July 2019 | Issue #33

THE PERFORMANCE DIGEST

A review of the latest sports performance research

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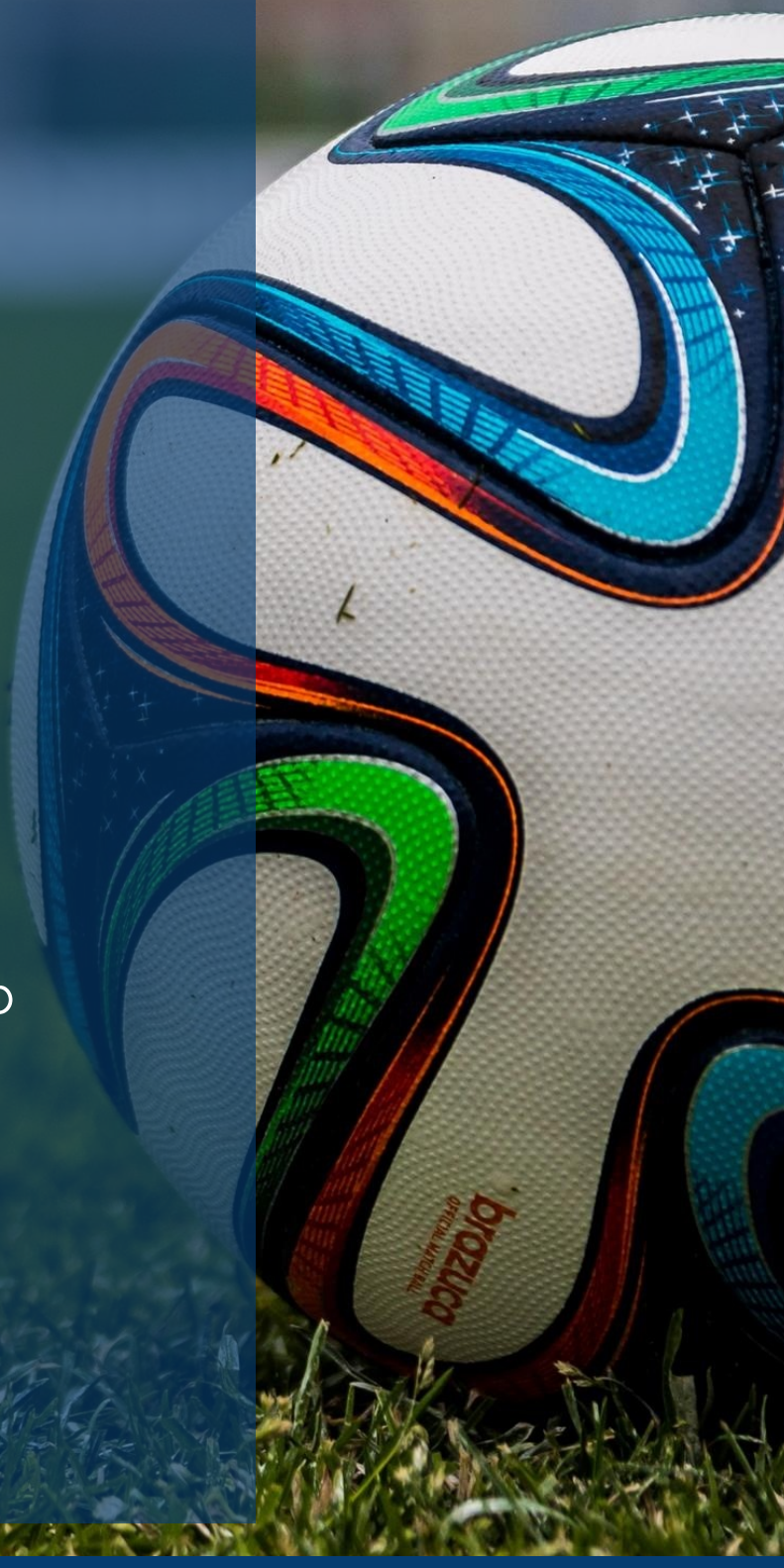

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Research Reviewers

Dr. Will Vickery
PhD

Chief Editor

Will is a Lecturer of Sport Coaching at Deakin University, Australia. Prior to this he has worked with Cricket NSW and Cricket Australia in an array of roles ranging from a sport scientist, development coach, and a strength and conditioning coach.

Dr. Francisco Tavares
PhD CSCS ASCA L2

Fatigue & Recovery

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.

Adam Nichol
PhD Candidate

The Science of Coaching

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

Tom Green
MSc UKAD Advisor

Youth Development

Tom is the Head of Athletic Development at St Peters RC High School. He holds a Masters in S&C and has previously worked with West Bromwich Albion FC, Gloucester Rugby club, and Great Britain Equine. Tom is our youth research reviewer at Science for Sport.

James de Lacey
MSc

Strength & Conditioning

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

James Morehen
PhD Candidate

Nutrition

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

Cody Roberts
MSE

Technology & Monitoring

Cody is a strength and conditioning coach and adjunct lecturer at the University of Iowa. He has an MSE in Exercise Science from the University of Kansas and also holds a CSCS from the NSCA.

Dr. Nicole Surdyka
DPT, CAFS, CSCS

Injury Prevention & Rehab

Nicole is a Physical Therapist and Certified Strength and Conditioning Specialist who runs her own concierge style rehabilitation and performance practice in Los Angeles with her husband, Marc. She is passionate about keeping athletes healthy and performing optimally.

