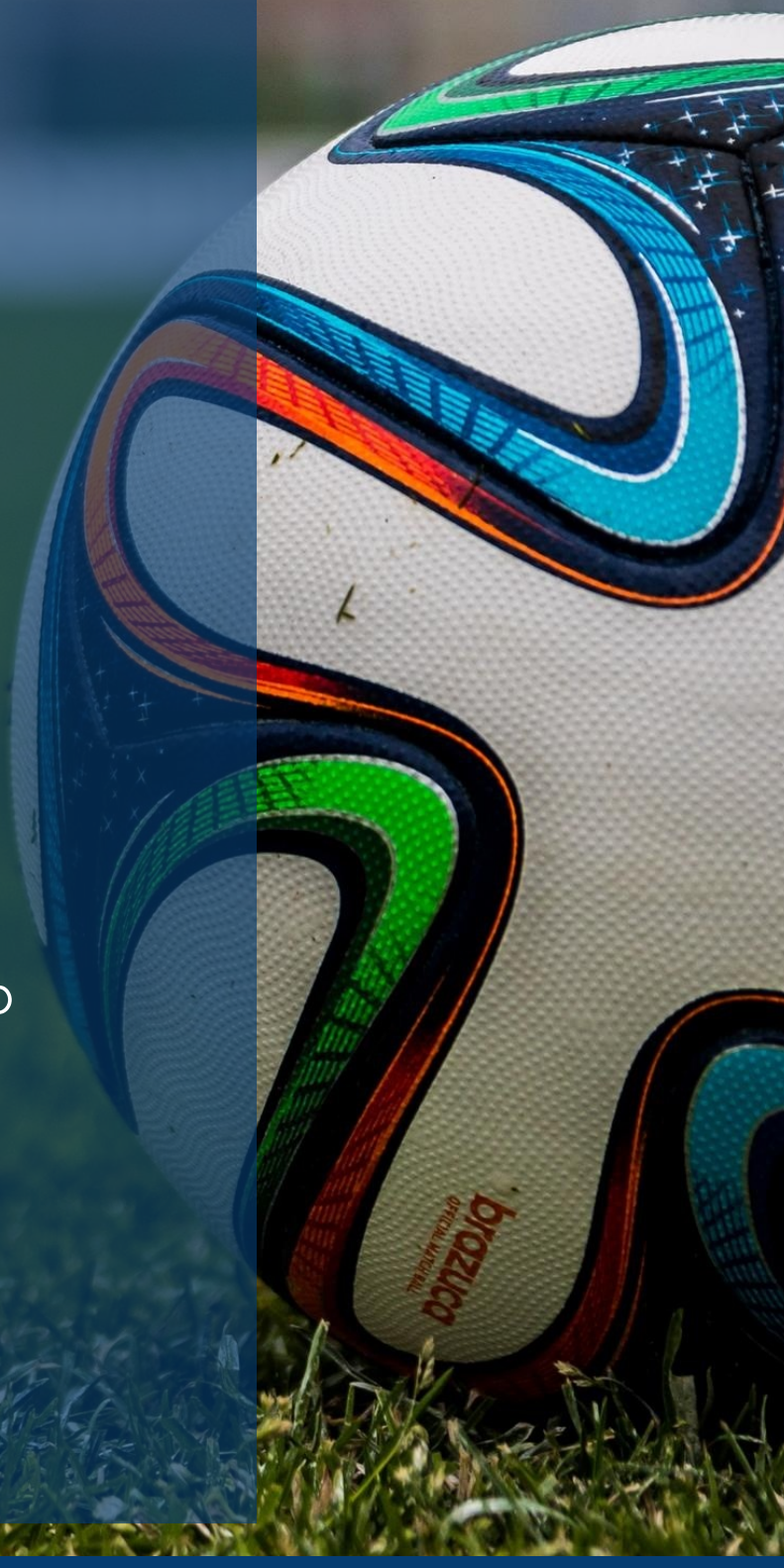

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Audio
REVIEW

Long-Term Athlete Development

A 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 discusses the Long-Term Athlete Development (LTAD) plan.

In this episode, you will learn:

- What LTAD is and why it is important
- The history of LTAD
- What is needed to plan a LTAD program
- How to structure an LTAD program

Episode length = 38 min

A bit about **Tom**

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

Listen Now

The Science of
COACHING

Enhancing the observation skills of coaches

What, how, when and why do coaches observe?

[Abstract]

INTRODUCTION

Observing or 'noticing what is going on' have been identified as crucial elements of effective coaching practice (**HERE**). Specifically, good coaches are often able to 'see' or 'notice' opportunities to act in particular ways (e.g. identifying that an athlete may need feedback and support to effectively develop their technique in a specific skill, or that the athlete may not need support and may be able to work out how to rectify the problem themselves). Although observation or noticing is such a key tool in a coaches' toolbox, little work has been conducted on what, how, when and why coaches effectively observe. As such, this study looked more closely into not only what coaches see, but also, importantly, how, when, and why such 'seeing' is brought to life in specific circumstances, as well as how other coaches might be able to learn from this.

WHAT THEY FOUND

One semi-professional football club, with over forty participants (which included two coaches, players and administrative staff), was followed over the course of a full season. Using observation and interviews, particular attention was paid to what the coaches observed and how this was evident in their practice (i.e. in their interactions with the team).

It was suggested that the act of observing when coaching is not simply what coaches see and how they see it, but is also how these observations are (sometimes) reached in collaboration with and then made understandable to others (i.e. other coaches and athletes). For instance, coaches were found to use criteria which they had set out in the pre-match team talk with players (i.e. to 'win second balls', 'play forward' and 'check shoulders') as a basis for what they observed when the match was taking place. The two coaches then discussed what they thought they had seen in the match with one another (actively co-creating their observations), before debriefing the players and making them aware that they felt they had (or had not) met these criteria. Coaches also actively discussed their observations of performance as a basis for future team selection.

WHAT THIS MEANS

Although understanding what coaches can pay more attention to when observing is clearly important, it is also necessary to begin to understand how, when and why these observations are completed and then made understandable to others. Making observations (often developed through discussion) understandable to others allows athletes to better understand the judgments made by coaches on their performance and what may be expected of them in future performances. However, this is reliant upon athletes being competent in reading these instructions and their meanings within performance.

There is a risk in using pre-set criteria to notice particular elements of performance (e.g. 'winning second balls' or 'playing forward') that we only focus on these aspects of performance. In other words, we see what we want to see as coaches. This may mean that we miss seeing something else which is of equal importance to the development of performance. Coaches who are therefore able to observe a wider range of 'what is going on' in their context (i.e. understanding why an athlete might be responding in a certain way) may be better able to support the effective development of athletes.

Practical Takeaways

It is important for coaches to reflect upon the ways in which they observe (sometimes with others), and also how their expectations based on these observations are made clear and understandable to others. For example, a cricket coach could compare their observations of tactics (e.g. field settings) with another coach, and consider the clearest way to make this understandable to the team. Importantly, coaches should try to broaden as opposed to narrow their 'net' of what is noticed - not just sticking to pre-developed criteria set for players.

For example, within a strength and conditioning context, instead of just looking for specific technique indicators which have been set out (i.e. to lift in a straight line), coaches could also aim to be attentive to wider aspects of performance (e.g. stance and position of mid foot, back position, form). Alternatively, in preparing a post-match talk, team sport coaches could examine performance by paying more attention to the opposition, reframing important information.

Adam Nichol

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

Strength & Conditioning

This month's top research in strength & conditioning.

DOES THE KETTLEBELL SWING PROVIDE A POTENTIATION EFFECT FOR SPRINTING?
Kartages, K. et al. (2019) Sports.

WHAT INFLUENCES VELOCITY FOR THE BIG FOUR BARBELL EXERCISES?
Fahs, C. et al. (2019) Journal of Strength and Conditioning Research.

ACCELERATIONS OR HIGH-SPEED RUNNING: WHAT IS A BETTER PREDICTOR OF PERFORMANCE DECLINE?
Delen, T. et al. (2019) European Journal of Sport Science.

[Abstract]

Does the kettlebell swing provide a potentiation effect for sprinting?

OBJECTIVE

Pre-conditioning activity is attributed to the post-activation potentiation (PAP) in which muscular performance characteristics are acutely enhanced in the subsequent task. Resistance exercises generally require specialised equipment (e.g. barbell, rack) which may not be accessible immediately before competition. Therefore, the primary aim of this study was to investigate whether including kettlebell swings (KBS) in the warm-up enhances sprint performance since this piece of equipment is portable.

WHAT THEY DID

Twelve healthy adults with a sporting background and minimum of six months of resistance training experience participated, firstly completing two sessions which involved the measurement of anthropometric measures, leg extensor strength, and power testing (isometric knee extension at 90° knee angle, 5 sec maximum voluntary contraction, and isokinetic power 2x5 maximal concentric reps with slow and fast angular velocities), KBS testing (mean power), and sprint testing (20 m). Subjects performed either 2x5 KBS with a load eliciting greatest mean power output (experimental) and then 3x20 m sprints at 4, 8, and 12 min after KBS or 5 min passive rest after the warm-up (control) followed by 3x20 m sprints. During the second week of testing, subjects performed the opposite condition to which they initially performed.

WHAT THEY FOUND

Sprint Time:

- ⇒ Neither the condition (control or KBS) or the time at which the sprints were performed produced an effect on 5 and 10 m sprint times.
- ⇒ There was a significantly faster sprint time at 12 min following the KBS protocol compared to 4 min for 20 m sprint in both conditions.

Muscular Performance:

- ⇒ A moderate, negative relationship existed between the change in sprint time and KBS load (absolute and relative) at 4 min after the KBS protocol.
- ⇒ There were small to moderate positive correlations for changes in sprint time and KBS load (absolute and relative) at 8 and 12 min following the KBS protocol.
- ⇒ Trivial to small correlations were reported between changes in sprint time, isometric strength, and isokinetic power at all sprint

» Practical Takeaways

Initial sprint time over 20 m was found to improve each attempt regardless of whether KBS were included in the warm-up, suggesting that sprinting itself has a potentiating effect. The relationships that were reported for measures of muscular performance and the protocol used suggests that athletes who have the ability to lift heavier loads when completing KBS, may require longer rest (>4 min) between the KBS and the sprint to potentially see any potentiation effect. Furthermore, including KBS at the end of a warm-up may be detrimental to sprint time for stronger athletes if the sprint is performed 4 min or less after the KBS.

