May 2019 | Issue #31

THE PERFORMANCE DIGEST

A review of the latest sports performance research

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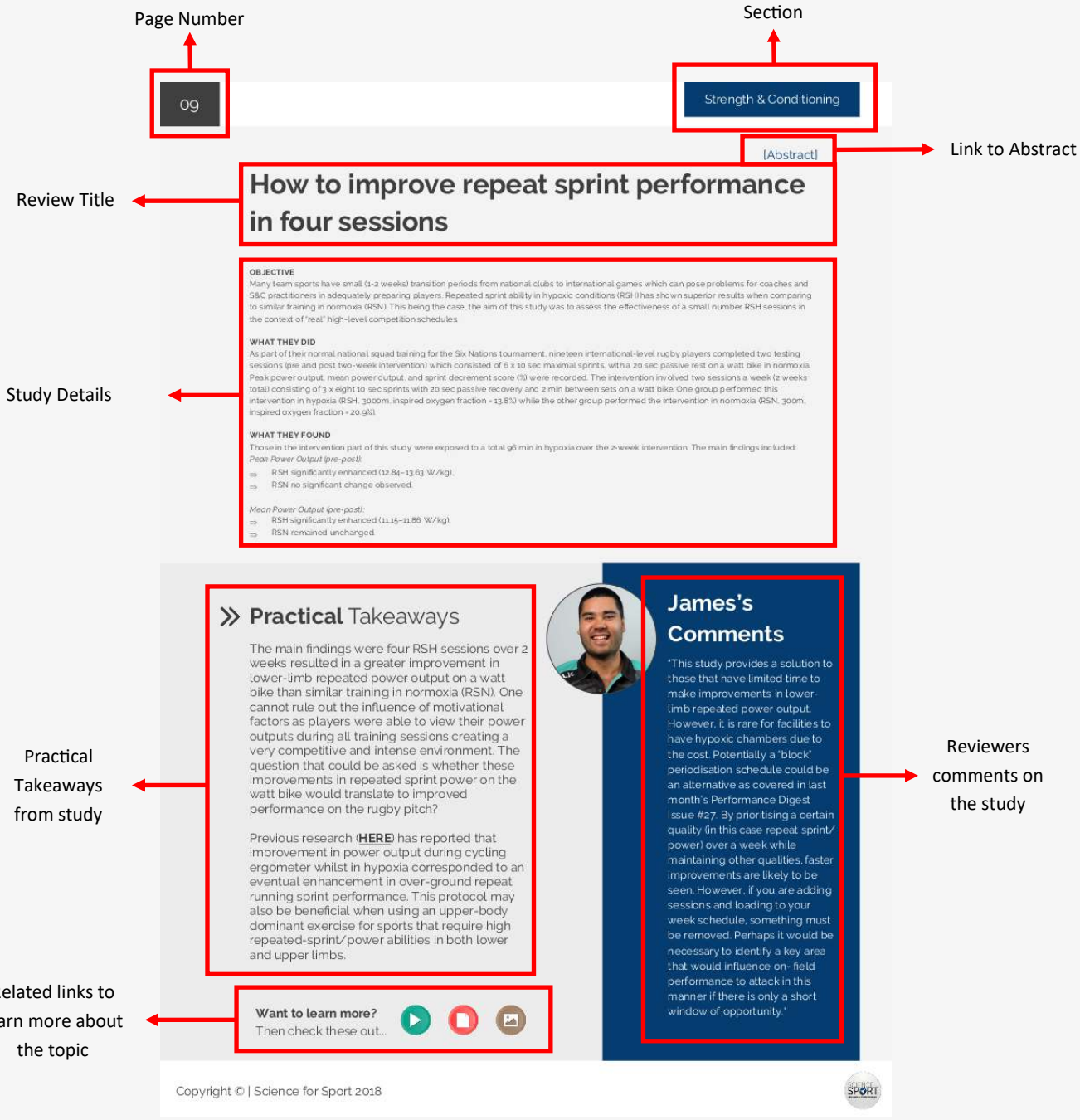

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Contents

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Audio
REVIEW

Fatigue, Recovery, and Training Load

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

with Dr Francisco Tavares

WHAT WE DICUSS

In this episode of the "Audio Review", Francisco discusses fatigue, recovery, and training load.

In this episode, you will learn:

- What recovery is and why it is important.
- How we couple recovery wit training load.
- Whether athletes need various recovery modalities.
- Whether or not recovery strategies need to be individualized.
- Future research regarding recovery.

Episode length = 29 min

A bit about **Francisco**

Francisco is the performance coordinator for Sporting Lisbon and has previously worked as a S & C coach in elite ruby with the Chiefs Super Rugby franchise and the PRO14 team, Glasgow Warriors. He holds a PhD from Waikato University and is a published author.

Listen Now

The Science of COACHING

Developing athletes' creativity

What can sport coaches learn from jazz music?

[Abstract]

INTRODUCTION

Traditional coaching approaches often limit opportunities for players to develop creativity. Given many sports involve constantly changing situations which often require creative solutions from players, there is a need to consider how a broader range of coaching practices may benefit the development of athlete creativity (**HERE**).

Recent research within the field of music has pointed to some useful strategies which may be helpful in developing innovation (**HERE**). This research has, for example, highlighted that musicians can develop creativity by being challenged to play a piece of music which follows on from a previous musician, borrowing from the previous notes played and then elaborating on them (working collaboratively). This study, aimed to test the effectiveness of collaborative creativity techniques borrowed from jazz music in developing the creativity of youth volleyball players within a sport coaching environment. Players took part in a collaborative, creativity-based intervention working with one coach who facilitated the intervention.

WHAT THEY FOUND

Seven female volleyball players were challenged by the coach to collaboratively develop creative outcomes by building on each other's performances within game-based activities, modified games, or game scenarios. Video clips of creative plays were also shown to the athletes, and they continued to take part in more technical-based drills to enhance the number of skills which it would be possible for players to creatively build from. Researchers kept a reflective log and conducted group interviews with the players to understand their experiences and assess the effectiveness of the intervention.

The researchers found that athletes had developed their creativity, mainly through:

⇒ Independently interacting with each other (e.g. discussing plans for new performances in response to the opposition, or evaluating plans which had been attempted).

⇒ Being encouraged by the coach to attempt different strategies, and then being afforded opportunities to try these within game-based environments

⇒ Reading the performances of others and increasing tactical knowledge.

WHAT THIS MEANS

Creativity is more likely to be developed where coaches create environments which allow players to feel comfortable in experimenting, making mistakes, and discussing or evaluating their creative plans. Indeed, creativity takes place within and is developed through interaction with others (e.g. teammates and in response to opposition performance/cues).

Appropriate opportunities, therefore, need to be provided for athletes to interact with teammates and to perform against opposition players for them to be more likely to develop creative performance which is relevant to, and effective within a game. For instance, when the ball is returned from a serve in volleyball, players must be able to independently read the position of their peers, game conditions, and cues to create the best possible creative outcome. Practice must, therefore, allow an opportunity for this full process to happen. Similar to jazz music, then, opportunities to build upon and innovate based upon the performance of others is crucial.

Practical Takeaways

Coaches wishing to develop creativity with their athletes should carefully consider how they make athletes feel relating to creativity. Here, encouraging athletes to play in a new and innovative way (and not criticising/punishing failed attempts to try something new) is an important starting point. Specifically, team sports coaches could look to enforce a rule where players cannot attack by applying the same skills or tactics used in the previous attack (e.g. ruling out attacking the opposition down the right wing).

Coaches could also look to give athletes opportunities to independently discuss and evaluate new tactics (e.g. letting athletes take the lead in speaking during a time-out). Importantly though, coaches should not forget about the value of drill-based activities to provide players with the 'foundation' skills to build upon. Securing basic skills of the sport often allows athletes greater opportunities to build from in order to develop creativity.

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.

DON'T JUST SPRINT IN A STRAIGHT LINE: WHY CURVED RUNNING IS IMPORTANT

Fitzpatrick et al. (2019) Sport Performance and Science Reports.

HOW TO INCLUDE BACKWARDS RUNNING INTO YOUR PROGRAM TO ENHANCE PERFORMANCE

Uthoff et al. (2019) Strength and Conditioning Journal.

SHOULD YOU FOAM ROLL BEFORE OR AFTER EXERCISE?

Wiewelhove et al. (2019) Frontiers in Physiology.

[Abstract]

Don't just sprint in a straight line: why curved running is important

OBJECTIVE

When training and testing sprint ability, the focus is typically on linear (straight-line) speed. However, due to the open nature of team-sports, sprinting is often completed in a curvilinear (non-straight line) manner. As such, the aim of this study was to assess the characteristics of sprinting such as sprint angle and evaluate any positional differences in sprint angle and number of sprints in elite youth soccer players.

WHAT THEY DID

Data was collected by Catapult GPS of thirteen elite youth male soccer players who compete in the U18 Premier League during six official matches. Raw data was plotted and given co-ordinates when running velocity exceeded 24 $km.h^{-1}$. This process involved:

- ⇒ Determining a line between the first and last point of the sprint (chord line).
- ⇒ A second line was plotted using the first three data points to calculate the initial trajectory.
- ⇒ Once both lines were plotted (like a V shape), the angle between them was then calculated to give the angle of the curvilinear sprint.
- ⇒ The average number of sprints, sprint angle, number of sprints between 0-5˚, 5-10˚, 10-15˚, and 15˚+ were calculated for different positions.

WHAT THEY FOUND

A number of key findings were reported within this study:

- ⇒ Substantial differences existed between the various positions for sprint angle with fullbacks performing smaller angled sprints compared to all other positions.
- ⇒ Those playing as a centre-forward performed larger angled sprints compared to all other positions. Centre -forwards performed a greater number of sprints between 10-15˚ and 15˚+ compared to all other positions.
- ⇒ Fullbacks, wide-midfielders, and centre-forwards performed more sprints compared to centre-backs and centre-midfielders.
- ⇒ There were no differences between sprint distances for all positions.

Practical Takeaways

Irrespective of the playing position, it appears that the average sprint angle (curve of the sprint from initial trajectory to end point) for soccer players during a match is around 5˚. One of the main differences with curvilinear running/sprinting compared to linear sprinting is that the body leans inwards (as opposed to remaining more upright). Thus, players are influenced by centrifugal force and consequently need to produce a medio-lateral ground-reaction force in order to counteract the centrifugal force and stay balanced whilst running. As running velocity increases, having the strength and technique to overcome these forces may be an important determinant in curvilinear sprint performance.

The vast majority of sprint training and testing in soccer is linear, therefore, testing curvilinear sprinting alongside traditional linear sprints may help inform practitioners about players who need to further develop this skill. While the average sprint angle is around 5˚, curvilinear sprints may be required to be performed up to a 30˚ angle. This has important implications for training, rehabilitation, or designing "worst-case scenario" drills. For example, an athlete returning from a hamstring injury may start to introduce small angle (5-10˚) accelerations alongside linear speed progressions. As the athlete progresses to maximal velocity, introducing a "worst-case scenario" sprint may involve a more aggressive 30˚ curved sprint to prepare them for match-play.