Audio
REVIEW

Heart Rate Variability

A recap on what we know and hope to find out from future research *with Cody Roberts*

WHAT WE DICUSS

In this episode of the "Audio Review", Cody discusses heart rate variability.

In this episode, you will learn:

- What heart rate variability is and why it's important.
- What the physiology underpinning heart rate variability is.
- Whether it can improve training and programming.
- The actionable steps of heart rate variability.
- Heart rate variability case study.

Episode length = 28 min

A bit about **Cody**

Cody is a strength and conditioning coach and adjunct lecturer at the University of Iowa. He has an MSE in Exercise Science from the University of Kansas and also holds a CSCS from the NSCA.

Listen Now

The Science of COACHING

What and how do coaches learn?

Examining methods to develop coaches' knowledge and behaviour

[Abstract]

INTRODUCTION

Coach learning is incredibly important to support effective practice. However, little is known about what or when coaches learn, and particularly, how this learning has an impact on a coach's practice (**HERE**). Many studies have attempted to understand the impact of coach learning by providing coaches with self-report tools (i.e. questionnaires to examine what has changed in their practice). Although, given that there is often a difference in the perceptions of a coach regarding their behviours and what they actually do within a practical setting, these studies lack an ability to fully understand the impact of coach learning.

Therefore, the purpose of this study was to assess changes in coaches' behaviour and knowledge between a group of coaches who took part in formal education (i.e. National Governing Body (NGB) courses), and a group who did not take part in formal education. Specifically, the study aimed to understand what changed in coach learning and how, through observing coaches' practice and interviewing coaches.

WHAT THEY FOUND

Eight youth soccer coaches (seven male and one female, mean age = 27 yr) were selected to take part in the study. Five coaches took part in the NGB coach education course, while three coaches did not, and instead carried out their practice as normal. Coaches were observed in sessions and their behaviours were recorded by an independent observer. They were also asked to take part in recall interviews to watch segments of sessions back (on video) and explain which sources of knowledge they had used (e.g. knowledge of how athletes learn, tactical knowledge or technical knowledge) and where they had learned this from.

Coaches in the coach education group, compared to the non-coach education group were found to:

⇒ Use more tactical focused knowledge compared to technical focused knowledge.

⇒ Use more questioning to set challenges for players to make independent decisions.

⇒ Develop a broader knowledge of why game-based approaches might be effective.

⇒ Use more behaviours directed towards individual athletes, as opposed to the whole group.

WHAT THIS MEANS

Coaches' practice can be influenced by learning on coach education courses, but learning is also developed through a much broader range of experiences and interactions. Experiencing coaching as a player, talking informally with other coaches, and being critical on what works for which athlete and under which circumstances, can be vitally important to support effective coaching.

Recall interviews (where coaches watch video-recorded segments of sessions back) can be an effective tool to show how coaches have learned and changed their practice. Watching videos in this way can also be an effective learning tool in itself to consider why practice was/was not effective and what might be changed in the future. Importantly, coaches often learn and develop knowledge on a topic, but then fail to apply this knowledge by changing their behaviour.

Practical Takeaways

In order to develop their practice through learning, coaches can attend coach education courses delivered by National Governing Bodies. Importantly, learning and knowledge developed on these courses can be supported and complimented by a much broader range of experiences. Among these, coaches can consider the benefits of video-recording sessions and watching footage back to reflect upon key interactions with players to consider why their practice was/was not effective and what can be done to enhance their practice.

For example, coaches could watch themselves providing feedback to an athlete in the gym who is attempting to perform a Romanian deadlift to consider why they (the coach) acted in this way, what influence they may have had on the player, and if anything, could have been done to more effectively engage with the player. Here, good coaches will not be afraid to challenge deep-rooted beliefs that they might have held for a long period of time about what they consider effective coaching to be.

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.

USING THE FORCE-VELOCITY IMBALANCE TO INDIVIDUALISE TRAINING

Jiménez-Reyes, P. et al. (2019) PloS One.

WHAT TRANSFERS MORE TO JUMP AND SPRINT PERFORMANCE, VERTICAL OR HORIZONTAL EXERCISE?

Abade, E. et al. (2019) Journal of Strength and Conditioning Research

IS THERE AN OPTIMAL RECOVERY TIME TO POTENTIATE SWIM START PERFORMANCE?

Waddingham, D. P. et al. (2019) Journal of Strength and Conditioning Research

[Abstract]

Using the force-velocity imbalance to individualise training

OBJECTIVE

For each individual, an optimal force-velocity (F-V) relationship exists that maximises lower-limb ballistic performance (e.g. vertical jump) and represents the optimal balance between force and velocity qualities. Thus, F-V profiling may provide a more accurate representation of an athlete's maximal force production capabilities. At this point in time, only one study has investigated the effects of an optimised training program based on individual F-V profiles (see **HERE**). However, the duration of this study was reasonably short (9 weeks), which may have resulted in only some subjects reaching an optimal F-V profile.

Therefore, the aims of this study were to:

1) Analyse the individual adaptation in F-V profile until every subject reached their optimal profile; and
2) Study the individual F-V profile in response to a three week de-training period.

WHAT THEY DID

Pre-Intervention

All sixty subjects (age = 23.7 ± 3.7 yr) were trained professional futsal or semi-professional soccer and rugby players. The squat jump (SJ) was used to determine each subjects F-V profile in a Smith machine. Five to eight progressive loads where used after bodyweight ranging from 15-90kg.