Previous research which has reported the potentiating effects of strength/power exercise on sprint performance have used professional athletes, whereas the subjects in this study were recreationally trained individuals that may not have had the training age elicit a PAP response. Furthermore, due to the implement used in the current study (a kettle clamp, see **HERE**), as load increased, the width of dumbbell used to load the implement also increased widening the stance making it more difficult to maximise the power from the hips.

Practically, KBS may still be a useful exercise during a warm-up for sprinting even if no potentiation effect is realised. Low volume, moderate load KBS tick a couple of boxes such as being a high-velocity eccentric hamstring exercise and speed-strength training. Potentially, your typical strength/power day could involve more work on the heavier and lighter sides of the f-v spectrum (e.g. Olympic lifts and assisted jumping). Then the KBS can implemented as part of the speed warm-up, finishing with 2x5 swings at a moderate load (20-40 kg) which will also assist as a great hamstring warm-up.

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

James' **Comments**

"I like the idea of using the KBS during a sprint warm-up, despite the fact that no potentiating effect was observed in this cohort. Kettlebells are portable, so getting extra "power" and posterior chain work on the road during times where you may not have a gym available seems invaluable. Furthermore, KBS don't have to be placed at the end of a warm-up right before sprinting. Instead, they could potentially be placed in the middle to help prepare the posterior chain for more intense warm-up drills such as primetimes and faster accelerations."

[Abstract]

What influences velocity for the big four barbell exercises?

OBJECTIVE

Average concentric velocity (ACV) can be used for the prescription of 1RM and velocity-based training (VBT) in athletes that require a blend of speed and strength. ACV for 1RM varies considerably between exercises, so prescribing similar velocity zones for training between exercises may result in heavier or lighter relative loading. The purpose of this study was to determine whether training age, current training frequency, limb length, height, and relative strength are related to ACV at loads between 35 – 100% 1RM for the squat, bench press, deadlift and overhead press. The secondary purpose was to compare the ACV values at each relative load between the four lifts.

WHAT THEY DID

Fifty-two subjects (19 women, 33 men) completed:
Session One: Testing & Load-Velocity Profile

- ⇒ Height, body mass, femur length, and humerus length.
- ⇒ Questions of training age, training frequency, and estimated 1RM.
- ⇒ Load-velocity profile ending with 1RM for either squat and bench press or deadlift and overhead press.

Session Two: Load-Velocity Profile

- ⇒ Load-velocity profile ending with 1RM for the remaining two lifts that weren't performed in Session One.

The load velocity profile of each individual was based on their estimated 1RM. Prior to each load-velocity session, 5 warm-up sets were performed with a Tendo unit attached which included:
Set 1: 30-40% x2-3
Set 2: 40-50% x2
Set 3: 60-70% x1-2
Set 4: 70-80% x1
Set 5: 80-85% x1

WHAT THEY FOUND

Squat ACV:

- ⇒ Faster at 1RM compared to all other lifts,
- ⇒ Slower than overhead press at loads <95% 1RM,

Bench Press ACV:

- ⇒ Slower than squat and overhead press at loads >95% 1RM but faster than deadlift at loads <85% 1RM,
- ⇒ Faster velocities than squat and deadlift at low loads (<45% 1RM).

Deadlift ACV:

- ⇒ Slowest compared to all the other lifts at loads <85% 1RM,
- ⇒ Relative strength inversely related to ACV loads >75% 1RM.

Overhead Press ACV:

- ⇒ Faster than other lifts at all loads <95% 1RM,
- ⇒ Relative strength positively related to ACV at loads <75% 1RM.

» Practical Takeaways

The relationship between ACV and relative strength suggests that someone who is considered to be a strong squatter may need to use higher velocity zones for VBT when performing at sub-maximal loads (<75% 1RM), but lower velocity zones when at maximal loads (>95% 1RM). Thus, the load-velocity profile would have a greater slope for stronger squatters compared with less proficient squatters. Bench press load-velocity profile seems to be unique compared to other lifts, mainly as a result of this having the slowest ACV during near-maximal loads and faster velocities at low loads. This suggests that velocity ranges that fit with other exercises may not be appropriate for the bench press.

For the deadlift, taller athletes should use a higher velocity zone when training with low loads. Furthermore, those who are better at performing the deadlift are typically able to move heavier loads at slower speeds, suggesting the velocity zones used for maximal strength may need to be lower. When performing the overhead press, the velocity zones for prescribing velocities at all ranges should be greater compared to other lifts. A general guide for ACV ranges for each lift has been linked below (see infographic). Putting this into practise, for example, if prescribing an ACV of 45% for the squat and bench press (0.84 and 0.89 $m.s^{-1}$, respectively), you may want to take into account the relative strength level of the athlete with stronger athletes (2xBW squat, 1.5BW bench) who might then have a velocity target of 0.86 and 0.95 $m.s^{-1}$, respectively, in order to stay in the 40-49% 1RM range.

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

James' Comments

"The differences in ACV at certain percentages of 1RM for different lifts suggests that for accurate prescription of ACV, multiple load velocity profiles need to be performed. This is likely to be time-consuming and may not be feasible for most coaches. However, performing load-velocity to estimate 1RM for one or two main lifts is a sound idea, as not only do you get a 1RM estimate, but you also see velocity improvements at lower loads. If using velocity as a metric for lifts that you don't already have a profile for, perhaps prescribing exercises based on velocity ranges (ala Bryan Mann, see **HERE**) will allow you to still use velocity to auto-regulate load. The article linked below lays out some great practical information for the use of VBT in training."

[Abstract]

Accelerations or high-speed running: what is a better predictor of performance decline?

OBJECTIVE

Maintaining accelerations are highly important for soccer performance, as up to 16% of the total player match load is caused by accelerations and decelerations. Further to this, a 90 min soccer match may contain as many as eight times more accelerations than sprints. High-speed running (HSR >15kmh^{-1}) is often used as an indicator of match performance. However, due to the various elements that effect HSR during a match (e.g. tactical, opponents, and score), individual players don't reproduce consistent HSR profiles across matches. Therefore, the aim of this study was to investigate whether the number of accelerations was a better estimate than HSR distances for match performance.

WHAT THEY DID

Data was used from 34 home games over three full seasons for a Norwegian Elite League Team. A hip sensor (RadioEye) was worn by each player which recorded accelerations with the threshold of >2 ms^{-2} and HSR threshold of >19.8km.h^{-1}. The mean number of accelerations and HSR distances were calculated for each rolling 5 min period, beginning with the first 5 min of the game. The second 5 min period began at the second minute and through to the sixth minute and this pattern was repeated until the end of each game in order to find the players peak periods. Comparisons were then made between these peak periods (P), the mean 5 min period for each half, the 5 min period before the peak period (pre -5P), and the subsequent 5 min period (post-5P).

WHAT THEY FOUND

A number of key findings were reported:

⇒ 91 ± 17 accelerations were performed during a match, with 14% fewer accelerations in the second-half compared with the first. Positional differences were observed with external midfielders completing the highest number of accelerations, whilst the central defenders completed the lowest.

⇒ A steady, consistent decrease was observed throughout the match for number of accelerations which showed a more concise decrease (r^2 = 0.9) compared to HSR. As for HSR, a 10% decrease in HSR distance was observed in the second half.

⇒ No positional differences in reduction of HSR distances around peak values were observed. The distance covered by HSR dropped from a peak of 60 m at the start of the match down to a level of 50 m ten minutes into the first half. Thereafter, players performed HSR at slightly above/below this level for the rest of the first half. A marked reduction in HSR distance was found for the last part of the match .

» Practical Takeaways

Based on the results of this study, HSR distance seems to be subject to higher variability between different periods of the match, whereas accelerations showed a steady decrease throughout the match starting. This suggests that tracking the decline in accelerations throughout a match may be a more precise indication of physical fatigue. Potentially, the number of accelerations measured through a training week and match can be analysed as a load monitoring and/or performance monitoring tool. For example:

Load Monitoring

⇒ Tracking acute:chronic workload of number of accelerations,

⇒ Using z-scores against the position average to influence training/recovery.

Performance Monitoring

⇒ Calculating position-specific peak number of accelerations in 5 min blocks, then developing training activities where the peak number of accelerations can be exceeded.

⇒ Tracking improvements in the decrease in number of accelerations during a match (like a fatigue index).

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

James' Comments

"The great thing about analysing data into peak periods is that it becomes multi-functional. As this study shows, the peak periods of the number of accelerations can be used as a way to show a 5 min 'worst case scenario', which can aid in influencing your training sessions as well as tracking physical fatigue throughout a match. Perhaps creating small-sided games or drills in smaller spaces into 5 min blocks may allow for a greater number of accelerations which allows you to exceed the demands of the game. In this scenario, you may also factor in the total distance and HSR distance covered in a peak period to really dial in your 'worst case scenario' training."

Technology & Monitoring

This month's top research on technology and monitoring.

RAPID ISOMETRIC SQUEEZE TESTS FOR GROIN FUNCTION: IS IT RELIABLE?
Wörner, T. et al. (2019) Orthopaedic Journal of Sports Medicine.

WHICH VELOCITY-BASED TRAINING SENSOR IS THE MOST RELIABLE?
Perez-Castilla, A. et al. (2019) The Journal of Strength and Conditioning Research.

GUIDING PERFORMANCE, ADAPTATION, AND LOADS ON THE PITCH USING HEART RATE VARIABILITY
Bryna C. R. et al. (2019) International Journal of Performance Analysis in Sport.

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[Abstract]

Rapid isometric squeeze tests for groin function: is it reliable?

OBJECTIVE
Like many sports, hip and groin injuries are common in ice hockey, which suggests that developing a method to reduce the occurrence and severity of the problem would be useful. Assessment of the hamstrings has proven to be both an accurate and valid measure of injury screening, so a similar test for the hip and groin region test that is easy to administer would be ideal for those looking to decrease the incidence of injury in this area. Thus, a simple, 5-sec groin squeeze test would be ideal for coaches. This study aimed to determine if any relationship existed between the 5-sec groin squeeze test, the function of the hip and groin, and strength measures.