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

James' Comments

"While linear speed is of upmost importance, not just for performance but also for hamstring health, curvilinear sprinting cannot be forgotten. Perhaps testing could be performed similar to a "change of direction (COD) deficit" (see Performance Digest Issue #28 for more on this topic), where time or velocity can be measured for a 20 m linear sprint and 20 m curved sprint during 1-3 different angles. Ranking the athletes based on the deficit between the linear sprint and curved sprints, then splitting them by the median score may help identify which athletes need a greater emphasis on curvilinear sprinting.

Furthermore, the skill of curvilinear running/sprinting should be trained alongside linear sprint or agility training. This may involve curved running around cones, as well as large agility games . These larger spaces may allow for higher speed agility manoeuvres, which is likely to encourage a "swerve" or curved run to evade defenders."

[Abstract]

How to include backwards running into your program to enhance performance

OBJECTIVE

Backward running (BR) has been used to prepare athletes for competition demands and as a return-to-play protocol for injured athletes. BR is different to other forms of backward locomotion such as back pedalling as BR more closely emulates forward running (FR). Recent reviews of BR have shown enhancements in a range of athletic performance measure and, as such, this study aimed to examine the acute responses to BR and provide practical recommendations for integrating BR into a training program.

WHAT THEY DID

A review was performed of the current BR literature and covered several themes:

- ⇒ The acute responses to BR
- ⇒ BR as an injury resistance tool
- ⇒ Enhancing muscular functions using BR
- ⇒ BR as a metabolic stimulus
- ⇒ Practical recommendations for applying BR into a training program.

This article set to highlight the role of BR in a sporting context, providing insight into why BR may be beneficial for athletes.

WHAT THEY FOUND

Acute Responses
Compared to FR, BR is categorised by a:

- ⇒ Greater energy expenditure
- ⇒ Lower running speed
- ⇒ Reliance on isometric and concentric muscle actions

Injury Resistance

- ⇒ Warm-up programs including BR were beneficial for reducing the amount of overuse and severe injuries in athletes between 13-20 yr.

Muscular Functions

- ⇒ Muscle and tendon length remains relatively constant upon ground contact, making BR primarily a concentric contractile movement.
- ⇒ Adolescents, at around the time of their growth spurt, respond very well to BR,

Metabolic Stimulus

- ⇒ Expend approximately 28% more energy than FR
- ⇒ This leads to an improved running economy and oxygen consumption abilities.

» Practical Takeaways

As stated above, BR can be used in a myriad of situations from return-to-play, rehabilitation, or performance enhancement as a result of physiological or muscular adaptations. It is suggested that BR be used as a method to vary exercise selection and should be progressed in the order of:

1. Running speed
2. Absolute (distance over week) and relative (distance by session) volume
3. By adding external resistance.

A general guideline for BR volumes that have shown to lead to positive adaptations are 2-3 times a week for >6 weeks with approximately 16 runs over 15-30 m per session. In Issue #20 of the Performance Digest, I detailed some practical uses of BR for aerobic performance and return-to-play. BR for return-to-play is a perfect regression to FR, especially for players with a knee, ankle, or foot injury that are ready to perform faster locomotion. Less compressive forces at the knee and decreased range-of-motion at the ankle, whilst putting greater contractile demands on musculotendinous structures makes it an enticing exercise. A good starting point based on the recommendations would be 10-16 x 15 m runs with a walk back recovery at slow speed. From here, speed and volume can be increased until the athlete is comfortable BR 3 times per week for 30 m at a time. By this time, it is likely you'll be able to mix in some FR to the session.

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

James' Comments

"While it is suggested to increase running speed first, I prefer to increase the volume first, especially in a return-to-play scenario. The extensive nature of the run will only help to build the structural tissue in the lower limbs that will help protect the area as speed increases and progresses to FR.

Furthermore, BR can be used as a tool during multi-directional tempo running to develop aerobic qualities. Perhaps, BR can be used as a variation to FR to reduce overuse FR injuries. So, if FR conditioning is usually performed 2 days following game day, potentially every 3-4 weeks, this could be replaced with repeats of 30 m BR."

[Abstract]

Should you foam roll before or after exercise?

OBJECTIVE

Foam rolling can be considered a form of self-massage and has become popular in the athletic population and recreational individuals due to its ease of use, affordability, and being time-efficient. The potential effects of foam rolling have been attributed to mechanical, neurological, physiological, and psychophysiological parameters. It is believed that foam rolling can improve both acute performance as well as recovery. Accordingly, the aims of this meta-analysis were to review the effects of pre-rolling and post-rolling on performance, flexibility, and muscle pain.

WHAT THEY DID

A search of key literature using keywords such as "self-massage," "foam rolling," "roller massage," "roller massager," "self-myofascial release," "performance," and "recovery." was performed. The following criteria was used for inclusion in the analysis:

⇒ Peer-reviewed.

⇒ Intervention had to be used as either a warm -up or recovery routine.

⇒ Before and after measures of performance, flexibility, or muscle pain.

⇒ A control condition.

Of the 21 studies that met the criteria, 14 used pre-rolling as a warm-up routine, while 7 used post-rolling to enhance recovery. Further analysis categorised each study according to the type of device (foam roller or massage stick).

WHAT THEY FOUND

Pre-rolling

⇒ Small improvement in sprint performance (+0.7%) and flexibility (+4.0%).

⇒ Negligible change in jump and strength performance.

⇒ The use of a foam roller showed overall greater improvements in performance and flexibility than a massage stick (+2.7% vs. +0.4%, respectively).

Post-rolling

⇒ Slightly attenuated exercise induced decreases in sprint (+3.1%) and strength performance (+3.9%).

⇒ Reduced muscle pain perception (+6.0%) compared to no-foam rolling.

⇒ Trivial effect on jump performance.

» **Practical** Takeaways

When performing self-massage it appears to be more beneficial when foam rollers are used, as opposed to, massage sticks and rollers. There are potentially a couple of reasons for this:

⇒ A foam roller allows greater pressure to be applied to the tissue.

⇒ Foam rolling puts the individual into a position where they have to support their own bodyweight similar to various isometric and "core" exercises. This may have provided a warm-up or priming effect which carried over into the performance tasks.

The underlying mechanisms as to how foam rolling works remains elusive, however, the limited evidence which highlights the benefits of its use should be considered when integrating foam rolling as a warm-up strategy or recovery tool. Some general recommendations from this meta-analysis would be to use foam rolling during pre-training for acute improvements in flexibility without decreasing performance and its "warm-up" effect. It is also recommended post-training to reduce the perception of muscle pain and promote recovery. For example, a pre-training preparation may look like this:

⇒ Foam roll tight areas 10-30 rolls (quads, hamstrings, calves, glutes)

⇒ General dynamic movement prep

⇒ Specific drills

⇒ Performance task (e.g. sprinting, sport training)

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

James' **Comments**

"Currently there is no evidence for an optimal foam rolling intervention. Foam rolling might be better reserved for problem areas, where tightness needs to be addressed for a specific task or muscle pain relief.

Additionally, as the apparent effects on attenuating performance decreases from previous exercise due to foam rolling, it may serve as an easy, low-cost recovery intervention for athletes that have short match turn-arounds. With foam rollers being relatively cheap and portable tools, even amateur athletes can benefit from a foam rolling intervention."

Technology & Monitoring

This month's top research on technology and monitoring.

SMARTPHONE VIDEO TECHNOLOGY: A RELIABLE TOOL TO MEASURE JUMP PERFORMANCE?
Sharp, A. P. et al. (2019) Strength and Conditioning Journal.

THE VALIDITY OF MEASURING BODY COMPOSITION WITH FOOT-TO-FOOT BIOELECTRICAL IMPEDANCE
Nickerson, B. S. et al. (2019) The Journal of Strength and Conditioning Research.

HOW PLACEMENT AND RUNNING SURFACE AFFECT THE RELIABILITY OF ACCELEROMETERS
Gomez-Carmona, C. D. et al. (2019) Journal of Strength and Conditioning Research.

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[Abstract]

Smartphone video technology: a reliable tool to measure jump performance?

OBJECTIVE

Video-based jump assessments can provide useful measures of athletic performance characteristics and readiness. The advent of smartphone cameras has brought about the development of applications that provide potentially useful metrics for an athlete in training. Although these apps are practical, the authors' goal was to review literature involving a smartphone video application – My Jump – against established devices such as a force platform and contact mat devices for validity and reliability in jump diagnostics.

WHAT THEY DID

Six studies (185 subjects) investigating the My Jump smartphone app were reviewed, which compared video jump analysis taken with a smartphone camera (iPhone 5s or iPhone 6s) against the criterion data obtained from force platforms or contact mats. Measures taken from all devices (i.e. jump height, flight time, reactive strength index (RSI), contact time, and mean power) were compared to determine the reproducibility and accuracy of the My Jump app testing procedure and degrees of error within-session, between-sessions, as well as between multiple practitioners using the app.

WHAT THEY FOUND

The main findings of the study were:

⇒ Strong support for the use of My Jump and newly updated My Jump 2 application for assessing jump performance.

⇒ High to very high validity in jump height, flight time, RSI, and contact time when using the My Jump application.

⇒ Excellent reliability and consistency within-session for My Jump as well as use between multiple practitioners.

⇒ Only moderate validity and reliability in mean power when using My Jump due to varied jump strategies or inaccurate calculation.

» **Practical** Takeaways

The My Jump app is a valid and reliable jump diagnostic tool for a S&C practitioner. There is strong evidence and support for using the My Jump app to gain performance measurements during various jump measures, providing reliable values in the form of jump height, flight time, RSI, and contact time.

Mean power appeared to be a questionable metric based on the fact that it is derived from a calculation rather then a direct measurement taken from a force plate. The reason the other values were more reliable is that the My Jump app uses the high-quality camera system that smartphones offer nowadays. Within the My Jump app, even RSI is considered valid and reliable as a jump metric since it is derived from the visual and time-based information from the built-in video camera, as opposed to a calculation as we see with mean power.

Practitioners should proceed with caution when measuring jump height or flight time from a drop jump, as the complexity of the jump increases and athletes unfamiliar with this may provide inconsistent results compared to more simplistic methods of the countermovement or squat jump.

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

Cody's **Comments**

"A force platform provides the most valid and reliable objective data (see podcast below), unfortunately, for most practitioners it is not a practical or cost-effective solution. A more cost-effective measure may be the My Jump app, as it has proven to be a viable option for measuring and tracking jump performance.

The My Jump app is extremely easy to use. The app provides valuable feedback to the practitioner and athlete relating to programme effectiveness, and an athlete's readiness to perform. This is vital information for practitioners as not only changes in jump performance drive motivation, but also within the strategy of the jump (e.g. RSI or contact time can be used as a marker of fatigue) (see article below). Further advancements of the My Jump 2 app may allow for the measurement of horizontally-oriented jumps, as well as force-velocity profiling and tests for asymmetry (see video below)."