Intervention

Subjects were assigned to one of four groups based on their F-V profile in relation to their optimal profile (F-V imbalance). 100% was considered perfectly balanced and the exercise prescription of each group included:

⇒ High force deficit (HFD) <60% of optimal profile; performed mainly very high load training.

⇒ Low force deficit (LFD) 60-90% of optimal profile; strength-power emphasis.

⇒ Low velocity deficit (LVD) 110-140% of optimal profile; power-speed emphasis.

⇒ High velocity deficit (HVD) >140% of optimal profile; performed mainly very high velocity training.

Once the subjects F-V imbalance reached the next groups range, they changed training group. As each got closer to their optimal profiles, F-V profiling was monitored every two weeks then eventually every week. Once a well-balanced profile was reached (defined as 90-110%), targeted training stopped.

WHAT THEY FOUND

HFD and LFD groups:

⇒ Extremely large increases in theoretical maximum force (F0) (HFD = 44.1 ± 11.7%; LFD = 16.5 ± 5.1%).

⇒ Extremely large reductions in F-V imbalance.

⇒ Large increases in jump height (HFD = 17.1 ± 8.1%; LFD = 7.8 ± 2.8%).

HVD and LVD groups:

⇒ Extremely large increases in V0 (HVD = 20.2 ± 2.4%; LVD = 12.6 ± 3.9%)

⇒ Extremely large reductions in F-V imbalance.

⇒ Moderate increases in jump height (HVD = 11.6 ±2.8%; LVD = 9.1 ± 2.2%).

De-training period:

⇒ All variables maintained their post-training values with minimal differences.

SJ height was significantly correlated with differences in both F-V imbalance (explained variance of 48.2%) and maximal power (explained variance of 37.7%).

» Practical Takeaways

Based on the results from this study, it seems the larger the initial deficit, the longer the training intervention needs to be to reach an optimal profile. Furthermore, F-V imbalance change had a greater effect on jump performance than maximal power change. It is important to note that an improvement in maximal power may not incur an increase in jump height, which provides practical significance to coaches looking to maximise jump height with their athletes. This highlights that focusing on reducing the F-V imbalance may provide greater performance improvements when compared to traditional programming.

Rather than a "one-size-fits-all" approach, F-V profiling can provide individual information not only on training content but also training duration. Given the ease of measurement, it could be recommended to monitor F-V profiles regularly to adjust athletes in different groups throughout a training period (e.g. every three weeks).

The image below shows the training guidelines for each group. The My Jump 2 app is the easiest, low-cost way of monitoring F-V profiles. SJ's performed over 4 progressive loads can be performed at the end of the warm-up and will only take approximately 10 min for a small group of athletes. These are the loading guidelines I have used successfully:

⇒ Males – 0, 20, 40, 60kg.

⇒ Females – 0, 15, 30, 45kg.

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

James' Comments

"To touch on the de-training period in the present study, only one other study has looked at changes in F-V profiles during a tapering period (see **HERE**). This previous study showed a "performance rebound" (improvement in performance after a de-training period) while the present study did not, which indicates changes in F-V profiles during de-training or tapering may be influenced by prior training. Furthermore, in Issue #32 of the Performance Digest, I reviewed a paper that showed a lot of strength can be retained after a 20 week de-training period. The present study showed all variables can be retained after three weeks of de-training potentially allowing resistance training to be left during small periods of training/competition depending on the sporting culture.

There is one pertinent question that must be asked before embarking on balancing everyone's F-V profile: Will a well-balanced profile for sports that have positions that require high force or velocity outputs hurt or enhance their sport performance? For example, a prop in rugby union requires the ability to produce large amounts of force during scrummaging. An initial F-V profile will reflect this likely showing a high velocity deficit. Neglecting high-load exercise for the sake of balancing the F-V profile and improving jump performance may leave the athlete lacking in the specific area they need to play their sport well."

[Abstract]

What transfers more to jump and sprint performance, vertical or horizontal exercise?

OBJECTIVE

General S&C programs may promote neural adaptations and increase power production. However, maximising transference to sports skills requires training to be specific, particularly within contraction velocity and movement pattern. According to the force-vector theory, exercises performed in the anteroposterior vector (e.g. hip thrust) may effectively improve sprint performance, while exercises performed in the axial force-vector (e.g. squat) have stronger transference to vertical jump.

Therefore, the aim of this study was to investigate the effects of adding specific horizontal and vertical force-vector exercises to a 20-week in-season general strength training program on jump and sprint performance.

WHAT THEY DID

Twenty-four experienced, male u17 football players (age: 16.56 ± 0.56 yr) who were competing in the Portugese u17 National Championship, initially completed a pre-test protocol (four days before the intervention) that consisted of a squat jump (SJ), countermovement jump (CMJ), horizontal jump (HJ), and a 10 m and 20 m sprint.

Each was then randomly assigned to a either the control group (CG), vertical training group (VG), or horizontal training group (HG). All groups performed a general strength training program once a week (bench press, row, upright row, trunk rotation, front and side planks) with the VG adding the back squat and HG adding the hip thrust at the end of the general routine.

WHAT THEY FOUND

Vertical Jump Performance vs. Control

⇒ VG likely improved SJ (4.5 ± 4.4%) and CMJ (4.9 ± 4.1%).

⇒ HG presented unclear results for the SJ and CMJ.