WHAT THEY DID
Beyond the 5-sec groin squeeze, players from thirteen Swedish ice hockey teams participated a number of tests which included hip strength testing using handheld dynamometry, as well as the Copenhagen Hip and Groin Outcome Score (HAGOS) assessment (see **HERE**) utilising a web-based survey. Analysis of the measures using Spearman's rank-order correlation was used to compare the findings between the two appraisals of hip and groin status, which allowed for a comparison of self-reported function (HAGOS) and actual muscle strength from the groin squeeze testing.

WHAT THEY FOUND
Muscle strength, pain, and functional reporting matched in a manner that could be used as a 'traffic light' (red, yellow, green) reporting measure. The inverse-relationship between pain and strength matched the pattern of higher discomfort and lower strength. Function of the hip also matched the pattern of strength and pain, which meant that as a decrease in function was observed, the weakness of this function and pain increased.

Practical Takeaways

The practical benefits of repeated testing were such that a coach can monitor any changes away from baseline over the course of a season. The 5-sec groin squeeze proposed by the authors certainly works for professional or high-level ice hockey athletes, but the methodology can also be applied to other sports as well.

The authors did refer to a very similar test used within soccer (see **HERE**), proving this test is not only useful for hockey players, but also a great option for all sports where the incidence of the hip and groin impacts on performance. Coaches should use the 5-sec groin squeeze as part of their monitoring system, as direct measurement of muscle function is an effective and reliable approach within team-sport settings.

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

Carl's Comments

"At first glance ice hockey research appears to be sport-specific that may not necessarily apply to other team-sports. What is useful though, is not necessarily the findings of this research, but more so that it was about the impact of and how to combat with the congested game schedules that high-level athletes face. Within this congested schedule, it makes it difficult to monitor workload and manage injuries. The test used in the current study provides an immediate "traffic light" (red = high risk; amber = at risk; green = low risk) summary.

For coaches who are not experts in sports medicine, the 5-sec squeeze test can be used without having extensive training and human resources, making it an ideal tool for monitoring hip and groin injuries."

[Abstract]

Which velocity-based training sensor is the most reliable?

OBJECTIVE
Commercially available velocity-based training (VBT) devices are popular with S&C coaches, however, they must be validated in order to provide a true value when preparing and developing athletes. The authors of this study set out to perform an extensive evaluation of the reliability and concurrent validity of multiple VBT sensors in order to help coaches make the right investment.

WHAT THEY DID
Seven different sensors, ranging from camera apps to linear encoders, to inertial measurement units (IMU) products, to a motion capture system from OptiTrack (more **HERE**) were used for comparison. Whilst performing a 1RM bench press and throughout 3 repetitions of various loads, the movement and velocity of each device was compared to that of the motion capture system.

WHAT THEY FOUND
The results of the study revealed that the Speed4Lift performed the best compared to all other sensors, followed by Velowin, PowerLift, T-Force, and Chronojump. The PUSH band performed poorly by comparison to the other sensors, but was still considered more reliable and valid than the Beast sensor. What was surprising, though, was the poor performance of the IMU sensors compared to the linear encoders. Based on the results, however, the sampling rate of these devices may not limit the reliability as much as the algorithms used.

» **Practical** Takeaways

The take home message from the study is that data quality comes at a price, however. be aware that higher costs may not dictate the success of the device. The PowerLift app outperformed the IMU sensors, likely due to the greater sampling rate of the camera, however, the feedback of this device is not instantaneous like the commercial products.

Coaches looking to purchase or use VBT sensors should start their search by considering the data quality of the products followed by seeing what features may or may not be valuable to their needs (e.g. wireless connectivity and what software they feel is practical for their environment). What is also valuable based on the results of this study is the strong case for reliability of the results given that all of the products were compared using a simple exercise.

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

Carl's **Comments**

"Although barbell tracking has grown in popularity in recent times, there is still a long way to go with regards to the methodology and data quality when using VBT devices. Several companies are unable to refine their calculations, even when time and adequate funding is involved, which suggests that periodic re-evaluation should be done internally. If you are going to invest into VBT devices, make sure you also realise that each exercise is specific and other types of measures from these devices may be more appropriate, such as peak velocity (see **HERE**). So whilst the bench press and squats may provide adequate measures, other ballistic and explosive exercises may not fair as well."

[Abstract]

Guiding performance, adaptation, and loads on the pitch using heart rate variability

OBJECTIVE

Monitoring athlete readiness to compete within a team-sport setting needs to be time-efficient, cost-effective, reliable, and provide immediate feedback. Objective data via practical measurements showcases the responses to training load. The aim of this study was to identify and examine the relationship between heart rate variability (HRV) and global positioning system (GPS) data. From this, it was hoped that this information would provide an insight into an athlete's readiness to train.

WHAT THEY DID

The HRV of six English Premier League soccer players was measured over a 4-month period prior to each training session using the ithlete application on a tablet and with a Polar T31 heart rate transmitter. HRV data was averaged per week and compared with external training load data gathered from a 10 Hz STATsports Viper GPS unit, specifically during possession-based drills at the beginning of each training session.

WHAT THEY FOUND

The main findings of the study were:

⇒ A strong relationship was found between HRV and equivalent distance index (EDI; EDI is a ratio of energy expenditure and total distance covered, see **HERE** for more information).

⇒ It was identified that when there was an increase in HRV, there was an associated increase in EDI. With little to no effect in other training load variables such as distance, high-speed distance, accelerations, or impacts.

⇒ Major individual differences were seen in HRV, EDI, and other external training load measures across the study.

Practical Takeaways

Monitoring an athlete's fatigue and training load effectively is vital to a coach's success in keeping athletes healthy, fresh, and playing their best throughout a season. The measurement of HRV provides insight into the psycho-physiological stressors the body is enduring (see article below), and with the use of a smartphone application (ithlete) the information gained is very practical and accessible as it showcases an athlete's potential fatigue status, and provides a gauge on the athlete's readiness to train.

At times, the data gathered from GPS wearables can be overwhelming for a coach. Therefore, focusing in on a specific metric such as EDI, can help better understand and quantify training load without having to be overly invasive. Having valid, reliable, and objective data can be empowering to the coach and athlete. This is achieved by removing the emotions from the decision-making process, but at the same time, being calculated with biological and data-driven decisions.

Application of this monitoring strategy will ideally help reduce the risks associated with fatigue (e.g. injury, illness, or maladaptation). The use of HRV can be useful in the development of effective recovery strategies that will improve an athlete's ability to manage external and internal stressors associated with high-performance sport. This will allow coaching staff to focus more on improving performance.

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

Carl's Comments

"The psycho-physiological demands of high-performance sport can increase an athlete's risk of injury if the training load exceeds their capacity. A coach has the responsibility to monitor readiness and dose training load appropriately to reduce this risk, promote adaptation, and enhance performance. HRV has proven to be a simple and efficient tool to examine the interaction and coherence of mind and body (see video below). The design of this study offered a practical way to assess HRV in a repeatable and reliable manner. This provided insight into an athlete's ability to adapt to all stressors, both from sport, as well as life (see podcast below). Using HRV may allow for better individualisation and management of players throughout the season. In addition to this, the use of the EDI provides greater clarity on what metrics to focus on when using GPS wearable data for monitoring training load."

Fatigue & Recovery

This month's top research on fatigue and recovery.

SUBJECTIVE VS. OBJECTIVE MEASURES OF FATIGUE: WHICH IS MORE USEFUL?
Rabbani, A. et al. (2019) Frontiers in Physiology.

HIGH AND LOW ACUTE:CHRONIC WORKLOADS ARE ASSOCIATED WITH A GREATER INJURY FREQUENCY
Sampson, J. A. et al. (2019) Journal of Strength and Conditioning Research.

A PLACEBO MAY BE JUST AS EFFECTIVE AS COLD MODALITIES FOR ENHANCING RECOVERY
Wilson, L. J. et al. (2019) European Journal of Applied Physiology.

[Abstract]

Subjective vs. objective measures of fatigue: which is more useful?

OBJECTIVE

Understanding how players recover from a match is of utmost importance in order to design an effective and suitable recovery program as well as a weekly training load plan. While heart rate variability (HRV) and the Hooper-Index are widely utilised for this purpose, there is little research comparing these measures within a post-match, professional sports context. The goal of this study was to compare how professional soccer players fatigue levels respond on the days following a match.

WHAT THEY DID

The Hooper-Index (see **HERE**), resting HRV and session rating of perceived exertion (sRPE) were obtained from nine soccer players on match-day and the following four days, over a period of three weeks. The Hooper-Index corresponds to an overall measure which is obtained from four questions which are based on sleep quality, stress level, muscle fatigue, and muscle soreness. Each question was rated using a 1-7 Likert scale.

To determine the usefulness of the monitoring variables, the typical error (TE) was compared to the smallest worthwhile change (SWC), and the match-related changes were compared to the TE (i.e. signal-to-noise ratio; SNR).

WHAT THEY FOUND

Regarding the accuracy of fatigue measures, the Hooper-Index was more accurate (i.e. small TE) than HRV (i.e. moderate TE). Additionally, the Hooper-Index appeared to be more useful than HRV at monitoring fatigue from a match, as it demonstrates a lower TE/SWC and a higher SNR. Additionally, sRPE on match day was ~700 AU, with it being ~50, 200, and 400 AU for the three days following the match, respectively.

Practical Takeaways

The main practical takeaways of this study are that the Hooper-Index can be implemented to monitor the readiness/fatigue level of soccer players on the subsequent days after a match, and HRV presents some gaps as a fatigue monitoring tool (i.e. for some players the HRV demonstrated a best score when compared to baseline on the days following the match).

Moreover, the fact that this tool is cost-free and easy to use makes it accessible to all levels of practice. Although the Hooper-Index is gained from player's reposnses, the results from the present study should not discourage practitioners from implementing self-designed questionnaires or use other questionnaires.

When I talk about monitoring fatigue/readiness, I like to categorise the analysis in two big areas of intervention. The acute area (make changes within that training day) and the chronic area (provide education to coaches and players about the training program). Using any marker of fatigue/readiness without contextualising the results with the training load will provide very limited conclusions (i.e. acute). In order to have a greater understanding of the training program (i.e. chronic), practitioners are advised to combine the monitorisation of fatigue/readiness and load markers individually and over-time.