[Abstract]

The validity of measuring body composition with foot-to-foot bioelectrical impedance

OBJECTIVE

Measuring body composition can provide impactful feedback to the training and nutrition intervention process. There are various methods available to provide predictions and context to an athlete's body mass relative to performance. Foot-to-foot bioelectrical impedance analysis (FF-BIA) is marketed as an affordable and practical method for assessing body composition in a time-constrained athletic environment. This study aimed to validate single-frequency FF-BIA against a criterion 3-compartment (3C) model within athletes.

WHAT THEY DID

The predicted body fat percentage (BF%) and fat-free mass (FFM) using the FF-BIA method of thirty-three NCAA Division I athletes, was compared with the 3C model using body volume (BV) via BodPod, total body water (TBW) via bioimpedance spectroscopy (BIS), and body mass. It has been found that the 3C model is the most simple and effective criterion method, offering identical validity to a more advanced 4C or 5C model. A true criterion 3C model needs to include the measurement of TBW as fluid content comprises the largest portion of FFM.

WHAT THEY FOUND

The main findings of the study were:

⇒ FF-BIA is a suitable alternative to a 3C model when estimating mean BF% and FFM in a group of NCAA Division I male athletes (i.e. football, baseball, basketball, cheerleading).

⇒ BF% is not valid for individual estimates when using FF-BIA, overestimating at lower values and underestimating at higher values.

⇒ FF-BIA is most effective when estimating group and individual FFM.

⇒ This is the first known study to report a significant trend between FF-BIA FFM and a 3C model.

Practical Takeaways

The goal of many training and dietary interventions focuses on increasing muscle-mass and reducing non-functional fat-mass based on a specific prescription and protocol for an athlete to follow. This is because changes in body composition can have implications on an athlete's speed, power, and strength development. Measuring and monitoring changes in body composition correlate with enhancements in athlete performance, providing objective feedback regarding an intervention's efficacy.

A caveat with any measurement is the practicality in a team setting, and FF-BIA offers a quick and effective method of assessing body composition in a group of athletes, in comparison to a more advanced and time-intensive multicompartment model.

Furthermore, the technology of BIA devices, as well as the algorithms associated with a specific athletic population, have evolved and now provide reliable feedback for the athlete and practitioner when evaluating a group or producing individual estimates of FFM. However, based on the current results, estimates for individual BF% from FF-BIA may not always be reliable.

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

Cody's Comments

"Comparing the procedures of each assessment, FF-BIA is by far the easiest and fastest method when predicting an athlete's body composition. Other tests, such as the BodPod or skinfolds can include time-consuming procedures. Across a team, this time quickly adds up and accurate results may get lost amongst the rush and impede on an already demanding schedule.

In the end, body composition is still just an estimate and not a precise measure. Sometimes close enough, rather than being completely accurate, can still offer an effective option for practitioners, given the reliable results of this study compared to the 3C model. Based on procedures within this study, much of the reliability stems from a standardised procedure respecting consistent timing, as well as activity and hydration level prior to testing. FF-BIA is only one option when assessing body composition, but one that provides useable values considering the cost and time invested."

[Abstract]

How placement and running surface affect the reliability of accelerometers

OBJECTIVE

External player load (PL) can be quantified with the advent of inertial motor units (IMUs) worn during activity. Providing a measure of mechanical stress using triaxial accelerometers, the goal of this study was to:

1. Assess the reliability of external (PL) measures using accelerometers (WIMU PRO) on multiple surfaces.
2. Examine the effect of anatomical placement of accelerometer and running surface on PL data at various speeds between- and within-subject comparison.
3. Determine the relationship between external PL measures with internal measures of heart rate (HRavg) and muscular oxygen saturation (SmO2).

WHAT THEY DID

Twenty men completed progressive, incremental running tests either on a treadmill or a track every week for 4 weeks. Each subject wore 4 inertial devices (WIMU PRO) at different anatomical locations (scapulae, centre of mass (COM-L3 vertebra), knee, and ankle), as well as a heart rate (HR) monitor and a near-infrared spectroscopy (NIRS) device on their calf.

The reliability of PL was compared at every site where a load monitoring device was placed on the different running surfaces (between- and within -subject), as well as the relationship between external PL measures with internal measures for HRavg and SmO2.

WHAT THEY FOUND

The main findings of the study were:

⇒ PL had a strong correlation with HRavg and moderate correlation with SmO2.

⇒ Based on athlete variability comparisons, within-subject results are most reliable and only comparing PL independently between subjects is suggested (disregarding internal data).

⇒ The PL as measured from the ankle when running on the track surface produced significantly higher values than when running on the treadmill.

» **Practical** Takeaways

The implementation of triaxial accelerometers in linear running provides a quantification of external load, serving as a potential tool for monitoring training and mitigating injury. Athletes that are required to perform a high-volume of linear running are likely to complete numerous ground contacts during the weeks and months of training which can lead to overuse injuries.

This study highlights that measurements taken from the ankle provide the most sensitive and reliable measurements based on forces endured, running surface, gait, and lower body workload, due to the proximity of the ground. The further away the inertial device is from the ground, the more variability possible, and the measurement is more likely a poor reflection of the stress endured.

To provide reliable load analysis and limit between-subject and unit variability, practitioners should respect that each athlete has an individualised gait and a measure of load is only applicable to that individual, suggesting athletes should wear the same device each session to ensure that PL values are specific to each athlete from a specific unit.

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

Cody's **Comments**

"Gait, speed, and workload are not created equal. For example, a kilometre ran at 15km.h^{-1} is an individual measure and advances in technology have allowed practitioners to better quantify loads endured by the body during training. Limiting the variables that may impact the individuality of the results only improves their accuracy and applicability.

All things being equal, the relationship between PL values on various surfaces is relatable in that the comparison does offer the opportunity to rank surfaces based on intensity. Confidently progressing loads in rehabilitation based on the surface used. Furthermore, there is potential in comparing PL values between individuals and potentially identifying inefficient running mechanics if a large discrepancy exists."

Fatigue & Recovery

This month's top research on fatigue and recovery.

WEARING COMPRESSION SOCKS DURING EXERCISE MAY ENHANCE PERFORMANCE
Brophy-Williams, N. et al. (2019) Journal of Science and Medicine in Sport.

TRAVELLING MAY AFFECT THE SLEEP OF PROFESSIONAL SOCCER PLAYERS
Lastella, M. et al. (2019) Sleep Health.

FOAM ROLLING INCREASES PASSIVE RANGE OF MOTION BUT DECREASES MUSCLE STRENGTH
Monteiro, E. R. et al. (2019) The Journal of Strength and Conditioning Research.

[Abstract]

Wearing compression socks during exercise may enhance performance

OBJECTIVE

Compression garments (CG) are widely utilised during and/or after exercise in order to aid recovery and subsequent performance. The majority of research has investigated the effects of CG during performance, either immediately after or in the days which follow afterwards. This study investigated the effects of wearing CG after endurance running performance.

WHAT THEY DID

This study had a crossover design where twelve well-trained male runners performed two 5 km time trials (TT) with 1 h in-between the TT. Athletes wore a CG sock either between the warm-up period and a 5 km time-trial (TT1 andTT2), or they did not wear the CG sock at all. Before each TT, the runners performed a 3x4 min warmup.

The measures obtained included:

⇒ VO2 during the warm-up

⇒ Blood lactate ([BLa¯]) after each warm-up stage and after TT1-TT2

⇒ Cross-sectional area (CSA) of the calf before the first warm-up and after TT1

⇒ Subjective measures of muscle soreness, fatigue (before and after each warm-up and TT), and recovery at the start and end of recovery.

WHAT THEY FOUND

The main finding of this study was that wearing a CG sock did not improve immediate performance. However, the athletes that wore CG during TT1 did improve their performance during TT2.The other objective and subjective markers obtained following each protocol (i.e. [BLa¯], VO2, CSA, muscle soreness, fatigue, and recovery) remained unchanged.

» **Practical** Takeaways

The practical takeaways of this study are that:

⇒ Using CG will not lead to immediate performance improvements.

⇒ When an athlete is required to perform in a short-term (e.g. ~1 h), CG should be considered as they were demonstrated to improve performance (TT).

⇒ Given that no harmful effects of CG socks have been reported, practitioners may consider recommending them to their athletes, particularly those who consider them to already be beneficial to their performance (i.e. placebo effect).

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

Francisco's Comments

"This is an interesting study which has investigated the mechanisms behind changes in performance from using CG. I really enjoyed that the garments were selected according to the athlete's calf girth and foot size, therefore, ensuring the (measured) pressure imposed by the CG was adequate. I was also pleased to see that the authors used the single recovery question (see issue #25 of the Performance Digest).

It was surprising that no subjective changes in perceived soreness were observed, as this is one of the most well-accepted benefits of wearing CG. This study failed to determine the mechanism responsible for the observed enhanced recovery. A series of mechanisms were speculated, but the authors underline the possibility of the placebo effect possibly being the cause for this improved performance.

Practitioners must be aware that although the TTs were performed at a high-intensity, the volume (2x 5 km) was low, probably leading to minor muscle damage. If the same study was performed in a team-sport with a large amount of accelerations and decelerations, the effects of CG may be more notable and possibly highlight the mechanisms involved. As I frequently mention, if CG do not affect performance or sleep, they can be implemented during and after exercise, including during sleep."

[Abstract]

Travelling may affect the sleep of professional soccer players

OBJECTIVE

Travelling is known to bring additional stress to athletes, particularly those with busy playing schedules, which can lead to fatigue. Furthermore, the characteristics of a flight (i.e. flight time, duration, and crossing different time zones) may contribute to further additional stress and sleep disturbance. The aim of this study was to examine the fatigue levels and sleep of soccer players during an intensive home and away travel schedule.

WHAT THEY DID

Sleep and fatigue data from seven male soccer players were collected during 19 consecutive days. The players flights were: Australia – Singapore – Japan (day 10 and 11); Japan – Singapore – Australia (day 15).

Sleeping measures were obtained from sleep diaries and wrist activity monitors and the measures gathered included: Bedtime, get-up time, sleep latency, time in bed, total sleep, sleep efficiency, moving minutes, subjective sleep quality, daytime nap duration, pre- and post-sleep fatigue level.

Comparisons were made between the following sleep periods: preceding a training day, preceding a rest day, preceding a night match, and following a night match.

WHAT THEY FOUND

The major findings of this study were:

⇒ Bedtime was later, and time in bed and total sleep times were shorter the night immediately following a night match compared to the other conditions.

⇒ In the morning immediately following games, get-up times were earliest compared to rest days and the morning before games.

⇒ Pre- and post-sleep fatigue were greatest immediately following night matches compared to training days and nights before games.

⇒ Bedtimes were significantly later during flights compared to bedtimes when players were in Adelaide or Hiroshima, resulting in a decreased sleep duration.