Horizontal Jump and Sprint Performance vs. Control

⇒ VG presented a moderate, most likely improvement in HJ (7.5 ± 2.7%).

⇒ VG small, likely improvements in 10 m time (-1.6 ± 2.0%), and moderate, very likely improvements in 20 m time (-3.3 ± 1.6%).

⇒ HG presented most likely, large improvements in HJ (13.0 ± 4.8%).

⇒ HG presented very likely, moderate improvements in 10 m time (-3.0 ± 1.8%), and a large, most likely improvement in 20 m time (-3.8 ± 1.0).

» **Practical** Takeaways

This study suggests there is a potential force-vector transference effect in non-resistance trained youth soccer players. The hip thrust exercise showed a greater transference to horizontal activities compared to the back squat. Nevertheless, both exercises enhanced sprinting performance when compared to the control training protocol.

Practically, within a S&C program, there is no reason both exercises, or force vectors can't be addressed within the same week. This is likely to give the greatest transfer to jumping and sprinting tasks at least within a youth soccer population. However, soccer generally doesn't have much of a strength and conditioning culture. So, as a coach, you may be constrained to one resistance training session a week. There are potentially multiple ways to attack this:

⇒ Perform the back squat as the main lower-body movement within your full body session as it transfers well vertical and horizontal movements within this population.

⇒ Use a program, such as 1 set x 20 repetitions, which was designed for novice athletes where you can address many movements within one session.

⇒ "Hide" the movements you may not be able to address in your on-field warm-ups with the use of partner or band resistance.

⇒ Using sleds as part of "conditioning" where you can again "hide" horizontal strength work within another session.

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

James' **Comments**

"In my opinion, getting out of the axial vector/sagittal plane training can only be beneficial to total athletic development. With many programs spending the majority of time within this plane of movement (squat, deadlift, Olympic lift), spending time within a variety of force-vectors - whether that be anteroposterior or mediolateral - may aid in reducing the risk of injury and further enhance performance in tasks, such as side stepping and sprinting. In my experience, regardless of the level of the population you are training, athletes generally perform movements poorly outside of the typical axial force vector."

[Abstract]

Is there an optimal recovery time to potentiate swim start performance?

OBJECTIVE

Warm-up protocols can be classified as active or passive, with passive strategies focusing on the use of external means, whereas active strategies focus on exercise. Competitive swimming (and many other sports) poses many issues that may cause disruptions to the use of active warm-ups such as race time delays, lack of warm-up facilities, the time required for clothing change, and long marshalling times, which can result in longer periods between warm-up and competition.

The dive start in swimming requires rapid force development and has been shown to contribute to 30% of 50 m swim time, which highlights the significant impact this can have on the final outcome of a race. The aim of this study was to determine the optimal recovery time following three ballistic warm-up protocols to optimise performance in countermovement jump (CMJ) and explore how practical potentiation protocols affect 15 m swim start performance.

WHAT THEY DID

Eleven national-level swimmers (8 men, 3 women, aged 18-22 yr) completed seven separate sessions:.

Sessions 1-3 (used to determine optimal recovery time):

⇒ Baseline CMJ (PUSH Band), 20 min rest then one of three potentiation protocols. CMJ performed 15 sec, 3-, 6-, 9-, and 12 min following potentiation protocol.

Sessions 4-7 (experimental condition):

⇒ Swim specific warm-up followed by 20 min wait period to simulate time spent in call room before a race.

⇒ During three sessions, potentiation protocol was performed during the 20 min wait period. During one session, no potentiation was performed.

⇒ Recovery time between the potentiation protocol and the 15 m dive start was set to the individual optimal recovery time.

Potentiation Protocols:

⇒ 3x3 band resisted-squats with 2 min recovery between sets (2 bands with 60-150 lbs of resistance).

⇒ 3x3 weighted CMJs with additional 15% body mass using a weighted vest.

⇒ 2x5 drop jumps from 45 cm box with 3 min rest between sets.

WHAT THEY FOUND

Sessions 1-3:

⇒ No significant differences between baseline CMJ and subsequent time-points following all three potentiation protocols.

⇒ Notable increases in peak power of 6.9% (band squats), 7.8% (weighted jump), and 2.9% (drop jump) were observed after 6, 3 min, and 15 sec respectively ., 3- and 6 min.

Sessions 4-7:

⇒ 15m start times were significantly faster in the band squat protocol compared to no potentiation (6.70 ± 0.45 sec vs. 6.81 ± 0.42 sec)

⇒ Significant difference between band squat and weighted jump protocol (6.70 ± 0.45 vs. 6.86 ± 0.42 sec).

⇒ No significant difference between weighted jump and drop jump protocols (6.86 ± 0.42 vs. 6.84 ± 0.44 sec).

⇒ No significant difference between drop jump protocol and no potentiation protocol.

» **Practical** Takeaways

A post-activation potentiation protocol of 3x3 band-resisted squats has the potential to enhance swim start performance after 6 min recovery and provides a practical method for competition environments. The weighted jump and drop jump protocol may not have provided a potentiation effect due to the high reliance on the stretch-shorten cycle (SSC). Swim starts mainly rely on starting strength and with virtually no SSC involvement. However, peak power increased in the weighted jump and drop jump in a shorter time frame than band squats, this may provide some practical insight to pre-competition primers in other sports requiring a slow or fast SSC component.

Practically, it may not be possible to time your potentiation protocol to exactly 6 min or your optimal recovery time before a race. So, a practical re-warm-up potentiation strategy could rather look like this:

Post swim-specific warm-up:

⇒ 5 min to get ready for race (e.g. remove clothing, put on swim equipment).