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

Francisco's Comments

"This is another study demonstrating the usefulness of simple and cost-effective tools. It is my advice that more complex measures of training load and readiness/fatigue (e.g. jumping performance, HRV) should be used to complement simplistic measures (i.e. subjective measures such as sRPE and wellness items) as the error associated with these measures, the time, and the cost constraints can be higher.

I have extensively used a 5-item questionnaire where the athletes report the level of soreness, fatigue, stress, sleep and mood, and a 5-muscle lower-body soreness questionnaire. However, when the time to collect and analyse the measures is a constraint, I have opted to use the perceived recovery scale (PSR) (see Performance Digest #25 November 2018). I particularly like this scale as it used the same scale as the RPE (i.e. 0-10)."

[Abstract]

High and low acute:chronic workloads are associated with a greater injury frequency

OBJECTIVE

The association between high and low acute:chronic workload ratio (ACWR) with injury is well described in the literature. However, less is known about the association between ACWR, fatigue/readiness-to-play markers for performance, and the likelihood of injury. This study investigated this relationship within an American football college squad.

WHAT THEY DID

Data from forty-two college football players obtained during one season was retrospectively analysed to understand the relationship between ACWR, non-contact injury, and subjective measures of sleep, soreness, energy, and overall wellness.

Training load ("PlayerLoad" a standard metric when using Catapult software obtained from global positioning system (GPS) devices) was obtained during every training session and match. The ACWR was calculated by dividing the acute load (7-day PlayerLoad) by the chronic load (21-day PlayerLoad) using the exponentially weighted moving average (EWMA) method. Subjective data was obtained from each player ~2 h prior to each training day using a 1-5 Likert scale and was analysed as Z-score fluctuations ("normal," "better," and "worse").

WHAT THEY FOUND

The main findings from this study were:

⇒ Wellness scores were lower (i.e. "worse") on the days after a high ACWR.

⇒ The risk of injury was very likely higher when an athlete's ACWR was high or low (two standard deviations above/below the mean).

⇒ When wellness, ACWR and injury risk were combined, the athletes that reported to be "better" in the overall wellness and soreness, had a greater risk of injury when they were exposed to a high ACWR.

⇒ No other clear interaction was found for the other wellness measures (i.e. sleep and energy).

Practical Takeaways

The results from this study reinforce the use of subjective measures of fatigue/readiness and an exponentially weight moving average ACWR. As extensively reported, a very low or a very high acute training load increases the risk of injury, reinforcing the need for practitioners to closely monitor training loads. Although in this study the authors obtained data from GPS, training load can easily be obtained by rating of perceived exertion (RPE) and the calculation of session RPE (sRPE).

Importantly, and as highlighted by the authors, the findings suggest that when the players report "better" wellness scores, if there is a spike in their training load, the chance of injury is increased. For this reason, practitioners are advised to maintain the workload and training content (i.e. drills) within the desirable (higher and lower) thresholds, especially with athletes that report they are feeling "better".

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

Francisco's Comments

"While the observed "U" relationship between training load and injury frequency was totally expected, the interaction between wellness scores, ACWR and injury occurrence is somewhat unexpected. I was expecting that a higher ACWR would be associated with a "worse" wellness score, which would result in an increased likelihood of injury. One of the possible explanations of this result, is the fact that when athletes report low wellness scores, especially soreness, it means that they are not capable to perform at their maximum output (e.g. muscle fibres won't be able to contract maximally), therefore, the risk of injury will likely be reduced.

As I mentioned in a previous issue (#24 October 2018), when analysing subjective data, it is important to normalise the results to the individual variation (i.e. Z-scores). The authors reported the Z-scores using a qualitative scale ("normal" mean Z-score, "better" ≥1 higher than the mean, and "worse" ≤1 lower than the mean). This can be a good way to report the data for the coaching staff."

[Abstract]

A placebo may be just as effective as cold modalities for enhancing recovery

OBJECTIVE
Cold-recovery modalities are widely implemented to speed up recovery between training sessions. However, little research has included a placebo group to provide a direct comparison to the currently used recovery methods to further understand the direct effect of these modalities. This study compared the effects of cold-water immersion (CWI), whole-body cryotherapy (WBC), and a placebo (PLA) intervention following a high-volume resistance training session.

WHAT THEY DID
Twenty-four males with at least 12 months of lifting experience (1RM back squat: ~123kg) performed a high-volume (i.e. 120 repetitions performed in sets of 6-8 reps with 80% of predicted 1RM) training session. After training, each participant was exposed to CWI (10 min of lower body immersion with water at 10°C), WBC (7 min at -85°C) or PLA (corn-starch pill). Measures were obtained 24-, 48- and 72 h after exercise and included:

⇒ Markers of muscle damage and/or inflammation (e.g. CK-M, IL-6, TNF-α).
⇒ Performance (knee extension peak torque (PTKE) and isometric contraction (ISOKE).
⇒ Drop jump reactive strength index (RSI), countermovement jump (CMJ), isometric squat peak force (SQPF), and rate of force development (SQRFD).
⇒ Perceived fatigue (DALDA) and perceived soreness (DOMS).

WHAT THEY FOUND
The main findings were:

⇒ DOMS: WBC was more beneficial then CWI and PLA (24 h)
⇒ PKISO: PLA was more beneficial then CWI (24- and 48 h)
⇒ PTKE: PLA was more beneficial then CWI (24- and 48 h) and WBC (48 h)
⇒ RSI: PLA was more beneficial then CWI and PLA (24- and 48 h), CWI was more beneficial then WBC (24 h)
⇒ CMJ: PLA and CWI were more beneficial then WBC (24 h), PLA was more beneficial then CWI (48- and 72 h)
⇒ SQPF: WBC was more beneficial then CWI and PLA (48 h)
⇒ SQRFD: PLA was more beneficial then CWI and WBC (24 h), PLA was more beneficial then CWI (48- and 72 h), WBC was more beneficial then CWI and PLA (48 h).
⇒ CWI was slightly more beneficial in comparison to WBC but not PLA in the inflammatory and muscle damage markers.

Practical Takeaways

The main practical takeaway of this study is that there is no clear beneficial effect of any of the recovery interventions in comparison to the placebo group after a lower-body high-volume, heavy resistance training session. It would be interesting to use the same study design in a well-trained population during a high-load training day to understand if the effects of the different recovery modalities and placebo are still similar to that of the current study. For example, in a contact sport like rugby, athletes frequently have two technical-tactical sessions with collisions and a heavy lower-body gym training session which are likely not included in a non-contact sport training session.

Importantly, as mentioned by the authors, the temperature of the WBC used in this study was higher than the temperature normally used for WBC (i.e. -85°C vs. -110 to -140°C), possibly limiting the effects on fatigue. Therefore, practitioners are advised that CWI and WBC may offer limited effects by speeding up recovery after a considerable level of fatigue, however, when recovering from a single, heavy-resistance training session, CWI and WBC may not offer additional effect in comparison to a PLA.

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

Francisco's Comments

"I found this is an interesting study as a placebo group rather than a control group was used. Moreover, this study demonstrated that CWI or WBC may not offer any additional benefits when recovering from a resistance training session when compared to the PLA group. As already mentioned, a single resistance training session may not reflect the daily load that some high-level athletes are exposed to. Nevertheless, the fatigue markers used in this study were substantially affected by the training session, and CWI or WBC weren't superior to PLA. Together with the harmful effects on muscle growth that can occur when using, the findings from this study reinforce that the implementation of CWI or WBC should be taken with caution."

Youth Development

This month's top research on youth development.

OBSTACLE COURSES TO ASSESS FUNCTIONAL MOVEMENT SKILLS: CAN THEY WORK?
Klingberg, B. et al. (2019) Journal of Sports Sciences.

LESS IS MORE? AN INVESTIGATION OF MULTI-SPORT PARTICIPATION IN YOUTH RUGBY PLAYERS
Hendricks, S. et al. (2019) International Journal of Sports Science & Coaching.

ADOLESCENT TO ADULTHOOD: AN INVESTIGATION OF PERFORMANCE CHARACTERISTICS OVER TIME
Loturco, I. et al. (2019) Journal of Sports Sciences.

[Abstract]

Obstacle courses to assess functional movement skills: can they work?

OBJECTIVE

Fundamental movement skills (FMS) are considered to be a key component of motor competency. The importance of FMS and motor competency has been studied worldwide, with many publications (**HERE**) showing a strong link between FMS competence and greater health and activity markers. Failure to meet and master age-appropriate FMS at a young age can limit such benefits, calling for assessments that are both feasible and valid as measures. In this study, the author's investigated the validity and feasibility of an obstacle course known as the 'Athletic Skills Track (AST)' in a pre-school setting to assess FMS.

WHAT THEY DID

This study consisted of two concurrently run studies, with the first being a validation study looking at the relationship between the AST and the commonly used 'Test of Gross Motor Development 2 (TGMD-2)'. The first objective was to assess the association between the AST and reference standards from the TGMD-2 which was achieved by staff performing both the AST and TGMD-2 with their students. The second was to determine the feasibility of the AST in a pre-school setting. To gauge enjoyment, semi-structured interviews were used to gain feedback from the staff, and a Smileyometer for the children. The Smileyometer used in this study was based around a 1-5 likert scale, using smiley faces to represent scores that were "awful" (1) and "brilliant" (5).

WHAT THEY FOUND

The results from this study suggest that the AST can be a feasible method when compared with the TGMD-2 to measure FMS competency. After adjusting for age and gender through a multiple linear regression analysis, the AST score was found to be a significant predictor of TGMD-2 scores ($p < 0.001$, $\beta = -0.55$). As this was the first time anything of this nature has been done, the authors place the correlation scores 0.37 to 0.49, where <0.79 is thought to have limited applicability due to a weaker association between a product and process-oriented assessment, made ever more challenging by a smaller sample size. In the semi-structured interview, staff found this an enjoyable and quick process, but sought additional information regarding each activities relevance to FMS. Finally, the mean score of the children's rating was 4.5 out of 5 on the Smileyometer, with only one child scoring below a three which was indicative of general enjoyment.