» **Practical** Takeaways

In athletes, monitoring sleep seems to be essential as demonstrated by the changes in sleep observed from night matches and flights. When compared to a normal training day:

⇒ Night matches affect the sleep patterns of players the most (i.e. the athletes in the study initiated sleep later (+2.2 h).

⇒ Players spent less time in bed (−2.9 h)

⇒ Players obtained less sleep (−2.5 h)

This reinforces the need for practitioners to develop good sleeping hygiene routines with their athletes when competing in the evening. When possible, adjusting the training schedule can also be an option.

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

Francisco's Comments

"Sleep deprivation is known to not only limit performance, but also increase the likelihood of injury. Individuals not only have unique sleeping characteristics, but the responses to different stimulus (e.g. training, environmental) also differ between athletes. For this reason, monitoring the sleep of your athletes is recommended. This can be as simple as asking your athletes, how long did you sleep for?

When using subjective data, it is important to individualise the data (refer to Performance Digest #24). However, in the case of sleep duration, looking at the absolute data (i.e. did the athlete sleep >7 h?) is also important.

I would recommend practitioners provide sleep education to the entire team. When this is not possible, from the individual analysis of sleep data (objective or subjective), practitioners can detect red flags and implement individual sleep hygiene routines. There are many examples of good sleep hygiene but, in general there are two areas that should be included:

⇒ Room environment (e.g. darkness and noise).

⇒ Athlete routine (e.g. shower time and temperature, drink and food, TV and gadgets)."

[Abstract]

Foam rolling increases passive range of motion but decreases muscle strength

OBJECTIVE

Foam rolling (FR) is widely implemented by athletes to improve range of motion (ROM) and speed-up recovery. Evidence demonstrating the effects of FR increasing passive ROM and decreasing acute fatigue are scarce. This study aimed to analyse the acute effects of two hamstring FR volumes on knee extensors fatigue, and to analyse the effect of hamstring FR on shoulder ROM.

WHAT THEY DID

Twelve women were exposed to two experiments:

⇒ To measure the effect of two hamstring FR protocols on knee extensor fatigue, and

⇒ The effect of hamstrings FR on shoulder flexion and extension ROM.

For the first experiment, the subjects performed 3 conditions on 3 different occasions, which included:

⇒ FR for 60 sec (FR60), 120 sec (FR120), or no foam rolling (control (CON)).

⇒ The subjects performed 3 sets of knee extensions (based on 10 RM load) to failure of followed by one of the conditions (FR60, FR120, or CON) during the 5 min rest period between sets.

For the second experiment athletes performed FR60 and shoulder flexion and extension ROM was measured before and at 0 min, 10 min, 20 min, 30 min, 24 h and 48 h after the protocol.

WHAT THEY FOUND

For the first experiment, fatigue index (calculated by the difference in reps performed on the 1st and 3rd sets) were higher in both FR60 and FR120 in comparison to CON, however, there were no differences in the fatigue index between the two FR conditions.

For the second experiment, it was observed that FR applied to the hamstrings influences both shoulder flexion and extension ROM.

Practical Takeaways

The main takeaways of this study are:

⇒ FR may have an acute effect on fatigue and ROM due to centrally mediated mechanisms.

⇒ FR for 60 sec or longer may influence the antagonist muscle force production (i.e. decrease resistance to fatigue).

⇒ FR for 60 sec may influence the ROM of joints that are not crossed by the muscles that were exposed to FR (i.e. FR on the lower limb affect the ROM of upper limb). Increasing ROM of joints without FR the muscles of that joint can help practitioners during rehabilitation processes.

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

Francisco's Comments

"In the current sporting envrionment it is rare for an athlete to not use FR as part of their training preparation or recovery routine. Research has demonstrated that FR performed before exercise increases ROM. It has also shown that it helps with recovery from muscle soreness and attenuate the reductions in muscle performance after exercise.

This study demonstrates that performing FR in an agonist muscle can lead to a decrease in performance in the antagonist muscle. It may be possible that FR performed in a non-athletic population leads to a tissue trauma, therefore impacting on performance. This being the case, the results from this study wouldn't stop me from using FR in well-trained or recreationally-trained subjects.

I have previously used FR and other types of self-myofascial massage with my athletes before training sessions. For time efficiency, I have targeted the muscle groups that would be more involved in that session. Interestingly, this study demonstrates that FR one muscle group will increase ROM on other joints. I think it would be very helpful to understand if the changes in ROM would be greater in the joints crossed by the muscles where FR was used, in comparison to other joints (e.g. FR the hamstrings and quadriceps and measure changes on hip flexion and shoulder flexion ROM)."

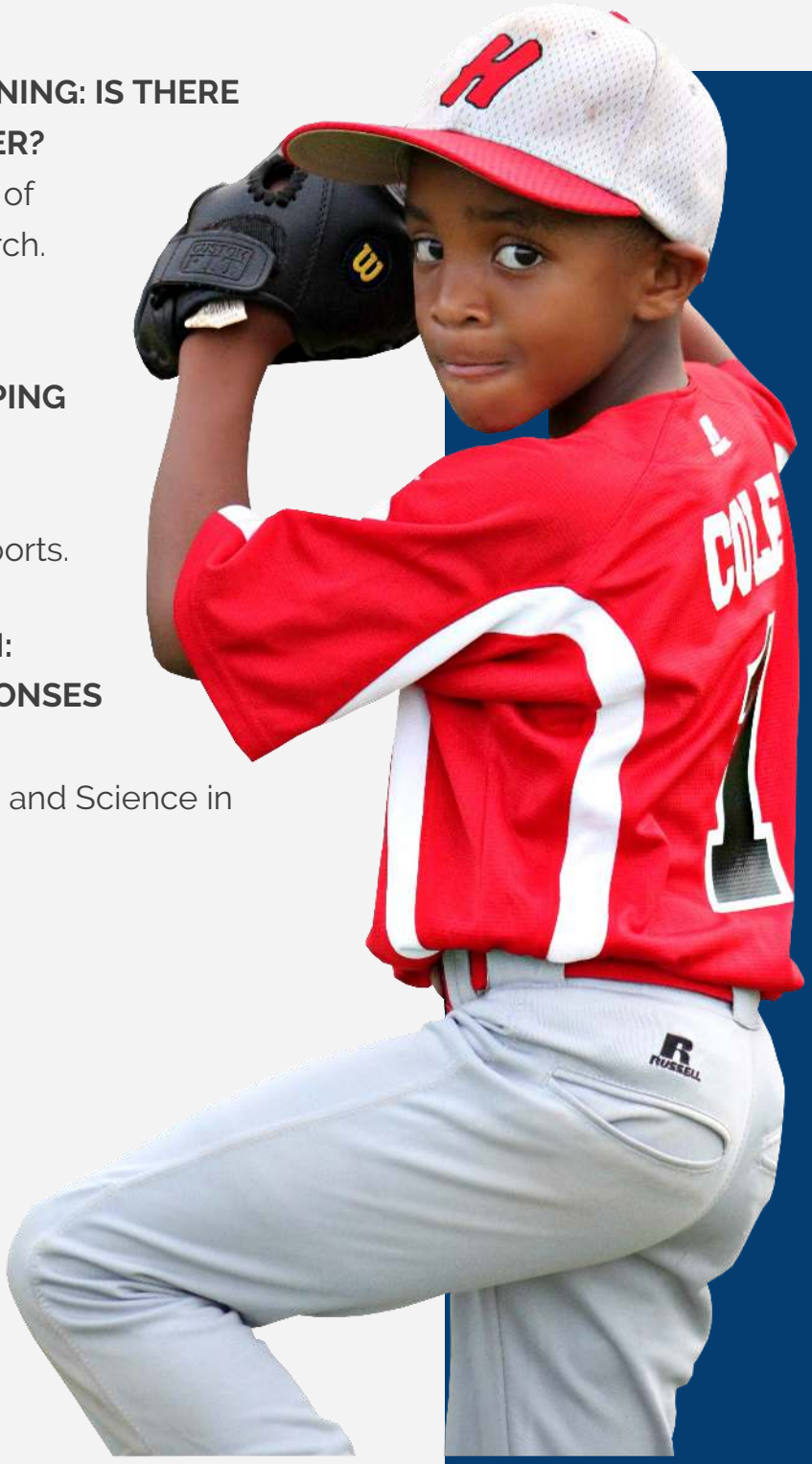
Youth Development

This month's top research on youth development.

BACKWARD VS. FORWARD RUNNING: IS THERE A BENEFIT TO SPEED AND POWER?
Uthoff, A. et al. (2019) The Journal of Strength and Conditioning Research.

HIP THRUST VS. BACK SQUAT: WHICH IS BETTER FOR DEVELOPING THE PERFORMANCE OF SOCCER PLAYERS?
González-García, J. et al. (2019) Sports.

MUSCLE-TENDON UNIT LENGTH: WHAT ARE THE TRAINING RESPONSES IN CHILDREN AND ADULTS?
Piponnier, E. et al. (2019) Medicine and Science in Sports and Exercise.



[Abstract]

Backward vs. forward running: is there a benefit to speed and power?

OBJECTIVE

Sprint performance has been identified as a key performance characteristic amongst youth athletes. In many sports (e.g. soccer, rugby, American football, and most racquet sports), sprint performances must be produced in a multi-directional manner due to the varied phases of play that can occur. The primary aim of this study was to explore the adaptations which accompany both forward running training (FRT) and backward running training (BRT) within adolescent male athletes.

WHAT THEY DID

The participants (age: 13-15 yr) were placed into either a BRT group (n=26), FRT group (n=17), or control group (CON) (n=24). Countermovement jump (CMJ) performance, vertical leg stiffness, and 10, 10-20, and 20 m sprint times were recorded for all participants.

After eight weeks of a supervised BRT or FRT programme performed at slow (20-45%), moderate (50-75%), or maximal efforts (>95%), CMJ performance, sprint times and vertical stiffness were measured a second time. Those within the CON group performed regular physical education activities during this eight-week period.

WHAT THEY FOUND

A major finding in this study was that both the FRT and BRT groups improved their sprinting performance when compared to the CON group, with moderate to large training effects.

Further analysis of the results found that both interventions also generated greater vertical leg stiffness in comparison to the CON group. Interestingly, BRT seemed to provide the greatest performance benefit for CMJ height (9.88 cm mean change) compared to FRT (2.82 cm). This was further supported in the acceleration data, where 10-20 m times were greater in the BRT group compared to the FRT group, although both training programmes led to sprint improvement.

» **Practical** Takeaways

The practical takeaways from this study are as follows:

1. Backwards running is indeed an effective method of developing forward sprint speed over short distance.
2. Backwards running could be incorporated into the "potentiate" phase of a warm-up as an increased intensity activity.
3. Backwards running allows athletes to transition into varied base positions or forward running and should not just be performed in its single form.
4. A variety of cues exist when coaching athletes to support learning. These include:
    - ⇒ Slight lean of the chest forward.
    - ⇒ Push explosively through the ball of the foot on the ground.
    - ⇒ Use similar arm action to forward running (i.e. contralateral arm/leg action).
    - ⇒ High heel recovery of the swing leg.
    - ⇒ Extend the swing leg behind by kicking and reaching rapidly.