⇒ Every 3 min perform one set of 3 banded squats.

Similar protocols can be used in team-sports:

⇒ 5-10 min to get ready for match (jerseys, team speech etc).

⇒ 3 jumps and a 10m sprint before lining up on the field.

If you have a higher-end budget, Issue #24 of the Performance Digest shows how an eccentric flywheel exercise can induce a potentiation response after 6 min of rest.

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

James' **Comments**

"It seems that according to this information regarding the re-warm-up, doing something is better than doing nothing. While the current study used higher intensity protocols to elicit a potentiation effect, lower intensity protocols can also be used as part of a re-warm-up strategy as shown in Issue #25 of the Performance Digest (a half-time re-warm-up example video below).

It is important to note that the optimal recovery times are based off of a group mean, so individual variance is likely to occur. In my experience, I use re-warm-up or priming strategies every competition day. Whether they actually create a potentiation outcome, I don't know, but feeling ready psychologically rather than standing around for 15+ min is a win for me."

Technology & Monitoring

This month's top research on technology and monitoring.

ACUTE PHYSIOLOGICAL RESPONSE TO USING A HYPOXICATOR OR ELEVATION TRAINING MASK
Ott, T. et al. (2019) The Journal of Strength and Conditioning Research.

WORKLOAD MONITORING APPROACHES IN BASKETBALL
Fox, J. L. et al. (2019) Universidad de Alicante.

WHAT IS MORE EFFECTIVE FOR MONITORING SPRINT PERFORMANCE, AN ABSOLUTE OR INDIVIDUALISED METHOD?
O'Connor, F. et al. (2019) International Journal of Sports Physiology and Performance.

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[Abstract]

Acute physiological response to using a hypoxicator or elevation training mask

OBJECTIVE

Training at high altitude provides a hypoxic condition (limited oxygen supply), leading to physiological adaptations that improve oxygen transport and utilisation. Elevation training masks (ETM) and hypoxic training devices, such as hypoxicators, aim to create a similar microhypoxic environment and, in turn, a beneficial aerobic training effect.

The aim of this study was to compare pulmonary and metabolic changes during high-intensity exercise to using a hypoxicator or ETM.

WHAT THEY DID

Eight active individuals completed 3 separate bouts of high-intensity interval exercise at a relative 90% VO2max for about 30 min. The first trial served as the control condition. Subjects were randomly assigned the ETM or hypoxicator for their second visit and completed the same testing procedure. The final trial allowed each subject the use of the opposing altitude-simulating device.

Resting metabolic rate, pulmonary function tests, and VO2max assessments were performed before, and after each trial. A blood sample was taken pre, immediately after exercise, and 60 -min post-exercise to identify hormone response. Analysis of the physiological response was performed for each trial.

WHAT THEY FOUND

The main findings of the study were:

⇒ Regarding pulmonary function, there was no significant change in forced vital capacity, peak expiratory flow, or forced inspiratory vital capacity between conditions (control, hypoxicator, or ETM). However, forced expiratory volume in 1 sec was higher when using the hypoxicator.

⇒ Post-exercise growth hormone was significantly higher compared to pre-exercise growth hormone for all conditions.

⇒ Erythropoietin was significantly lower when using the hypoxicator compared to the control condition post-exercise and 60-min post-exercise.

⇒ Blood oxygen saturation was lower with hypoxicator use versus the ETM.

» **Practical** Takeaways

Although the ETM is generally promoted as a respiratory training device, the hypoxicator had greater impact on pulmonary function, as well as blood oxygen saturation. The ETM failed to induce the same acute responses as seen with the hypoxicator, not upholding the altitude-simulating claims with high-intensity exercise. Further research is needed on long-term adaptations to chronic use of the ETM, as this study only examined the acute response from one session.

Based on the significant change in blood oxygen saturation, the hypoxicator is capable of creating a hypoxic condition, whereas the ETM is not capable of simulating altitude training acutely. Further research is needed to determine prescription and potential in creating pulmonary and respiratory adaptations, as studies have shown the resistance to breathing increasing ventilatory threshold and the exercise prescribed was only 30-min in duration. Based on this study, using the hypoxicator is the optimal route for simulating high-altitude conditions and training.

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

Cody's **Comments**

"This study highlights the false marketing claims of companies pushing devices and promising training results that are not supported by research. Perception is not reality, and just because it is harder to breathe does not mean that the implementation of an ETM may be an effective alternative to traditional training or truly being able to train through lower oxygen partial pressure at higher altitudes. These same companies will not give up on the ETM's place in improving aerobic abilities, further pushing their potential in improving respiration.

Through these results, we are led to believe that the ETM's ability to increase pulmonary performance may even be false and there are better routes at improving respiratory function."

[Abstract]

Workload monitoring approaches in basketball

OBJECTIVE

Quantifying workload is the main goal of athlete monitoring strategies; targeting recovery, preparedness, and injury mitigation. Advances in technology (and the access to this technology) has led to a disconnect across teams in consistent implementation in effectively quantifying workload.

The aim of this study was to examine the prevalence of monitoring across various organizations, identify barriers and facilitators to player monitoring, with special attention related to microsensor use in basketball.