Practical Takeaways

In consideration of the results, it is important to see these findings as a "work in progress". For example, as the AST has not yet collected enough data to provide discriminate norms, it remains hard to see how coaches/teachers can really visualise where their club/school is compared to others. Furthermore, assessing FMS can be challenging to analyse and develop by the untrained eye. I would suggest that coaches and teachers become more conscious of the long-term benefits of developing FMS, with the overall aim being to assess a clear and understood skill (i.e. balance), run an intervention (i.e. proprioception task), and assess again to see if the child has improved. Some fantastic examples of young children engaging in obstacle courses can be seen in the video below.

Children are the future superstars, so it is important that we track their progress to give them goals to pursue. A strong link has been found between movements and learning (see attached article), which is important given the nature of this study. According to the Smileyometer's results, children performing the obstacle course really enjoyed this experience, which will hopefully increase their likelihood of repeating this test. In my own experience when I've performed obstacle courses, you can really gauge who is truly movement competent and good under limited time/competitive constraints. As such, it is important that children are given the opportunities to practice such skills. However, there is a risk that the children will learn "how" to pass the course, and not improve their general FMS's. To combat this, staff/coaches may want to think about subtle differences that are challenging for progressive years/ athletes.

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

Tom's Comments

"Overall, I feel that obstacle courses can be a great way of assessing one's movement competence but also expand our understanding of the participant's attitudes and reaction to challenge. Children hold a perception of their capabilities and I believe that it is our job to change these, with the overall goal of them being to push for new standards and beliefs about their capabilities. During these challenges, coaches must have the requisite skills to understand and be empathetic to the individual's needs. As such, Maggie Dent, also known as the 'Queen of Common Sense', has produced a podcast (see below) on helping children to overcome adversity and create new standards.

Future research such as this needs to be longitudinal in nature, building on the work of others who have investigated long-term athlete development and have provided normative data to set standards (e.g. 30 cm = a good CMJ for an 11-year-old as a hypothetical example). In turn, this could generate a series of resources that practitioners could quickly set up and compare with age-related norms leading to more assessments. From the teacher's perspective, this would also be less time-consuming and not require as much of a critical eye to see/assess the differences between large amounts of students."

[Abstract]

Less is more? An investigation of multi-sport participation in youth rugby players

OBJECTIVE

Rugby is an intermittent team-sport, requiring individuals to be strong and robust to handle high physical demands. As such, rugby remains a late specialisation sport where players are encouraged to remain engaged in multiple sports throughout the year before they transition into rugby specialisation (14-18 yr). The aim of this study was to quantify how much rugby training, matches, and engagement in other sports occur over different stages of the season in youth rugby union players.

WHAT THEY DID

Over the course of a typical rugby season, 492 youth rugby union players provided individualised information on their weekly frequency, intensity, and duration of all exercise commitments using a sport activity questionnaire (see the article link below). Once collected, this data was grouped into three different time categories (September-December, January-April, and May to August). The volume of all sporting commitments was calculated (frequency x duration = minutes per week [min/wk]) and these sports were then combined and compared across season stages using a one-way analysis of variance (ANOVA).

WHAT THEY FOUND

During September-December, the volume of rugby matches was far greater during this period for the U15s (116 ± 57 min/wk; $p<0.001$, ES = 1.42 ± 0.22) compared to May-August. This trend continued in the months between January and April (97 ± 61 min/wk), but significantly dropped between the months of May to August (33 ± 60 min/wk). An inverse relationship was found with participation in other sports external to rugby, where participation during Sept-Dec was at its lowest but increased during May to August. Similar trends were seen in overall training volume for the U15s in rugby training participation, being at its highest during September-December. The data from the U16s closely mimicked that of the U15's (September to December [105 ± 68 min/wk]), (January to April [85 ± 71 min/wk]) and May to August [24 ± 50 min/wk], showing a decrease over time in terms of rugby participation. Similar results were also seen to the U15s, where participation in other sports (i.e. gymnastics) increased, and trends in volume followed.

Practical Takeaways

The findings of this study indicate that, on average, both U15s and 16s were completing roughly 10-11 sessions per week of rugby, physical education, and external sporting commitments between September-April, equating to 12 h per week. As S&C coaches, we know the toll that a busy sporting period can have on the body. In the attached video, Sam Warburton (Welsh Rugby International) discusses the role that injury played in his career and opens up about his experiences playing at the highest level. In this, it is important to remember that external to sport, life stressors can sometimes be unpredictable or psychologically challenging, such as a busy exam period or troubles at home as an example. In accordance to this, we must alter volume and intensity accordingly. However, with 12 h of exercise per-week, I do question if schools/external clubs are considering this and adjusting the intensity of their sessions accordingly.

To combat this, we may wish to monitor acute: chronic workload ratios. Fortunately, the team at Science for Sport have you covered with this impressive article and excel template (see **HERE**). Tracking acute: chronic workload ratios allow coaches to track a player's activity on a weekly basis, using a rolling average to identify if an individual is working too hard. Although this may seem advanced for school-aged children, I believe that these are necessary, particularly to those with a heavy sporting schedule both in and outside of school. From a performance perspective, coaches can evaluate if a player is over-worked, or requires a different form of session to create a positive response (i.e. a recovery session). Once spikes in activity are seen (>1.50 ratio of training increase), athletes are placed at a greater likelihood of injury.

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

Tom's Comments

"When working with children during periods of heightened activity, it is important that we can identify with our athletes where there may be 'voids' or deficiencies in their skill-set or experiences in sport. For example, a child who is in an academy set-up with highly structured and ordered sessions, must experience the fun side of sports to balance out their development. Similarly, a child with a less structured approach could benefit from some discipline. The balance here is difficult to find, especially with limited time. Sadly, someone must consider alterations in training volume/intensity, which often falls under the S&C coach's remit. However, a good compromise between comfort, fun, and uncomfortable experiences, as suggested in the linked podcast, may be the best way to guide an athlete through periods of heightened participation which will inevitably occur. To progress, academies or organisations that demand high contact time as seen in this study (1.5-1.8 h rugby per-week; 3.6-4.1 h rugby training sessions), must consider the physical and psychological load associated with heavy training bouts, and should communicate this accordingly with players and parents."

[Abstract]

Adolescent to adulthood: an investigation of performance characteristics over time

OBJECTIVE

Over the years, an increased emphasis on technical and tactical performance in soccer has called for players to be in greater physical shape, particularly with regards to speed and strength. The purpose of this study was to investigate the evolution of vertical jump height, linear speed, change of direction (COD) speed, and COD deficit in soccer players within the same club over different age groups.

WHAT THEY DID

The vertical jump height (squat and CMJ), speed over 20m, Zigzag COD test, and COD deficit of 182 youth soccer players (U15, U17, U20, and senior) was examined. All participants were involved in various training methods, with small-sided games, set pieces, heading, and dribbling being the main focus. In the U15 and U17 squad, both completed a neuromuscular training programme consisting of plyometric training and half squats with light loads (≤40% of body mass). The U20 and senior players completed strength-power training, which comprised of drop jumps, half-squats, and loaded jump squats at 40-70% of body mass. To assess between-group differences, magnitude-based inference was used which provide an alternative to other statistical measures (refer to article below for explanation).

WHAT THEY FOUND

The main findings of this study were that linear speed increased over longer distances (10-20 m) with age. However, the same did not occur over small distances (>5 m), with the U20 and senior group performing poorly when compared to the U15 group. In contrast, COD ability remained relatively consistent in the younger categories but decreased with age. Surprisingly, the COD deficit presented a gradual increase with age as the U15 group performed worse than the U17 group, which was a trend through to the senior team. Finally, squat jump and countermovement jump scores were notably poorer in the U15 group, but were greater at U17, U20, and senior teams.

» **Practical** Takeaways

From this study, it is important that the results are considered and interventions are created to address such issues. For example, over the initial 5 m of acceleration, the U15s performed the best. This could be due to a greater power-to-weight ratio, or the exposure to more specific training over smaller distances/pitch dimensions leading to short-distance (5 m) acceleration improvements. In the other teams (U17, 20, senior), initial 5 m times were not as impressive, yet 10-20 m distances were better. The obvious approach here would be to invest in greater sprinting distances for the U15s and acceleration/strength training to make the "older" teams more explosive over smaller distances. This could be a maturation-related phenomenon, or a representation of the inadequacy of the football clubs training to promote performance improvements.

With regards to COD performance, it is important that we understand the differences between COD and agility (see definitions **HERE**). Following this, we can begin to design tasks based around specific encounters that one would experience in the sport. In football, for example, a player may have to quickly transition from an attacking stance (driving forward at high velocity) to a defensive stance (deceleration, high force) from a loss of possession. As an S&C coach, I would look to run a possession-based game where the coach can randomly "switch the play" by introducing a new piece of equipment/ focus to pursue in a slightly chaotic nature. Naturally, you would then hope to see some COD mechanics (drop steps, crossover etc.) happen implicitly in the game. These must occur at all ages and continue throughout adolescent to senior training to combat the loss in COD speed with age.

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

Tom's **Comments**

"Speed and COD/agility ability are vital characteristics in football at all levels. I think as coaches we can overly focus on technical high-speed running (e.g. A-B skips) when players will often fail to reach distances/ velocities in football that require a good knee position and arm-rhythm. As an example of this, the attached video below shows the difference in technique over shorter distances between Christiano Ronaldo and an elite sprinter. In this video, Ronaldo adopts a more horizontal, "grabbing" technique, which benefits him in short chops and changes of direction. This does not only indicate that shorter distances may be completed in greater times with suboptimal technique, but that a balanced programme should consider highsspeed running, short-distance running, reactive agility, and open/closed COD work.

With regards to jump performance, plyometric interventions have always proved beneficial to many athletes in sports. The results (i.e. improved SJ and CMJ with age) clearly show a maturation-related process. However, it is without doubt, in my opinion, that plyometrics and eccentric training can be adopted from a young age, which could improve the quality of the jumps. Given the constraints of modern football (e.g. limited time, funding at lower levels etc.), this would require a qualified S&C coach to oversee."

Nutrition

This month's top research on nutrition.

BACK TO BASICS: CHOCOLATE MILK IN RECOVERY AND PERFORMANCE
Born, K. A. et al. (2019) Journal of the International Society of Sports Nutrition.

THE BENEFITS OF TAURINE SUPPLEMENTATION AND CYCLING IN THE HEAT
Page, L. K. et al. (2019) European Journal of Sport Science.