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

Tom's **Comments**

"This study has supported the notion that BR may be classified as a forward sprint-specific training method, since running backwards appears to improve FR times. It is thought that the neurological adaptations that occur in response to backwards running are similar to those in forward running, with this locomotive skill sharing a similar neural pathway. This highlights a very interesting finding, which over time should be investigated for both performance and rehabilitation purposes. For example, the alterations in step frequency which are representative in early acceleration sprinting were higher in backwards running. Although these were more voluminous, they may have been less forceful and, therefore, beneficial to those in a return-to-play phase (see article below).

Finally, when programming for BRT, it is important that the same technical attention we pay to FRT is afforded. Running backwards at high-speed is similar to deceleration, placing large forces on the hamstring muscle complex. As such, it is recommended that these skills are developed over time at slower speeds, using the cues mentioned above to support performance."

[Abstract]

Hip thrust vs. back squat: which is better for developing the performance of soccer players?

OBJECTIVE

Prior to scoring a goal during a typical soccer match, linear or straight-line sprinting is the most common action that occurs. Developing sprint speed is, therefore, of high importance and should be included in a training programme. To achieve this, there are multiple training methods and exercises that can be used, two of the most common being the back squat [BS] and hip thrust [HT]. The aim of this study was to compare which is the most effective training method for the purposes of improving the physical performance of adolescent female soccer players.

WHAT THEY DID

Baseline assessments of countermovement jump (CMJ) performance, vertical jump (VJ), 10 m and 20 m sprint speed, T-Test (change of direction) and 1 RM estimations of twenty-four adolescent female soccer players were collected. In addition to this, concentric velocity measures were collected for two different loads (60 & 80% RM) during the HT and BS exercises. Performance variables were collected after a 7-week training period and were compared using effect sizes (Cohens d).

WHAT THEY FOUND

The main findings of this study were:

⇒ HT group showed greater improvements in 10 the 20 m sprint performance, as well as the T-test.

⇒ In response to this intervention, the HT training allowed those involved to produce greater bar velocities at both 60 and 80% 1 RM.

⇒ In contrast, the BS group showed higher barbell velocities at only 80% 1 RM with medium to large improvements in CMJ height and mean concentric velocity overall.

⇒ It was unclear if either exercise produced greater improvements in VJ performance.

» **Practical** Takeaways

The practical takeaways from this study are:

⇒ Progressive strength training from 60-90% of 1 RM can develop both strength and power qualities in young, adolescent female soccer players.

⇒ Acceleration over 10-20 m increases with 7 weeks of HT training compared to BS training.

⇒ Agility, as measured by a T-test, improved to a greater degree following HT training in young adolescent footballers than during BS training.

⇒ Horizontal force production is greatest following HT movements (as supported by Bret Contreras, see article below).

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

Tom's **Comments**

"The results of this study are hardly surprising, with young soccer players showing some remarkable adaptations following a relatively short period of training time. These heightened adaptations could be explained by elevated periods of neuroplasticity, where young athletes experience an ability to learn either consciously or associatively to a greater degree compared to adults. When viewing this video, it is important to think about how our communication skills and how we programme sessions should be linked to performance to ensure that children can understand this.

Initially, the results seem heavily supportive of programming horizontal HT. Whilst this may not be wrong, it is important to acknowledge that a majority of the movements we perform daily such as sitting down, standing up, and walking require high levels of hip, knee, and ankle extension which are better mimicked by the squat. Therefore, the ability of the squat to create high levels of adaptation when compared to the hip thrust may be less, as loaded hip extension isn't as common in daily life and would most likely yield greater results. Finally, velocity-based training at high loads is cautioned, especially in those with a young training age due to the high risk of injury or neuromuscular overload over time."

[Abstract]

Muscle-tendon unit length: what are the training responses in children and adults?

OBJECTIVE

Sports performance accumulates large amounts of fatigue, which over time can impact the torque which a muscle can create and, therefore, alter the muscles ability to produce and absorb force. It is thought that the time to reach muscular fatigue is different between children and adults. The aim of this study was to compare the child-adult differences in the development of neuromuscular fatigue at different knee extension (KE) muscle-tendon unit (MTU) lengths (short, optimal, and long).

WHAT THEY DID

Twenty-two pre-pubertal boys (9-11 yr) and 22 men (18-30 yr) with various sporting backgrounds were placed on a Biodex system 3 to measure muscle torque, velocity, and force throughout various knee angles (30˚, 50˚, 70˚, 75˚, 80˚, 85˚, 90˚, 100˚; 0˚ = full extension). All participants performed three KE fatigue protocols at short, optimal, and long MTU lengths which were standardised for each participant. Repetitions were held for 5 s, with 5 s passive recovery until torque reached 60% of initial maximal voluntary isometric contraction (MVIC) torque. An example of this procedure can be seen in the attached video below.

WHAT THEY FOUND

Performance fatigability, defined as the time required to reach a given level of exhaustion, was different between men and children. Boys completed more repetitions to reach 60% of their initial MVIC at optimal, and long MTU lengths. However, no difference was found at short lengths.

Peripheral fatigue was found to decrease in all MTU length trials for men, where the twitch force (electrical potential sent to a muscle cell) decreased. However, in boys, this only decreased at long MTU lengths. Finally, boys displayed a greater decrease in voluntary action (a measure of central fatigue) when the fatigue protocol was performed at optimal length.

» **Practical** Takeaways

The practical takeaways from this study are as follows:

⇒ Boys take a longer time to fatigue than adult males, which is thought to occur as a result of less muscle tissue and specific neural regulations.

⇒ Differences in muscle torque values between boys and males could be explained by differences in bone levers and the ability to produce high-levels of force.

⇒ Monitoring MVIC could prove a valid and reliable indicator of neural adaptation, as MVIC is a standardised, objective, and sensitive tool for the measurement of muscle strength and changes in strength.

⇒ Children may be better prepared for advanced loading schemes, such as heavy isometric or eccentric exercises with less muscle soreness.

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

Tom's **Comments**

"This study was both interesting and frustrating to read. In my opinion, the author's fail to communicate the science in a manner which is both understandable and relatable to the practical coach. As an example of this, **THIS** study is similar in nature, but compares muscle tendon unit changes between children and adults in a more applied manner. Similarly, the attached podcast (see below) acts as a great way to fill in any gaps in your knowledge left as a result of the current study, where more complex terms are made easy to understand and applicable.

From this study, the child-adult differences are interesting to review, with an improved work capacity, but not necessarily force-producing potential, highlighting an opportunity for youth to train differently. In children, this may mean that programmes can be more voluminous compared to adults, where lower sets/reps are often associated with intensity developed through heavy strength training. However, correct form should always be maintained. In adults, heavy strength training produces high neuromuscular load, which over time can lead to burnout, overtraining, or injury. The differences seen in children may be due to the increased reliance on the aerobic system in youth compared to adults when training, but could further suggests that youth are more than capable of eccentric/isometric training modalities. In the long-term, it would be great to see studies that monitor these adaptations to training (pre-puberty) to understand if this is beneficial to their sports performance."

Nutrition

This month's top research on nutrition.

SUPERCOMPENSATE CARBOHYDRATE INTAKE BEFORE EXERCISE FOR 20-30% INCREASE IN WORK CAPACITY
Doering, T.M. et al. (2019) Journal Journal of Science and Medicine in Sport.

NICOTINE ADMINISTRATION VIA GUM OR TRANSDERMAL PATCH: DOES IT HARM THE ATHLETE?
Mündel, T. et al. (2019) Frontiers in Physiology.

DO CAFFEINE AND CARBOHYDRATES WORK HAND-IN-HAND TO IMPROVE PERFORMANCE?
Germaine, M. et al. (2019) Sports.

[Abstract]

Supercompensate carbohydrate intake before exercise for 20-30% increase in work capacity

OBJECTIVE

One of the main issues with exercise performance that involve limited recovery in between performances is residual fatigue. This is especially true during periods of within a season that are congested with competitive matches and training.

The authors of this study had a clear aim. Does loading carbohydrate for 4 days, in-between exercise trials, result in a supercompensation of muscle glycogen concentration and, therefore, transpire into improvements in work capacity.

WHAT THEY DID

Seven trained cyclists completed a 9-day experimental period which included three intermittent, exhaustive cycling trials on day 1, day 5 and day 9.

Following trial 1, cyclists were fed a high carbohydrate diet (10 $g.kg^{-1}.day^{-1}$) for eight days to assess their capacity to repeatedly supercompensate muscle glycogen with 4 days of recovery in-between trials.

All meals and snacks were provided to participants and all foods were weighed prior to packaging for estimation of consumed carbohydrate.

WHAT THEY FOUND

The main findings of the study included:

⇒ Repeated muscle glycogen supercompensation was achieved with a consecutive 4-days carbohydrate feeding strategy.

⇒ 72 h interstitial glucose level was lower through the second carbohydrate loading period compared to the first carbohydrate load, despite the matched dietary intake.

⇒ Glycogen supercompensation was successfully accompanied by a ~25-30% increase in exercise work capacity on each experimental trial.

» Practical Takeaways

These findings suggest that it is possible to repeatedly supercompensate muscle glycogen with high carbohydrate feedings for 4 days between exhaustive exercise trials in trained athletes. Furthermore, this strategy may maintain high-intensity capacity during "back-to-back" exercise performances. As such, this suggests that during busy competition schedules, where limited recovery time exists between the matches and other events (e.g. in a tournament setting, practitioners and athletes should carefully consider the dietary and recovery strategies to best maintain exercise capacity.

Specifically, practising repeated carbohydrate loading for 4 days may provide improvements to a fatigued athlete. Whether severe glycogen depletion is a requirement for repeated muscle glycogen supercompensation to occur, and whether an impairment of repeated muscle glycogen supercompensation may be caused by such exercise protocol with limited recovery (<48 h) remain important questions to be answered (see related video and article links below). Furthermore, there are many different ways to achieve high glycogen stores, and the type of carbohydrate is as important as the total amount of carbohydrates. Practically, consuming high-glycaemic index carbohydrates may be favoured over low-glycaemic index carbohydrates to maximise muscle glycogen saturation. Athletes often experience stomach problems, thus, carbohydrate sources should be selected carefully, and they could benefit from a lower fibre intake (see infographic below).

It should be considered that participants in this study were well-trained athletes. As such it is unclear whether a repeated 4-day carbohydrate loading (compared to a 2-day carbohydrate loading) is necessary for recreational or untrained athletes.

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

James' Comments

"This data provides support for the practical tool of utilising carbohydrate loading to elevate muscle glycogen concentrations for enhancing performance capacity in competitions. The study has replicated a real-life scenario for a typical athlete during competition seasons. Furthermore, this data provides new information showing that repeated glycogen supercompensation is sufficient in augmenting the capacity for glycogen storage within a 4-day time-frame, which has an important impact on the dietary strategies used during competition schedules which have limited recovery time between events.