WHAT THEY DID

A survey which asked multiple-choice and open-ended questions relating to player monitoring practices, perceived obstacles, and microsensor use was completed by various practitioners who were/are currently involved within monitoring basketball players. No restrictions were placed on the demographic or experience of those who could complete the survey and, as a result, forty-four respondents completed the survey. Following this, responses were analysed and summarised to identify tendencies in facilitation, purpose, and opinions related to perception and opportunity as it relates to athlete monitoring strategies.

WHAT THEY FOUND

The primary findings in the study:

⇒ Only 61% of respondents indicated player monitoring is conducted within their respective teams.

⇒ Of those that monitor, 48% of respondents indicated microsensors (heart rate monitors, accelerometers, and positioning devices) are used for player monitoring and 89% agree monitoring is important (which includes tracking progress, comparing training loads, mitigating injury, and guiding recovery interventions).

⇒ Some uncertainties exist of how to interpret and effectively apply player monitoring in basketball.

» **Practical** Takeaways

There appears to be a disconnect between the research and practice of effective monitoring strategies in the decision-making process, which is highlighted by the fact that:

⇒ Training appears to still be modified primarily based on practitioner observation and uninformed by any data.

⇒ Interest to utilise and implement microsensors for objective internal or external data, but lack of understanding on how to use them or how to use the data.

⇒ Limited understanding of practical ways to monitor with a limited budget and resources.

This survey highlights the need for structured professional development, mentoring, and a focus on disseminating information and recommendations for strategies for effective player monitoring and microsensor use in basketball.

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

Cody's **Comments**

"Microsensors are a new and exciting tool within the performance sport environment, and each sport is finding ways to implement this technology. Practitioners need to be creative and strategic with how they go about implementing monitoring strategies to ensure they are effective. The collection of information needs to be time efficient, easy to administer, providing information that is both valid and reliable, and sensitive to change. These are the guidelines for a S&C coach to follow when getting the head coach to support the process and improve athlete compliance and understanding.

Monitoring does not come down to what you have, but rather the effectiveness of the decisions you make and what influences those decisions. Microsensors can be helpful in the process, but if there are financial limitations, other methods that involve simple paper and pen techniques collect valuable information to reference over time rather than working from memory. Stay optimistic and be resourceful with your approach."

[Abstract]

What is more effective for monitoring sprint performance, an absolute or individualised method?

OBJECTIVE

Speed is vital to athletic performance, but an athlete working at or near maximal velocity is very stressful and requires particular attention. Proper management is necessary due the individual variation between athletes needs and physical characteristics.

The aim of this study was to compare an absolute (e.g. >24.9 km·h^{-1}) to an individualised approach (e.g. 85% of maximal speed) to monitoring speed thresholds and their association with lower-body soft tissue injury.

WHAT THEY DID

Fifty-three professional male Australian Rules Football athletes from the same club had their non-contact soft tissue and bone stress injuries recorded across all pre- and in-season training, as well as during competition, across an 18-month period (November 2016 to June 2018).

Each athlete's maximum velocity was obtained via GPS and from this measure, relative thresholds were created (≥75%, ≥80%, ≥85%, ≥90%, ≥95% of maximal speed). The number of sprints and distance covered above each relative threshold was quantified across 1-week and 4-week periods, and this information was compared to injury incidence, specifically non-contact soft tissue and bone stress injuries.

WHAT THEY FOUND

The main findings of the study were:

⇒ Monitoring distance covered using an absolute speed threshold (>24.9 km·h^{-1}) is a poor indicator of injury risk.

⇒ When measuring speed thresholds relative to the individual (≥85%), there was a greater association with an injury with very low and very high cumulative sprint loads across a 4-week period, when compared to an absolute speed threshold,

⇒ There was an ineffective relationship between injury incidence and sprinting loads across a 1-week period.

» Practical Takeaways

Recognising the individualised maximal velocity capabilities of athletes when monitoring sprinting load (number and distance covered) is a more effective way to quantify sprint workload and manage the prescription of work relative to the demands of competition.

Further, looking longitudinally at the accumulation of load across a 4-week period was more effective than 1-week cumulative loads when quantifying injury occurrence. We need to appreciate the highs and lows of sprint load endured to determine the necessary dose to maintain workload and prevent injury. The results of the current study suggest that these athletes should complete ~1 km ≥80% maximal velocity across a 4-week period to mitigate injury risk. Based on the movement demands that occur in match-play, this information can help coaches supplement or restrict athletes to operate in a safer and potentially more productive workload across the weeks and months of training.

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

Cody's **Comments**

"The use of GPS allows for continuous measurement and monitoring of an individual's maximal sprint speed, which is a very important performance metric that is captured simultaneously within both training and competition. Access to this information (and when used effectively) reduces the risks of injury associated with a separate training session and anxiety-ridden testing environment.

Practitioners must appreciate that it is the accumulation of training over time, rather than the individual sessions themselves being an important factor in developing preparedness, robustness, and resiliency to injury. The concept of micro-dosing training (see **HERE**) is supported with the encouragement and effectiveness of focusing attention on the workloads accumulated across the 4-week period, rather than a 1-week span. The goal of training is to be effective with the time allowed and collaborate with the loads experienced in competition. Using individualised sprinting workloads allows for an increase of confidence in preparation."

Fatigue & Recovery

This month's top research on fatigue and recovery.

HOW DO PLAYERS RESPOND TO COMPETING IN AN INTERNATIONAL RUGBY SEVENS COMPETITION?

Fowler, P. M. et al. (2019) The Journal of Strength & Conditioning Research.