IMPROVE YOUR ENDURANCE RUNNING TOLERANCE WITH CAFFEINATED GUM
Dittrich, N. et al. (2019) Journal of Strength and Conditioning Research.

[Abstract]

Back to basics: chocolate milk in recovery and performance

OBJECTIVE

There is already laboratory-based evidence for the enhanced efficacy of carbohydrate and protein drinks for recovery compared to just carbohydrate or just protein drinks (see **HERE**). However, few studies have investigated this in a real-world setting and with commercially available drinks. The researchers here sought to determine whether drinking a store-bought carbohydrate/protein drink - in the form of chocolate milk - enhances strength gains in adolescents compared to a store-bought sports drink (carbohydrate only).

WHAT THEY DID

A summer-camp designed to improve strength and agility in adolescent high school athletes (mean age 15.3 ± 1.2) was utilised for the data collection period and took place 4 days a week for seven weeks. The participants were randomly assigned into a chocolate milk condition (CM) or a carbohydrate sports drink condition (CHO) which was consumed every day of camp following the completion of a two-hour gym and field-based session. Measurements of body weight, bench press, squat, and composite strength (bench press combined with squat) were recorded prior to and following the camp period and were used to determine the efficacy of the two drinks in facilitating strength improvements.

WHAT THEY FOUND

A seven-week high-school summer camp focusing on strength and agility elicited overall improvements in composite strength (bench press + squat) from an average of 173.6 ± 81.9 kg to 185.8 ± 80.2 kg across 103 student athletes. When comparing CM and CHO, those assigned to the CM group saw an average improvement of 20.5 kg, whereas those in the CHO group improved by only 4.8 kg. There were no significant changes to bodyweight over the duration of the camp, for either group. Unexpectedly, average performance in the bench press actually decreased by 2.3 kg in the CHO group, whereas the CM group improved by 0.2 kg on average, although this was non-significant.

Practical Takeaways

This study demonstrates that a store-bought chocolate milk drink (473 ml, 44 g carbohydrate, 16 g protein, 5 g fat, 300 Kcal) facilitates strength improvements over the duration of a seven-week training camp in high-school athletes. The improvements seen in the chocolate milk condition were significantly higher than the carbohydrate drink condition (710 ml, 42 g carbohydrate, 0 g protein, 0 g fat, 160 Kcal), likely due to the protein content of the chocolate milk which would enhance recovery more so than a carbohydrate-only drink. This highlights that something as rudimentary as chocolate milk can provide sufficient fuel for performance and recovery. Chocolate milk is easily accessible, relatively cheap (compared to specialist supplements, for example) and palatable and, as such, proves to be a suitable choice for those looking to facilitate performance without the need for expensive supplements.

The aim of this study was not so much to prove that chocolate milk is a better option for post-workout recovery than carbohydrate drinks, as this finding has already been shown. Instead, this study sought to take laboratory findings into the real-world and, as such, the authors decided not to match the energy content or volume of the two beverages as this would take away from the "store-bought" nature of the two beverages.

By using a pre-existing summer camp, the results highlight that chocolate milk is not only an effective post-workout drink but also that it is feasible, practical, and accepted by actual athletes in a real-life training setting. Coaches should therefore consider that just because a drink isn't produced by a supplement or sports company, this doesn't mean it cannot provide the right fuel for the performance and recovery of their athletes and this is discussed well in the podcast link below.

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

James' Comments

"Combining carbohydrate and protein to maximise recovery and subsequently improve performance is by no means a secret in the world of sport, and chocolate milk happens to contain roughly the recommended carbohydrate:protein ratio (3:1) for optimal recovery (see **HERE** and **HERE**).

The authors acknowledge that the study isn't the most precise or well-controlled, but it makes up for this with its real-world applicability. The summer-camp, participants, outcome measures and beverages were all pre-existing and not manipulated by the researchers at all which gives this study high ecological validity. It is important to remember that lab-based findings, at least in the world of exercise performance, are essentially redundant if they cannot be translated to the real-world. Those looking to implement strategies based upon lab-based research should always remember that just because something works in a laboratory and under controlled conditions, does not mean it will work for an athlete in the real-world, under uncontrollable conditions."

[Abstract]

The benefits of taurine supplementation and cycling in the heat

OBJECTIVE

Taurine is reported to enhance endurance-based performance when orally ingested both chronically and acutely (see article below). There is, however, a lack of consensus regarding the mechanisms by which taurine facilitates performance. The authors postulate that a primary mechanism involves improved thermoregulation via both central and peripheral systems which translate to improved performance when exercising in the heat. This study aimed to investigate the effects of oral taurine supplementation on cycling time to exhaustion at a fixed-intensity and thermoregulation in the heat.

WHAT THEY DID

Eleven males (mean age 23 ± 2 yr) took part in two time-to-exhaustion trials, cycling at ventilatory threshold in 35˚C heat and at 40% relative humidity. Two hours before each trial, participants ingested a capsule containing either taurine (50 mg.kg^{-1}) or maltodextrin (3 mg.kg.$_{-1}$). Time-to-exhaustion, core temperature, skin temperature, and sweat rate were all measured to determine thermoregulatory control during the trials.

WHAT THEY FOUND

Acute taurine ingestion two hours before the exercise trial increased the time-to-exhaustion by 10% (22:43 min to 25:16 min), increased sweat rate by 12.7% and decreased post-trial blood lactate by 16.5% compared to the placebo (maltodextrin) condition. Taurine also elicited a lower core temperature during the final 10% of the trial, compared to placebo. Finally, the RPE (rate of perceived exertion) at 18 min and the end of the trial was significantly lower in the taurine condition.

» **Practical** Takeaways

Taurine is commonly implemented as an ergogenic aid in athletes as there is substantial evidence that taurine can enhance performance via improved mechanical efficiency of movement or an increased rate of ATP resynthesis at a cellular level (see article below). However, this study presents a new mechanism by which taurine can enhance performance - through improved thermoregulation.

The primary practical takeaway from this piece of research is that a single, acute dose of taurine (50 mg.kg-1) can improve endurance performance in hot conditions (35˚C) in young males. The primary mechanisms by which this ergogenic effect occurs appear to be an increase in sweat rate, allowing for greater heat dissipation from the body. A significant reduction in blood lactate also occurs as a result of ingesting taurine. Not only will this enhance performance at the cellular level, but it also reduces sensations of effort for the exercising athlete, as reflected in the lower RPE in the taurine condition. Heat acclimation can be a complex process, taking place over several days. For those endurance athletes who need to optimise their performance in hot conditions, acute taurine ingestion should be considered as an ergogenic aid which require minimal advanced planning.

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

James' **Comments**

"This is the first study I am aware of to demonstrate the ergogenic effects of taurine via mechanisms of thermoregulation in human subjects exercising in the heat. The measurement techniques used in this research are advanced and will have higher accuracy than some less-advanced techniques. For example, using a rectal thermistor to measure core temperature and four separate skin thermistors in different areas to obtain a mean skin temperature will yield more accurate results. As with all supplementation, ensure that you check for batch testing and obtain batch codes to avoid accidental use of banned substances."

[Abstract]

Improve your endurance running tolerance with caffeinated gum

OBJECTIVE

Caffeine is available in many forms including coffee, sports drinks, powder forms, capsules, and chewing gum. Recent studies have proposed the use of chewing gum as a delivery method due to its quicker absorption time via the buccal mucosa, which results in a shorter duration to obtain the effects of caffeine. The aim of this study was to analyse the effect of caffeinated chewing gum on endurance running tolerance, and to assess its effects on neuromuscular functions.

WHAT THEY DID

Twelve trained male runners with a maximal oxygen uptake of 62.0 ± 4.2 ml.kg-1min-1 initially completed an intermittent treadmill test to determine their maximal aerobic speed and delta 50% intensity. Following this, participations performed two randomised time-to-exhaustion tests after the ingestion of 300 mg of caffeine in a double-blind crossover design at 50% intensity. Neuromuscular fatigue of the knee extensor muscles was assessed before and immediately after the tests.

WHAT THEY FOUND

The main finding of this study is that the tolerance enhancement (18%) during running at submaximal intensity induced by caffeine intake by chewing gum is not associated with differences in neuromuscular responses. Neuromuscular responses decreased similarly after time-to-exhaustion in both exercise conditions; however, athletes were able to run a longer distance in the caffeine condition

Practical Takeaways

Based upon the results of this study, a 300 mg dose of caffeine administered through chewing gum (3 pieces of commercially available, Stay Alert; Amurol Confectioners) enhanced exercise tolerance. Although the performance enhancement was not associated to the neuromuscular parameters, athletes were able to run longer distances within the caffeine condition. As such, this study supports the current literature that caffeine induces beneficial effects on exercise tolerance.

Therefore, caffeine delivered through chewing gum could be an effective and convenient strategy of caffeine ingestion to be used by athletes who have to cover longer distances and have short/no breaks during competition, such as team-sport athletes or endurance running/cycling exercise. However, coaches and athletes must consider how a person's body size, age, gender, previous use, and level of tolerance all influence ergogenic effects of caffeine on sports performance (see article below link 2). Therefore, trials during training are recommended in order to prevent side effects that may outweigh the performance benefits. Another important factor to consider is whether the product is tested for prohibited contaminants to provide a high-level of assurance for athletes. See the infographic link for more information on different supplements that are supported for use in sport using evidence-based protocols.

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

James' Comments

"It is important to outline the limitations of the study. In agreement with the authors, the lack of reassessment of the neuromuscular parameters immediately after chewing caffeine gum would have been valuable information in relation to the acute effects of caffeine on neuromuscular parameters. Second, the magnitude of performance enhancement (18%) should be interpreted cautiously given the nature of the protocol (i.e. time-to-exhaustion) which can be variable compared to time-trials. Lastly, it is suggested that a caffeine ingestion protocol should be an individualised. The responses to caffeine are variable and athletes need to determine whether the ingestion of 300 mg of caffeine on a 70 kg male athlete (~4.3 mg caffeine per kg, respectively) before training is ergogenic on an individual basis before applying this to a competition setting. More information on the different alternatives of caffeine on endurance sport performance including caffeine gum can be seen in the video link below."

Injury Prevention & Rehab

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

USING THE NORDIC HAMSTRING EXERCISE TO REDUCE HAMSTRING INJURIES

van Dyk N,Behan, F. P. et al. (2019) British Journal of Sports Medicine.