It is worth noting that the study did not measure post-exercise muscle biopsies following trials 1 and 2, however, the results of a previous study using a similar protocol (see related article below), there was a clear significant reduction in muscle glycogen concentrations (~ 100 mmol.kg-1 dry mass) after exercise when compared a pre-exercise state."

[Abstract]

Nicotine administration via gum or transdermal patch: does it harm the athlete?

OBJECTIVE

Currently, the use of substances containing nicotine is not banned by the World Anti-Doping Agency (WADA). However, the use of such substances is high and on the increase amongst elite and professional athletes with reports of 25-35% prevalence of smokeless tobacco use (see article below).

Previous research investigating the performance effects of nicotine has not used highly valid or reliable protocols nor trained athletes. Therefore, this study had two clear aims: Firstly, 1) determine if nicotine provided ergogenic, and 2) determine if the nicotine delivery system had any differential effect on exercise performance.

WHAT THEY DID

Ten well-trained male cyclists competing at club or national level took part in this study. They completed baseline tests and familiarisation followed by three TT's after a ~30 min administration of either 2 mg nicotine gum, ~10-h administration of 7 mg. 24 h^{-1} nicotine patch or a placebo patch.

Participants completed an individualised set amount of work (~996 ± 132 kJ) as quickly as possible. The study measured each athlete's physiological (core body temperature, heart rate, blood chemistry, and metabolites) and perceptual responses (rating of perceived exertion), as well as performance time and power output.

WHAT THEY FOUND

The study found:

⇒ Nicotine administration, regardless of the delivery method did not exert any beneficial or detrimental effects on 1 h cycling TT performance.

⇒ The systemic delivery of nicotine was greatest when using a transdermal patch than a nicotine gum.

⇒ Heart rate, core temperature, and perceived exertion was not dependent on treatment of Nicotine administration. All variables increased as expected in terms of heart rate, core temperature increased during exercise, but this was not dependent on the intervention of nicotine.

» **Practical** Takeaways

In accordance with a previous study (see article below), athletes believe that the consumption of nicotine provides ergogenic effects to performance by preventing dry mouth, weight control, improving reaction time and concentration, and helps with relaxation. However, the current study showed that nicotine does not alter any physiological or perceptual responses during a self-paced cycling TT. This supports the majority of previous studies that suggest that nicotine is unlikely to affect performance. Thus, there is no detrimental nor beneficial impact on performance. Furthermore, it is important to highlight that the current study used a study protocol which is not only applicable to competitive cycling but all endurance sport/athletes.

Although this article suggests nicotine use has no real benefit, others have found potential physical and mental performance (see article below). What I think most practitioners would agree on, however, is a substance that has the potential to be highly addicted may be morally and ethically wrong to be recommend to any athlete (see related podcast by Dr. Nick Gant). Considering that the WADA has placed nicotine onto its monitoring program in 2012, and the current evidence for efficacy, safety, and health of the athletes is unclear, other supplements are more advisable for performance enhancement amongst endurance performance (see infographic below).

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

James' **Comments**

"There are many different nicotine delivery methods commonly available including nasal spray, gum, inhaler, lozenge, sublingual tablet, and transdermal patch. It is possible that many athletes use these products to prevent actual tobacco smoking, and possibly not for a performance enhancement.

The authors proposed, that in order to better understand the results on nicotine administration during exercise, a rigorous experimental design, for example a double-blind placebo-control protocol with manipulation check, is necessary. There should be an increased focus on whether nicotine can enhance performance and represents any health threat to athletes in order to inform WADA if nicotine should remain a monitored substance or added to the prohibited substances list."

[Abstract]

Do caffeine and carbohydrates work hand-in-hand to improve performance?

OBJECTIVE

The use of caffeine for performance improvements is well researched in the sporting world. Not all athletes want to or enjoy consuming caffeine before or during performance due to taste and gut issues, for example. As such, other mechanistic methods are being researched, in particular the use of mouth rinsing techniques. As a result, researchers sought to determine whether a synergistic relationship exists between caffeine and carbohydrate mouth rinse (CMR) to improve high-intensity running performance in recreationally trained males, compared to caffeine-only and placebo conditions.

WHAT THEY DID

In a randomised, repeated measures, and double-blind study, eight young, recreationally-trained male participants completed an exercise test in a fed state under three conditions

⇒ Placebo capsule and placebo mouth rinse (PLA)

⇒ Caffeine capsule and placebo mouth rinse (CAF)

⇒ Caffeine capsule and CMR (CAFCHO)

The exercise protocol started with a 45-min steady-state run at 65% VO2max followed by high -intensity intervals of 1 minute at 90% VO2max and 6 km.h^{-1} walking which continued until volitional exhaustion. Outcome measures included time-to-exhaustion, heart rate, blood lactate concentration and rating of perceived exertion (RPE). Caffeine dosage was 400 mg and the carbohydrate mouth rinse had a 6% concentration of maltodextrin.

WHAT THEY FOUND

The main findings of this study included:

⇒ Time-to-exhaustion in both CAF and CAFCHO conditions was significantly increased, on average by ~10 min, compared to PLA.

⇒ There were no significant differences between conditions in heart rate, blood lactate concentration, and RPE.

⇒ There was no significant difference in time-to-exhaustion between CAF (mean 46.8 min) and CAFCHO (mean 46.9 min).

» **Practical** Takeaways

The results of this study suggest that young, recreationally-trained males gain ergogenic benefits from a 400 mg dose of caffeine prior to running exercise, compared to a placebo. The most interesting finding of this research though, is the lack of any combined performance enhancement when combining 400 mg of caffeine with a CMR. Previous research has demonstrated the effectiveness of CMRs in 40 km cycling time trials (see **HERE**) and repeated cycling tests to exhaustion (see **HERE**). The authors suggest that the lack of further enhancement by CMR may be due to the fed-state of participants and that a more pronounced effect would be seen in a fasted-state.

However, in real-world competition, athletes are rarely fasted, therefore, this provides a real-world indication of what may occur in this scenario. The primary takeaway form this study is that a high dose of caffeine in isolation can be a sufficient ergogenic aid for high-intensity running performance, as is required in field-based sports such as football, rugby and hockey.

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

James' **Comments**

"It is worth noting that this research investigates one performance outcome in one exercise protocol and in one population. The authors acknowledge this as a limitation and highlight that this study does not discount a synergistic relationship between caffeine and CMR as this may exist, just not within the context of this current study. The study design is excellent, using repeated measures rules out the possible effects of "responders"and "non-responders"to caffeine which can affect results when using different subjects for each condition.

Furthermore, existing research suggests that rinsing with a CMR for 10 sec (see **HERE**) or ingesting the CMR (see **HERE**) (vs. the 5 sec of rinsing and spitting in the current study) may elicit further benefits to performance. Had this been the case in this study, the use of CMR may have added to the benefits of caffeine."

Injury Prevention & Rehab

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

DOES RETURN-TO-SPORT TESTING REALLY TELL US WHETHER OR NOT AN ATHLETE IS READY TO RETURN FROM AN ACLR?

Webster, K. E. et al. (2019) Sports Medicine.

DO WEEKLY CHANGES IN RUNNING DISTANCE AFFECT RUNNING-RELATED INJURY RISK?

Damsted, C. et al. (2019) Journal of Orthopedic Sports Physical Therapy.

THE SUCCESS OF RETURN-TO-SPORT FOLLOWING ANTERIOR SHOULDER INSTABILITY TREATMENTS

Shanley, E. et al. (2019) The American Journal of Sports Medicine.

[Abstract]

Does return-to-sport testing really tell us whether or not an athlete is ready to return from an ACLR?

OBJECTIVE

Return-to-sport (RTS) testing following an anterior cruciate ligament reconstruction (ACLR) is typically done to assess an athlete's readiness to return to their typical sporting activities, and to reduce the risk of a secondary injury occurring. However, with the high rate of secondary ACL injuries once an athlete has successfully completed RTS testing, it is unclear how effective current RTS testing batteries are at determining whether or not an athlete is prepared to RTS with a reduced risk of secondary injury.

WHAT THEY DID

This systematic review followed the referred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and searched for articles from as early as they could find, through to May 2018 on PubMed, MEDLINE, Embase, CINAHL, and SPORTDiscus. Studies were included if:

- ⇒ They were written in English.
- ⇒ Considered patients who had undergone either a primary ACLR or a revision.
- ⇒ Assessed patients with a RTS testing battery.
- ⇒ It was mentioned how many participants passed the RTS testing battery. The testing batteries described must have utilised testing from multiple domains, and there were no restrictions on individual studies' cut-off values.

From this criteria, 18 studies were included for qualitative analysis and 17 were included for meta-analysis. They assessed patients who passed and failed RTS criteria and subsequently RTS, and who passed and failed RTS criteria and then went on to have a secondary injury.

WHAT THEY FOUND

The main findings of this study included:

- ⇒ Only 23% of athletes pass RTS testing criteria.
- ⇒ Patients who pass RTS testing have a reduction in risk of graft rupture, but actually have an increased risk of contralateral ACL injury.
- ⇒ Most of the RTS testing was done at 6 months after ACL operation, however, even when the testing occurred after the athletes returned to their sport, the pass rate was still only 23%.

» **Practical** Takeaways

This study highlights a significant problem with the current methods of RTS testing. Not only are very few patients even able to pass the RTS tests, but the testing also does not truly tell us if an athlete is prepared to RTS with a decreased risk of re-injury. Revamping our RTS testing criteria and basing them on the specific demands that athletes will be facing in their sport may be a better way to assess an athlete's readiness to RTS.

To be a successful soccer player, for example, requires strength, single-leg stability, power, agility, ability to decelerate and change directions, a good aerobic base, and repeat-sprint ability. Assessing each of those attributes opposed to relying on a RTS testing protocol may be more specific and meaningful which may, in turn, give us a clearer picture of an athlete's readiness to RTS. There should also be a reactive component to RTS testing as there is a large difference between performing a task within the closed environment of a clinic or gym and performing that same task in an open environment which includes many other distractions and cognitive demands.

Aside from the objective criteria required to pass RTS testing after an ACLR, it is also important to consider the time since surgery. Grindem et al. (see **HERE**) shows that each month delay in RTS leads to a 51% reduction in re-injury risk, up to 9 months. It may be worthwhile, therefore, to delay RTS until at least 9 months to reduce the risk of secondary injury. It has also been shown that psychological readiness is associated with ability to RTS (see **HERE**). Patient reported outcome measures (e.g. ACL-RSI, IKDC-10, KOS ADLS, and Global Rating Scale of Perceived Function) can be utilised to determine an athlete's psychological readiness to RTS.

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

Nicole's **Comments**

"The fact that this study showed that athletes who pass RTS criteria are at an increased risk of secondary injury on the contralateral side of the body, highlights a larger issue with RTS testing and the rehabilitation program that is used.