WHAT IS BETTER FOR IMPROVING RANGE OF MOTION, FOAM ROLLING, STATIC STRETCHING, OR A COMBINATION OF BOTH?

Hodgson, D. D. et al. (2019) The Journal of Strength & Conditioning Research.

MICRO-CYCLE SCHEDULES: HOW THE PROFESSIONALS ARE DOING IT

Cross, R. et al. (2019) European Journal of Sport Science.

[Abstract]

How do players respond to competing in an international rugby sevens competition?

OBJECTIVE

Both subjective (e.g. muscle soreness, sleep duration and quality) and objective (e.g. jumping performance, heart rate variability) markers of fatigue are commonly collected in the applied sport setting in order to monitor athletes' responses, allowing practitioners to adapt training in order to increase readiness, decrease likelihood of injury, etc.

International Rugby Sevens players compete several 2-3 day tournaments during a typical season in different countries. In addition to the fatigue accrued from training and competition, practitioners also have to account for the fatigue from long-haul travelling and, as such, this study monitored the fatigue levels of an international Rugby Sevens team.

WHAT THEY DID

During a 6 week period, sixteen elite Rugby Sevens players participated in four tournaments in four countries (New Zealand, USA, Hong Kong, and Japan). In order to monitor player's fatigue and training load, the following subjective and objective markers were obtained during/after:

⇒ Subjective: Training load (session rate of perceive exertion (sRPE)), sleep quality, energy levels, and muscle soreness.

⇒ Objective: Resting heart rate (HRrest), heart rate recovery (the last 3 min of a 5 min run; HRex) and heart rate recovery obtained after the run (HRR).

The baseline for each measure was obtained in the United Kingdom for three consecutive days prior to each of the two competitions.

WHAT THEY FOUND

The main findings of this study were:

⇒ Subjective and objective responses were observed to be highly individual, even following long-haul travelling and competition.

⇒ In general, sleep quality improved on the first night of the first two tournaments, decreasing throughout the 3 days of each tournament. No trend for sleep quality was observed for the last two tournaments.

⇒ Energy and muscle soreness HRrest and HRR were less variable across the different tournaments.

Group HRex was negatively affected throughout competition during the last two tournaments but not during the first two tournaments.

» **Practical** Takeaways

Given that subjective and objective measures were observed to be highly individual, individual fatigue monitoring is recommended and the use of z-scores can be of great use for interpretation and reporting this information (see **HERE**).

As mentioned by the authors, subjective rather than objective markers seem to provide greater information to practitioners due to the increased sensitivity and applicability. This can be used to make individual adjustments in recovery protocols, sleep hygiene recommendations, and manipulation of training load.

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

Francisco's **Comments**

"I have really enjoyed reading this study as it demonstrates a real-world example of how fatigue can be monitored at a high level of practice. Furthermore, it demonstrates how individual the responses can be, reinforcing the need to have an individual approach to adjusting training loads but also when designing recovery protocols.

As frequently demonstrated (e.g. see **HERE**), subjective markers seem to have the greatest use for practitioners. Measures such as these questionnaires can be self-designed, are easy to implement, and should provide information almost instantaneously to coaches and sports science staff. In my personal experience, a different item should be included for muscle soreness and pain. This is because if it is not described correctly, athletes will often report pain as muscle soreness. When possible (e.g. digital body graph), soreness/pain should be distinguished for the main muscle groups. Some research demonstrates that collecting muscle soreness from different muscle groups is more sensitive to training load than a single question of muscle soreness."

[Abstract]

What is better for improving range of motion, foam rolling, static stretching, or a combination of both?

OBJECTIVE

Static stretching (SS) is widely implemented to increase range of motion (ROM), nevertheless recent research demonstrates that SS may lead to acute impairments in neuromuscular tasks. Therefore, other strategies to increase ROM without affecting performance are being explored. SS in combination with roller massage (RM) has been recently suggested to acutely improve ROM.

Nevertheless, little is known about how SS together with RM affects performance. Therefore, the goal of this study was to analyse the effects of different SS and RM combinations in ROM and performance.

WHAT THEY DID

Twelve active subjects performed the following five different conditions on separate days:

- ⇒ SS only (SS-rest).
- ⇒ SS and RM (SS-RM-rest).
- ⇒ SS with additional RM after 10 and 20 min (SS-RM).
- ⇒ SS and RM with additional RM after 10 and 20 min (SS-RM-RM).
- ⇒ Control.

Performance and ROM measures were obtained before and immediately (POST0), 10 min (POST10), 20 min (POST20) and 30 min (POST30) after SS or RM and included: hurdle jumps (HJ), countermovement jump (CMJ), active ROM (aROM) and passive ROM (pROM), hip and knee flexion (HF and KF) ROM, and knee flexion and extension maximal voluntary isometric contractions (MVIC).

WHAT THEY FOUND

The main findings of this study were:

- ⇒ Passive ROM was improved in all conditions in comparison to control.
- ⇒ Active and passive KF and HF ROM were improved for up to 30 min from SS with additional RM, particularly in the SS-RM and SS-RM-RM conditions.
- ⇒ SS, with no additional RM, negatively effected CMJ height in comparison to control. No differences were observed from SS with additional RM at any time point.
- ⇒ Hurdle jump height and contact time were not affected for any experimental condition and time point.