DETERMINING RISK FOR ACHILLES TENDINOPATHY

van der Vlist, A. C. et al. (2019) British Journal of Sports Medicine.

HOW CAN THE FIFA 11 PROGRAMME REDUCE THE COSTS OF INJURED PLAYERS?

Nouni-Garcia, R. et al. (2019) European Journal of Sport Science.

[Abstract]

Using the Nordic hamstring exercise to reduce hamstring injuries

OBJECTIVE

Hamstring strain injuries are one of the most common muscular injuries across various sports. Several studies have now shown a reduction in the risk of hamstring strain injuries when the Nordic hamstring exercise (NHE) is performed (see **HERE**). The aim of this study was to look at the abundance of literature already published, pool the data, and find just how effective the Nordic Hamstring Exercise is at preventing hamstring strain injuries.

WHAT THEY DID

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, and searched for articles from January 1950 up to August 2018 on PubMed, Ebsco, and OpenGrey. Studies were excluded if they lacked a control group, but not on the basis of gender, age, or level of activity. From this exclusion criteria, 1590 studies were initially identified, and 15 were kept for analysis. Seven were randomized controlled trials, one was non-randomized, and seven were cohort studies. The population was any athlete from any sport, and the Nordic Hamstring Exercise, or any program including the NHE, was the intervention. This was to be compared to either training as usual or any program that did not include the NHE. The primary outcome was incidence of hamstring injuries.

WHAT THEY FOUND

The pooled data showed a 51% reduction in hamstring injuries within an intervention group in which the NHE was performed either alone or within an injury prevention program compared to a control group that either performed training as usual or an injury prevention program that did not include the NHE. Based on these results, and the fact that the review included studies from different sporting codes and from different countries, with different ages, genders, and levels of activity represented, it is recommended that clinicians utilise the NHE to reduce hamstring injuries, regardless of age, sport, or gender.

» **Practical** Takeaways

This systematic review and meta-analysis further adds to the body of literature supporting the use of the NHE as a way to reduce the risk of hamstring strain injury. There are arguments against the NHE that suggest that it is too challenging for some athletes to perform, and that regressions of the NHE should be made available for these athletes. The whole point of the NHE, however, is that it is a supramaximal load which causes a positive adaptation to decrease the risk of hamstring injury. It has also been argued that the movement of the NHE is too slow and a knee-dominant movement, whereas, the primary mechanism of injury for a hamstring strain is usually hip-dominant movements at high velocities.

This review shows that regardless of the arguments and theories against the NHE, it continues to be effective in reducing the risk of hamstring strain injury. As is highlighted within this study, the NHE is an effective injury prevention tool which is also time- and cost-effective. Adding the Nordic Hamstring Exercise to the end of the warm-up or including it within the FIFA 11+ program can be easy ways to implement it in a team setting.

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

Nicole's **Comments**

"Normally, in a systematic review and meta-analysis, it is important to consider the quality of the information that is being used for analysis to ensure the recommendations of the review are also of high quality. Therefore, it is usually only randomised controlled trials that are included in these studies. However, in this particular review, the authors purposely did not limit their inclusion criteria to high-quality randomised controlled trials as they wanted to be more comprehensive and inclusive in their review by including more studies to represent different ages, genders, sporting codes, and activity levels. To ensure that the cohort studies and studies with high risk of bias did not significantly impact the results, they ran several analyses and found no significant statistical differences when including these studies or not. This means that we can generalise the findings to more populations outside of those included strictly in the randomized controlled trials and still expect to see a reduction in hamstring strain injuries with performance of the NHE."

[Abstract]

Determining risk for Achilles tendinopathy

OBJECTIVE

Although there are many variables (e.g. body weight, BMI, systemic diseases, and use of fluoroquinolones) believed to be risk factors for the development of Achilles tendinopathy, there is a lack of conclusive evidence that would actually suggest this is the case. Being able to identify risk factors, specifically modifiable risk factors, can help to reduce one's risk of developing Achilles Tendinopathy. This systematic review aimed to do just that, and looked at the potential clinical risk factors for developing Achilles Tendinopathy.

WHAT THEY DID

This review utilized the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Articles were searched up until February 2019 from multiple databases.

Potentially relevant studies (5,111) were narrowed down to 55 studies that were included in the review, based on the inclusion and exclusion criteria which were chosen to asses strictly clinical risk factors, and not studies based on imaging.

The potential risk factors were extracted and grouped into patient characteristics (modifiable and non-modifiable), biomechanical factors, pre-existing diseases, medication and training factors.

WHAT THEY FOUND

The authors found that there is some evidence for 9 clinical risk factors:

- ⇒ Having a history of another lower-limb tendinopathy or a previous fracture
- ⇒ Use of ofloxacin (an antibiotic in the quinolone family)
- ⇒ A longer duration of time before initiating quinolone treatment after a heart transplant
- ⇒ Moderate alcohol use (7-13 drinks per week for men and 4-6 drinks per week for women)
- ⇒ Cold weather training
- ⇒ Decreased strength of the plantarflexors
- ⇒ Decreased forward progression during the push-off phase of gait

» **Practical** Takeaways

When working with patients with Achilles tendinopathy, or when assessing one's risk for developing Achilles tendinopathy, the current research has identified a number of risk factors which may contribute to this. In particular, the use of Ofloxacin, ensuring patients have a moderate alcohol consumption, and improving a person's reduced plantarflexor strength are modifiable risk factors that can be altered to decrease the risk of Achilles tendinopathy. For example, advising a patient to decrease their alcohol consumption to less than 4 units per week for women or less than 7 per week for men. It may also be helpful to advise them to take an antibiotic other than ofloxacin, if possible, as this particular antibiotic may be a risk factor, but other quinolone antibiotics may not be.

Physical activity was not found to be a risk factor for developing Achilles tendinopathy. This may be because looking at physical activity is really only looking at one's cumulative workload, and not the spikes or changes in their workload. It may be that cumulative loads have no impact on the development of Achilles tendinopathy, but that sudden changes or spikes in a patient's load might. One way in which this could be minimised is by monitoring the training load of patients to avoid excessive peaks in load.

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

Nicole's **Comments**

"This systematic review did a good job of identifying some of the clinical risk factors for developing Achilles tendinopathy. The fact that the authors excluded studies which focused on the imaging of Achilles tendinopathy so that the focus could be on those factors which could be identified whilst working with a patient was of particular interest to me. There are, however, a few variables that need special consideration. For example, this review shows that certain gait abnormalities are associated with Achilles tendinopathy. One study in particular showed this effect, although this was within novice runners who performed barefoot running over a 10-week running program. It is, therefore plausible that there are many runners who may demonstrate a gait "abnormality" but do not develop Achilles tendinopathy. It could also be that these novice runners developed Achilles tendinopathy simply because it was a novel stimulus for them, and they were therefore unconditioned to this. It should be mentioned though that this one particular study is not enough for us to definitively say that certain gait mechanics are associated with Achilles tendinopathy."

[Abstract]

How can the FIFA 11 programme reduce the costs of injured players?

OBJECTIVE

Hamstring strain injuries and lateral ankle ligament injuries are two of the most common injuries amongst male football players. The FIFA 11 programme is a dynamic warm-up that was created with the aim to help reduce the risk of injury in football players, and has been shown to be effective in doing so. Since the FIFA 11 has been so effective in reducing the risk of injury, this study examined its cost-effectiveness, specifically for hamstring and ankle injuries.

WHAT THEY DID

This study required one group of amateur soccer players to complete their typical training session (control group), whilst another completed the FIFA 11 programme which took place two times each week (intervention group), both over a two-season period. During this time, the lateral ankle ligament and hamstring injury data was analysed monitored. The costs of injuries in the intervention group were compared to the costs of injuries in the control group which included and analysis of the FIFA 11 intervention costs, direct healthcare costs, and indirect injury-related costs.

WHAT THEY FOUND

A number of key findings related to the cost-effectiveness of the FIFA 11 programme were identified:

- ⇒ The only cost identified that was associated with the FIFA 11 programme was the salary of the physiotherapist that was hired to lead each session.
- ⇒ Mean total cost per intervention group player for hamstring injury was €742 compared with €1271 in the control group.
- ⇒ Total cost of injuries per player in the control group was €2199 compared to €1273 for those in the intervention group.
- ⇒ There was a mean savings of €924 per player for the two seasons within the intervention group compared to €462 per player per season within the control group.
- ⇒ Overall, the total investment of the FIFA 11 programme was €9,766.68 and the total estimated avoided costs were €38,892.

» **Practical** Takeaways

The FIFA 11 programme has previously been shown to reduce the rate of injury in football players and this study adds further evidence from a cost-benefit perspective. The cost associated with implementing the FIFA 11 programme is low, particularly since most clubs already employ a physiotherapist and other support staff who can lead the programme.

One of the biggest challenges, though, is encouraging teams to implement the programme consistently. There would likely be much higher implementation and compliance rates if players, coaches, and managers were made aware not only of the reduction in injury, but also the reduction in days missed of training and games, as well as the costs associated with injury. This study gives performance and sports medicine staff another strong argument in helping other key stakeholders to buy into implementing the FIFA 11 programme into their club. It can also help the performance and sports medicine staff to objectively prove their worth and value within a club.

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

Nicole's **Comments**

"This article is helpful in addressing one of the major pitfalls of the FIFA 11 programme – club implementation. If clubs can see how much money they could save by implementing the FIFA 11 programme, they may be more likely to implement it on a more regular basis. Although this article only reported the costs associated with lateral ankle and hamstring injuries, it is possible the savings would be even higher if they also included knee injuries, which are typically often more costly due to the need for surgical intervention and longer time lost from sport."

Infographics

A round-up of our monthly research infographics.

REACTIVE STRENGTH H INDEX

Solomon, M. (2019) Science for Sport.

STRETCH SHORTENING CYCLE

Solomon, M. (2019) Science for Sport.

@ScienceforSport

REACTIVE STRENGTH INDEX

What is it?

The reactive strength index (RSI) demonstrates an athlete's ability to rapidly change from an eccentric motion into a concentric muscular contraction, and is an expression of their dynamic vertical jump capacity.