Throughout the course of the rehabilitation program, the emphasis is usually on the limb that has been operated on which can cause the contralateral limb to become deconditioned. Then, when athletes perform RTS testing and compare the surgical side to the uninvolved side, we as practitioners are just comparing a post-surgical limb to a deconditioned limb.

Furthermore, with the learned nonuse of the surgical side, there may be corresponding overuse of the contralateral limb. This might cause a fatigue effect and make the contralateral limb more susceptible to injury."

[Abstract]

Do weekly changes in running distance affect running-related injury risk ?

OBJECTIVE

Participation in half marathons has been increasing amongst the general population over the past decade. While it is generally accepted that training for such a race should not progress too much-too soon, it is unclear how much changes in weekly training load affects running-related injury risk. This study sought to determine how much weekly changes in running distance affects injury risk in runners training for a half marathon. Furthermore, the study looked to determine if whether utilising distance-based or pace-based training schedules modified the injury risk in relation to changes in weekly mileage.

WHAT THEY DID

This study followed 261 healthy runners aged 18-65 yr over the course of 14 weeks as part of a larger nationwide, prospective cohort study called ProjectRun21. Runners self-selected either a distance-based (running longer distances) or pace-based (running faster) training schedule and utilised GPS to track the distance covered while running. The primary outcome measure was running-related injury (RRI) which was tracked by sending out a weekly email inquiring about any RRI. Change in weekly running distance was the primary exposure and was calculated after each running session by dividing the current week's mileage by the previous week's mileage. Changes in running distance was then categorised into either low (less than 20% increase in mileage), moderate (20-60% increase), or high (>60% increase). Risk difference (RD), a measure of the association between change in running distance and time-to-first RRI, was analysed at the 3-, 8-, and 14-week mark.

WHAT THEY FOUND

Following the 14-week period:

⇒ Fifty-six (21.5%) participants sustained a RRI.

⇒ Significantly more injuries occurred when runners increased their running distance by 20-60% compared to the previous week's distance, but this effect only held for the 3-week follow-up period, and not at 8- or 14-weeks.

⇒ Utilising a pace-based schedule may mitigate this risk, but there were not enough RRIs to draw any definitive conclusions on the modifying effects of training schedule.

» **Practical** Takeaways

This study used distance as a measurement of training load, which is considered an external load and does not consider internal load. Tracking internal load can be helpful, since a 10 km run on a given day may elicit a different stress response from that same individual on any other given day. This can be due to stress, fatigue, lack of sleep, poor nutrition, or any other factor that may influence how one responds to a given external load. It may be that applying a load, even a load that the individual is used to, may overload a system that is already stressed in other ways.

This study also utilised a weekly change model instead of the acute to chronic workload ratio (ACWR) (see **HERE**), which takes into account the previous months' worth of training as opposed to just the week prior. The ACWR may provide a clearer picture of what the athlete is prepared for. In the case of the current study, though, the weekly model does not account for training sessions further than a week prior to the current (or acute) training load. This has implications as the training completed over the course of a month can have an effect on the athlete's current fitness and load capacity.

Tracking a runner's training load can be as simple as recording distance and multiplying that by their session RPE. This can then be used to track load with either the weekly changes model utilised by this study or by utilising the ACWR. This may help give a clearer picture of a runner's load and tolerance to that load over time.

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

Nicole's **Comments**

"This study shows that increases in weekly running distance by over 20% is associated with RRI risk for up to 21 days. The heterogeneity of this sample means that the data can be extrapolated to many other runners. Since the RRI risk did not seem to increase with associated increases in weekly running distance in the pace-based training group, it may be that this type of training schedule has a protective factor and allows for more variability in weekly training loads.

It should be noted that although this study found that increasing distance by <20% each week was not associated with RRI risk, the authors warn against consistently increasing distance by nearly 20% each week. There may be a certain threshold each runner has at which point increases need to be smaller in scale."

[Abstract]

The success of return-to-sport following anterior shoulder instability treatments

OBJECTIVE

Anterior shoulder instability among youth athletes accounts for nearly a quarter of all shoulder injuries. The current options for treating an episode of shoulder instability includes either operative or non-operative management. Often, young athletes who experience a shoulder instability episode decide to try to finish out the remainder of their season, and then undergo surgical intervention at the end of the season. This study aimed to determine if there was a difference in an athlete's ability to return-to-sport (RTS) after an episode of shoulder instability between athletes who underwent surgery and those who chose not to have surgery and used non-operative management instead.

WHAT THEY DID

This study followed twenty high schools in South Carolina for four years and included any athlete who was part of a high-school sports team and experienced a traumatic shoulder instability episode during a game or practice that resulted in time-loss from sport.

The first instability episode was considered the initial encounter. The primary outcome measure was successful RTS, which was defined as the ability to return to the same sport and position, and the ability to complete the following season without an injury recurrence causing time-loss from sport. When an athlete experienced a shoulder instability episode, they were first evaluated by their high-school's Athletic Trainer. Following this, the athlete's injury was reviewed by a sports medicine physician or orthopaedic surgeon who confirmed the direction and classification of the instability and prescribed the plan of care (surgical or non-surgical intervention). The surgeon's recommendation was followed, and then either after surgery or as part of the non-operative management, the athlete participated in exercise-based therapy by either a Physical Therapist, Athletic Trainer, or both. An athlete was cleared to RTS when they met set criteria (painless activity, symmetrical range of motion, 67% external to internal rotation ratio, apprehension test, and body weight loading during functional upper-extremity movement without apprehension).

WHAT THEY FOUND

Overall, there were 129 athletes included in this study; 32 of them underwent surgical intervention, and 97 were managed non-operatively. Of the athletes who were managed non-operatively:

- ⇒ 82 (85%) were able to successfully RTS.
- ⇒ Of the 32 athletes who underwent surgical intervention, 23 (72%) were able to successfully RTS.
- ⇒ During the follow-up period, 8 athletes suffered a recurrence of shoulder instability, leading to time-loss from sport, 6 of these from the non-operative group (6.2%), and 2 from the operative group (6.3%).
- ⇒ Overall, 88% of 129 athletes included in this study were able to successfully RTS.
- ⇒ Furthermore, athletes who sustained a dislocation were nearly 3x more likely to fail RTS than those who experienced a subluxation. Superior outcomes were noted in athletes who had a subluxation and were treated non-operatively.

» **Practical** Takeaways

In this study, there was no difference in RTS outcomes for athletes who were managed operatively vs. non-operatively for anterior shoulder instability. There was also a similar recurrence rate of about 6% in both groups. Of the 15 patients in the non-operative group who failed to successfully RTS, 11 ended up having surgery with an 82% successful RTS after surgical intervention. This tells us that it may be beneficial to initially prescribe a non-operative plan of care and then perform stabilisation surgery on athletes who fail to RTS.

Other studies have looked at successful outcomes after non-operatively managed anterior shoulder instability using a primary outcome measure of recurrence (see **HERE**), and found a 44% success rate in athletes who were managed non-operatively (as opposed to the 85% reported in this study). Since the primary outcome measure in the current study was the ability to RTS and complete a subsequent season without a recurrence causing a time-loss from sport, it may be that the athletes in this study did experience recurrences in instability but were able to cope with them and continue playing in spite of them.

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

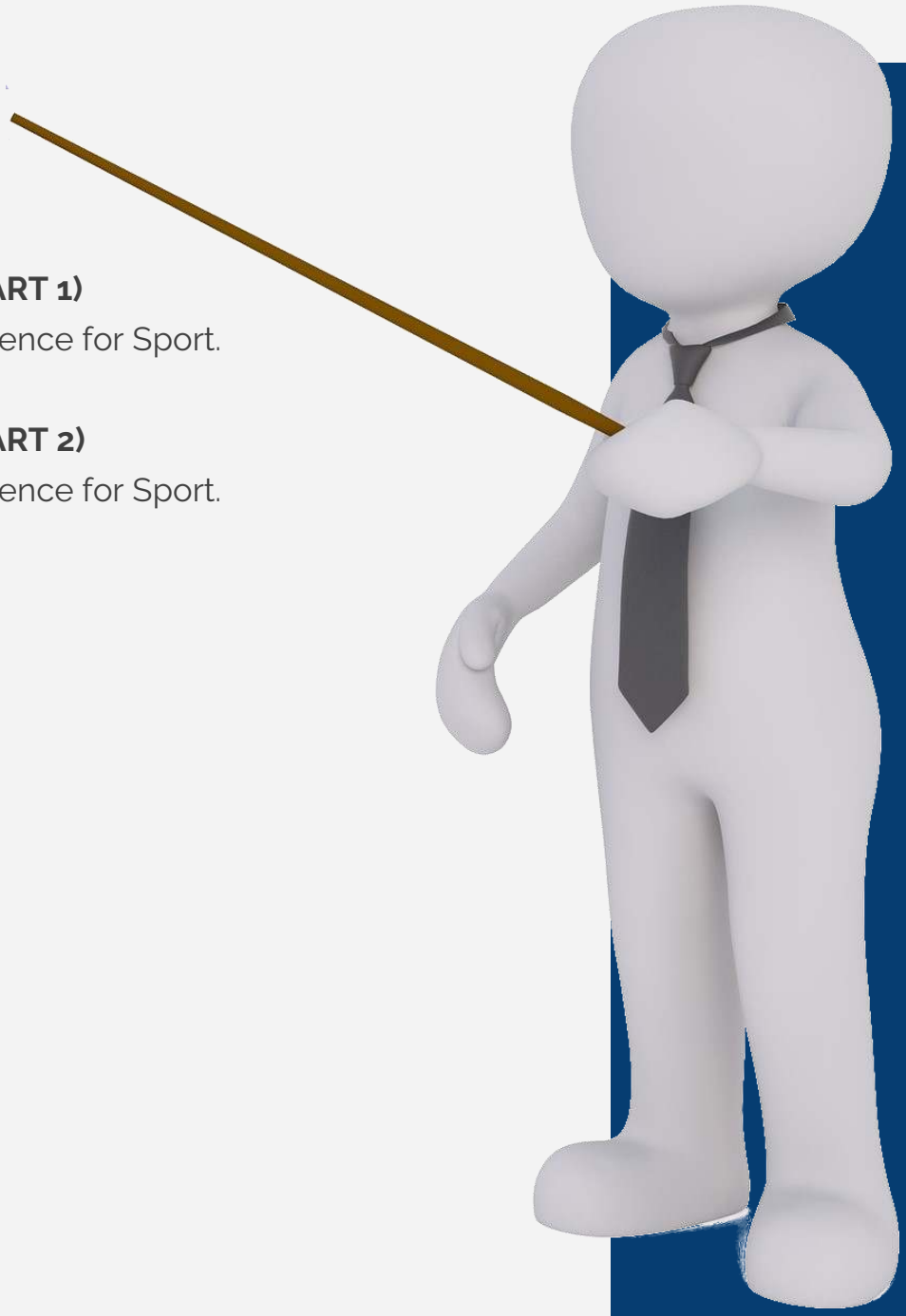
Nicole's **Comments**

"This study utilised a follow-up period of one season after the initial encounter. Indeed, there may be subsequent episodes of instability in high-school athletes beyond the follow-up period of this study. Take, for example, a high school freshman who experiences an episode of shoulder instability. According to the metrics utilised in this study, as long as they are able to play in their sophomore season, then they would be considered to have had a successful outcome. What if that same athlete then goes on to have a recurrence in their junior season which causes them to miss most of the season and, therefore, not be seen by college scouts? Or what if they don't sustain another instability episode, but is consistently fearful of reinjury and has feelings of instability that cause them to have decreased performance and, therefore, never reaches their potential playing ability?