Importance

The RSI demonstrates an athlete's ability to quickly and effectively change from an eccentric to a concentric contraction, therefore representing their ability to utilise the stretch-shortening cycle and their explosive capabilities. The RSI has been shown to have a strong relationship with both change of direction speed and acceleration speed.

Valid & Reliable

The RSI has been proven to be a valid and reliable measure of reactive jump capacity.

Using the RSI

The incremental depth jump RSI can provide recommendations for an athlete's optimal drop height for plyometric exercises. Figure 1 provides a clear example of a performance drop-off after a given drop height – in this case at 80cm. This suggests that the athlete's 'optimal' box height for a depth jump is 60cm.

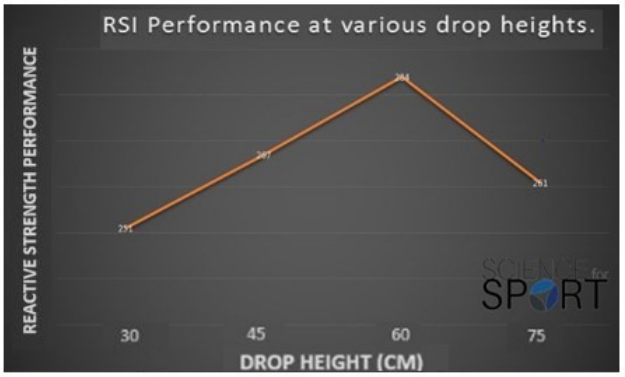

Figure 1: RSI performance at various drop heights

Fatigue

RSI tests are also commonly used to measure neuromuscular fatigue during competition periods in team sports.

Our summary

The RSI is a useful tool in assessing an athlete's explosive capabilities during dynamic jumping. The RSI appears to be linked to acceleration, agility and change of direction speed. Practitioners must take into account an athlete's technical proficiency in plyometrics, as this may influence their RSI results.

For the full article check out the Science for Sport website

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STRETCH SHORTENING CYCLE

SCIENCE for SPORT

What is it?

The stretch shortening cycle (SSC) is described as a rapid cyclical muscle action whereby the muscle undergoes an eccentric contraction, followed by a transitional (amortization) period prior to the concentric contraction.

Rate of loading

The action of the SSC is perhaps best described as a spring-like mechanism, whereby increasing the speed at which the coil is compressed or how hard it is pressed down (amount of force applied) will result in the spring jumping higher or farther. This is known as the 'rate of loading'.

Fast vs slow

A fast SSC is considered as <250ms. While a slow SSC is >250ms. This is evident in the type of exercise performed, for example sprinting vs walking.

Our summary

The SSC is a spring-like mechanism shown to enhance athletic performance both in explosive and endurance based sports. Well-trained athletes appear to possess better SSC capacities than less or non-trained individuals, and this therefore highlights the necessity to optimise this property to enhance athleticism.

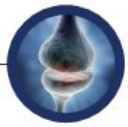
Mechanisms

There are three primary mechanisms responsible for the performance enhancing effects of the SSC.

Elastic energy storage

Elastic energy is stored in the tendon in the eccentric and amortization phases, and can be used as additional propulsive force in the concentric phase of the SSC.

Neurophysiological model



The engagement of muscle spindles during the eccentric phase is thought to cause an increased recruitment of motor units and/ or an increased rate coding effect.

Active state

This is the period of time in which force can be developed during the eccentric and amortization phases. The longer these phases of the SSC the more time is available for the formation of cross-bridges, which will improve concentric force output.

For the full article check out the Science for Sport website

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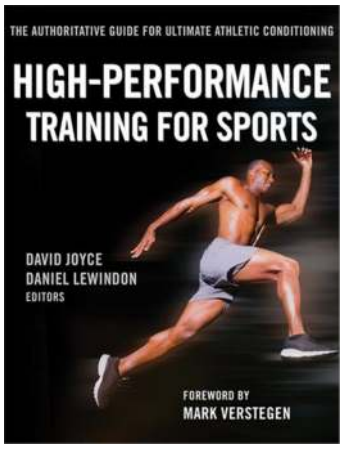

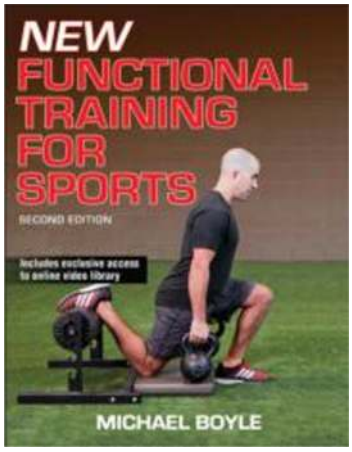

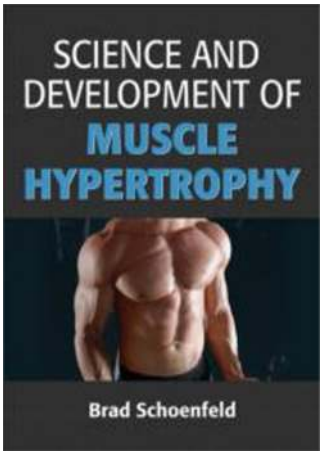

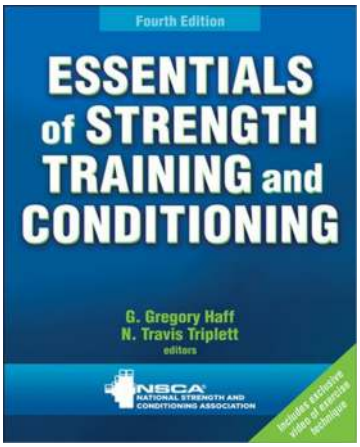

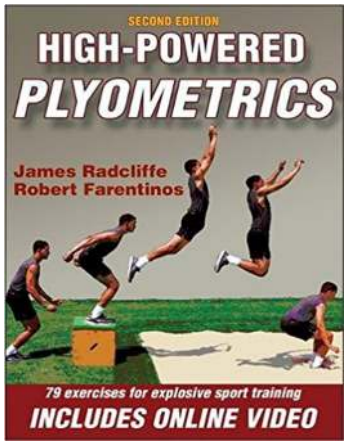

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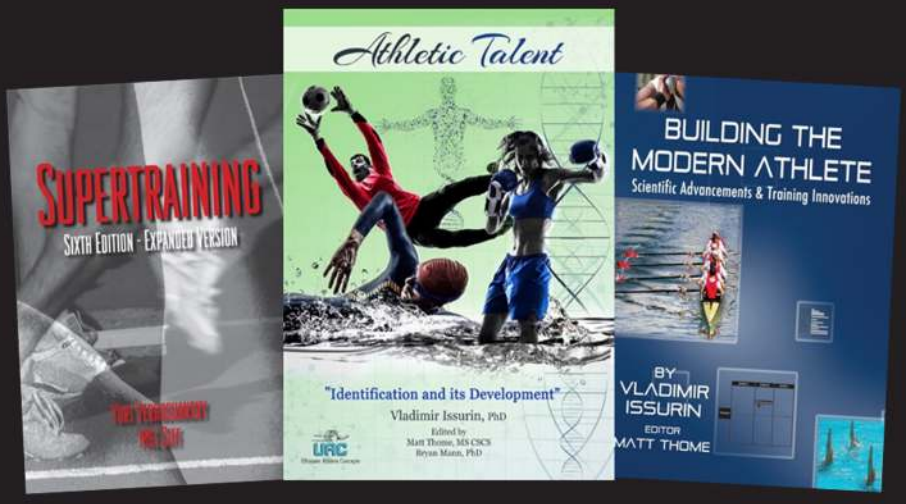

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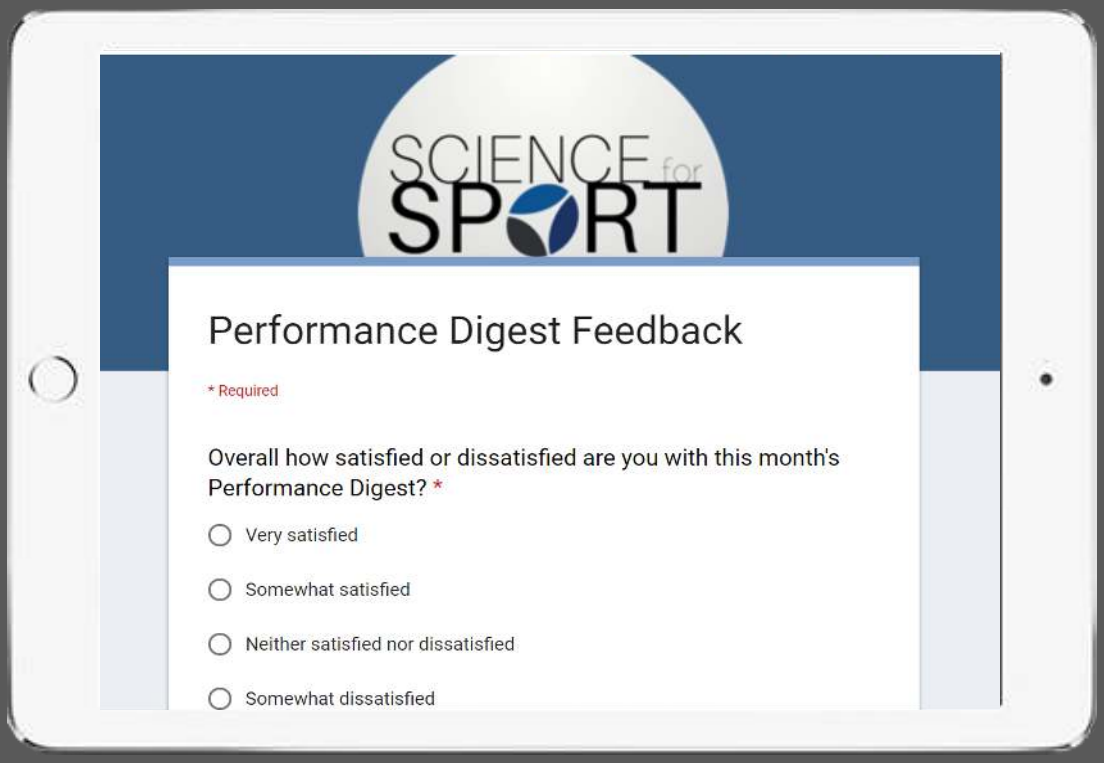

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Science for Sport