We can hardly consider these to be successful outcomes, although in this study, an athlete such as this hypothetical example would have been part of the "successful" group. As stated above, it is therefore favourable to make sure that the athlete plays a key role in determining what a successful outcome looks like to them."

Infographics

A round-up of our monthly research infographics.



GPS MONITORING (PART 1)

Solomon, M. (2019) Science for Sport.

GPS MONITORING (PART 2)

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GPS MONITORING (PART 1)

SCIENCE for SPORT

What is it?

Global positioning systems (GPS) track the locomotive movements of athletes during both training and competition.

Importance

GPS devices can enable coaches to determine an athlete's; velocity, acceleration, deceleration, change of direction, distance covered during a training session.

How they work

The GPS device communicates with satellites to determine the athlete's current position in space and time.

Valid & Reliable

There is still an abundance of concern regarding the validity and reliability of GPS devices.

Frequency

GPS devices which sample at 10 or 15Hz (10-15x per second) have both been repeatedly proven to be more reliable at monitoring performance than 1 and 5Hz models.

Movement speed

Reliability is reduced at speeds over 20km/h, with additional concerns over short distance movements. Practitioners should take caution when analysing data derived from short-distance, high-speed movements (e.g. small-sided games).

Signal interferences

Some GPS devices are able to connect to more satellites and obtain stronger connections. These units can typically provide more accurate data. The strength of these signals can often be affected by the surroundings such as; heavy tree cover, tall buildings, and stadiums.

Additional concerns

Reliability may also be affected by; location precision, software calculations, and/or hardware reliability, for example, reliability of the accelerometer.

Our summary

GPS devices are highly popular in team sports, Devices appear moderately reliable for measuring player locomotion but struggle during high-speeds, and during short and fast changes in direction. Part 2 will cover metrics and data use.

For the full article check out the Science for Sport website

SCIENCE for SPORT

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GPS MONITORING (PART 2)

SCIENCE for SPORT

Importance

The use of wearable technology in professional sports is common practice and can supplement the physical development department's ability to monitor athletic performance and readiness.

Metrics

There are numerous useful metrics, the sports scientist will often only monitor the ones they deem most important, useful, or reliable.

Distance

Total distance measures the "volume" of work in kilometres while relative distance is the average distance an athlete travels per minute. Scientists must understand how the way that these metrics are accumulated may alter the athletes level of fatigue.

Number of high-speed sprints

This metric is typically classified and reported using a 'work-rate zone'. It must be noted that the magnitude and volume of these is sport and athlete specific.

Accelerations

The extremely high energetic demand of accelerating and the disruptive effects on tissue from decelerating make these metrics important. However the poor accuracy of GPS units to measure accelerations and decelerations is well documented.

Metabolic Power

This metric aims to provide an overall estimate of total internal energy expenditure during a performance. Unfortunately there are concerns regarding the validity and reliability of this metric during sport-specific tasks.

Player Load

Player load is the "arbitrary measure of the total external mechanical stress as a result of accelerations, decelerations, changes of direction and impacts". There is currently a lack of transparency as to the algorithms which calculate this metric.

Our summary

Reliability issues associated with the micro-sensors are inherently passed onto the metrics, thus raising concerns with the variables used to monitor athletic performance. It is suggested that time is spent researching and identifying which metrics are most reliable, and appropriate for monitoring purposes.

For the full article check out the Science for Sport website

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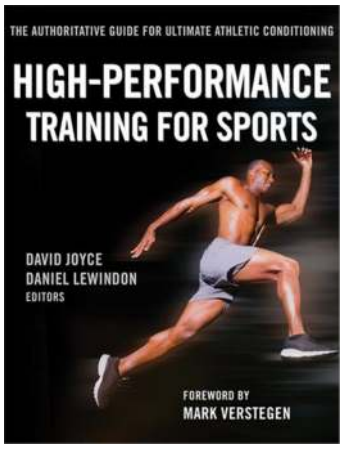

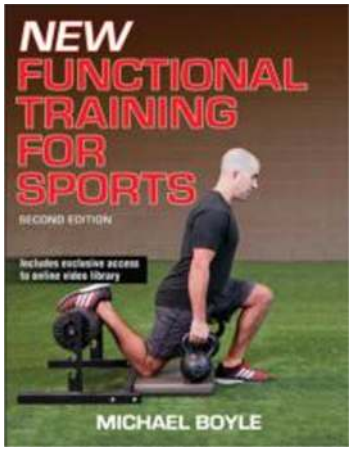

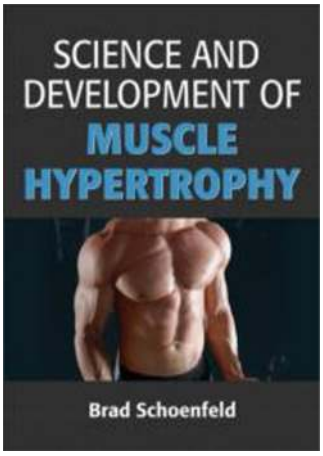

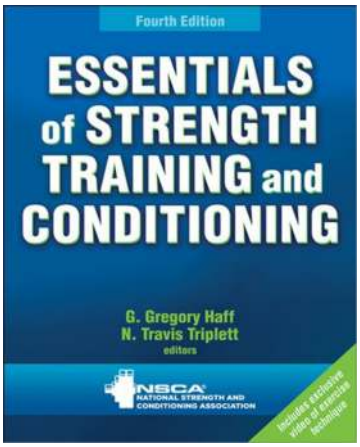

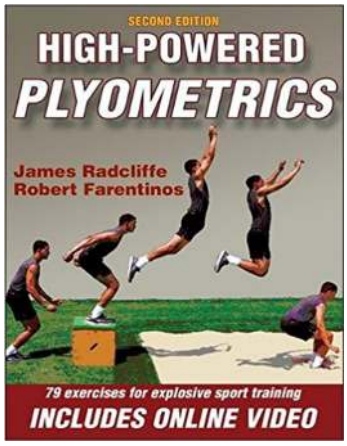

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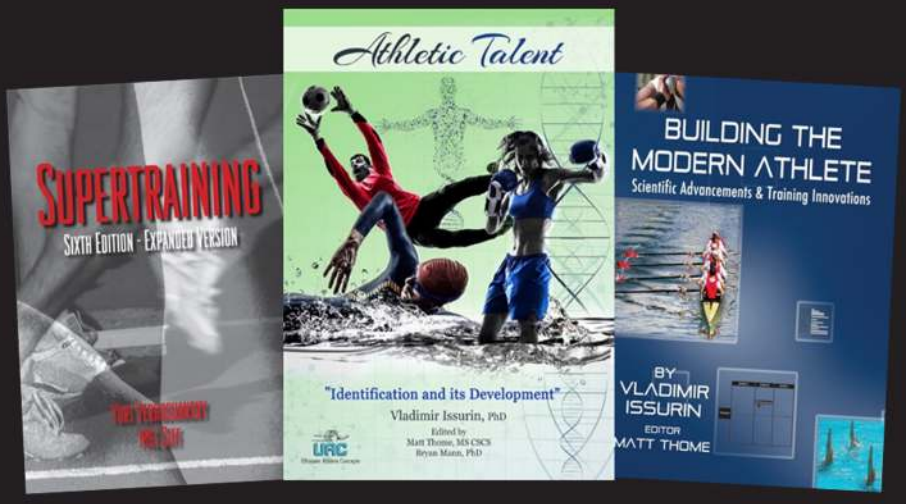

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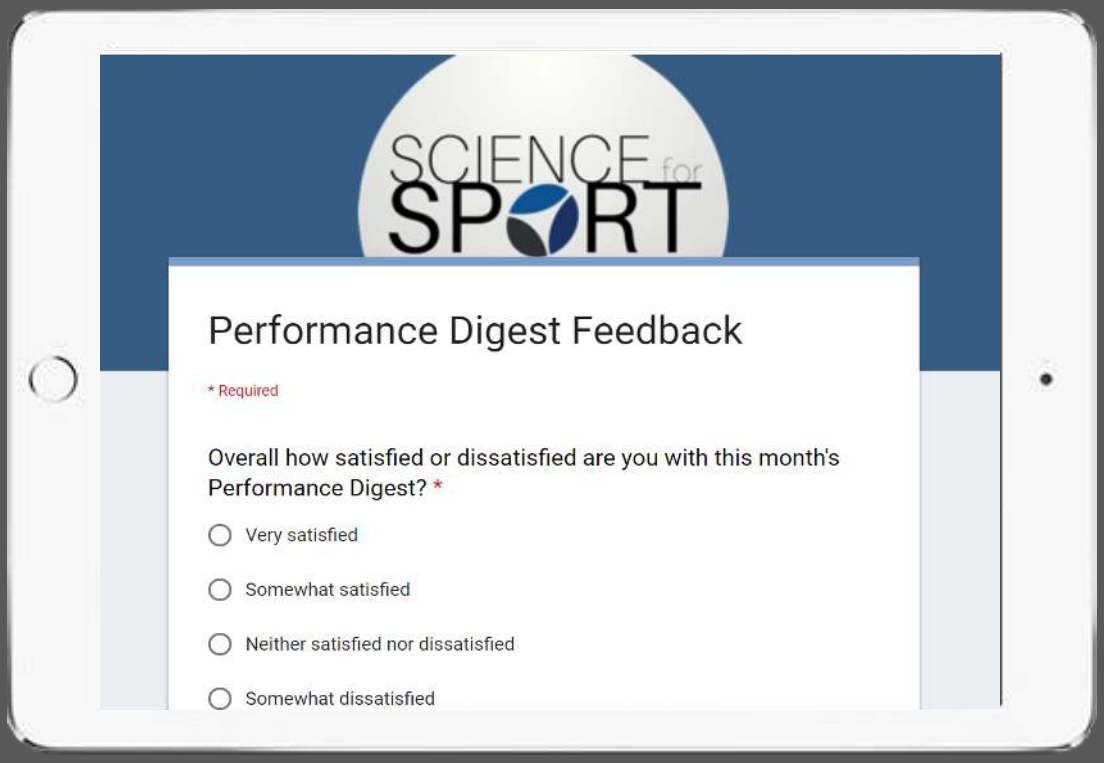

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Science for Sport