» Practical Takeaways

- ⇒ SS performed for 2 sets of 30 sec impaired performance (i.e. CMJ height), therefore, suggesting that SS before exercise should be avoided.
- ⇒ When combined with RM, SS provides additional benefits in ROM, particularly in active ROM.
- ⇒ Athletes who want to increase active and passive ROM without affecting performance should complete SS, followed by RM every 10 min until they have to perform. An example on how this strategy can be useful is when substitutes are waiting on the bench to play.

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

Francisco's Comments

"Recent reviews (see **HERE** and **HERE**) have established that performance is not affected by SS when it is conducted for <60 sec per muscles group. Nevertheless, in this study, the authors have observed a decrease in jumping performance from 2 sets of 30 seconds of SS, demonstrating that practitioners must be cautious when using SS with athletes This should not discourage practitioners to include SS with their athletes as it seems unlikely that 20-30 sec SS performed during a warm-up affects performance.

Moreover, from my experience, athletes perform SS early in the warmup before moving into ballistic stretching and some other more sport-specific exercises, which may reverse performance impairment that may have occurred from the SS. Future research should aim to understand the effects of SS performed before other forms of stretching (e.g. dynamic stretching and exercise). It is also important to mention that SS may increase force production over higher muscle lengths which can be beneficial for some sports, such as gymnastics."

[Abstract]

Micro-cycle schedules: How the professionals are doing it

OBJECTIVE

The organisation of the training schedule between matches is essential, particularly in team sports where there is limited time between each scheduled match, and so that a balance of training stimulus and recovery can be achieved.

Including different types of training within a micro-cycle, without increasing the risk of injury or compromising performance can be challenging, as each training environment has its own characteristics. This study compared the knowledge and use of the micro-cycle schedule during training and recovery from practitioners working for different sports at a professional level.

WHAT THEY DID

Thirty-five S&C practitioners from professional soccer, Australian football, rugby league, and rugby union completed a 23-items questionnaire that was divided into four different sections:

1. Micro-cycle scheduling: When recovery (R), resistance training (RT), tactical and skill (TS), and aerobic sessions (Aer) occurred in a 7-day turnaround.
2. Influencing factors: How they perceived difficulty/importance of an upcoming match, physical cost of the previous match, athlete recovery status, athlete subjective wellbeing, previous total weekly micro-cycle training load, total meso-cycle training load, and how the acute:chonic workload ratio affected training prescription.
3. Practitioner satisfaction: The level of satisfaction of the practitioners of the current schedule on the effects on physical qualities.
4. Recovery: Insight into the recovery modalities and monitoring tools used.

WHAT THEY FOUND

The main findings of this study were:

- ⇒ Collision and non-collision athletes implement a similar number of R sessions during the week (~7.5 sessions)
- ⇒ RT occurred more often in collision sports (2.4 times per week) in comparison to non-collision sports (1.5 per week) and occurred between match day (MD)+3 and MD-2.
- ⇒ TS occurred more frequently during the week in collision sports (3.5) in comparison to non-collision (2.9)
- ⇒ Aer were rarely prescribed in collision and non-collision sports.
- ⇒ The most used recovery modalities (in order of frequency used) were: Cold water immersion, active recovery, and compression garments
- ⇒ The most used monitoring tools (in order of frequency used) were: Subjective markers, performance measures, and heart rate indices.

» **Practical** Takeaways

- ⇒ Recovery sessions occurred frequently, demonstrating the need to speed-up recovery. Based on the findings and the potential of some recovery modalities to blunt training adaptations, practitioners can implement cold water immersion to speed-up recovery for the match (e.g. MD-1 and MD-2), while implementing active recovery and having athletes wear compression garments throughout the week.
- ⇒ Similar to previous research, in order to monitor fatigue, 94% of the practitioners reported the use of subjective measures within training programmes (see **HERE**).
- ⇒ When multi-session training is prescribed, TS was shown to be mainly performed in the morning and RT in the afternoon. Some exceptions can be made when power training is prescribed, as it can provide an additional benefit in terms of neuromuscular performance to the TS session.
- ⇒ When designing the training week, the first two training days were essentially designed with an aim towards "recovery". During the first two training days, "recovery" was the factor that most impacted on training prescription. Most practitioners reported MD+3 as an important day for athletes to "achieve a high training stimulus". Practitioners consider the latter parts of the week (MD-3 and MD-2) to be important to allow athletes to "achieve a high training stimulus" while focusing on "match specific preparation". Finally, MD-1 was used as a "recovery" or "taper" period.

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

Francisco's **Comments**

"I found the planning of the weekly schedule one of the most challenging areas within the S&C programme, as the training environment is so different, even within the same sport. I recently faced this challenge, moving from rugby to football. In rugby, teams typically train for 2 days, rest 1 day, and then train for another 2 days leading into match day. In football, the "tactical periodisation" suggests that athletes must train for 4-5 consecutive days as long as there are fluctuations of the different mechanical outputs (e.g. acceleration/deceleration, speed, distance per minute). In my experience, these fluctuations are small, not allowing for a proper overload and also increasing the risk of injury.

Below you can find three main points I consider when scheduling a 7-day turnaround:

- ⇒ Allow for 1 or 2 days where a given physical quality is overloaded (i.e. above match intensity). Normally one day focusing on the density of the session and the other day focusing in the capability to repeat high-intensity efforts.
- ⇒ Have a pronounced decrease in load (or rest) after a big training day.
- ⇒ RT focusing on maximal strength or hypertrophy after TS (e.g. MD+3). RT focusing in power outputs before TS (e.g. MD-2)."

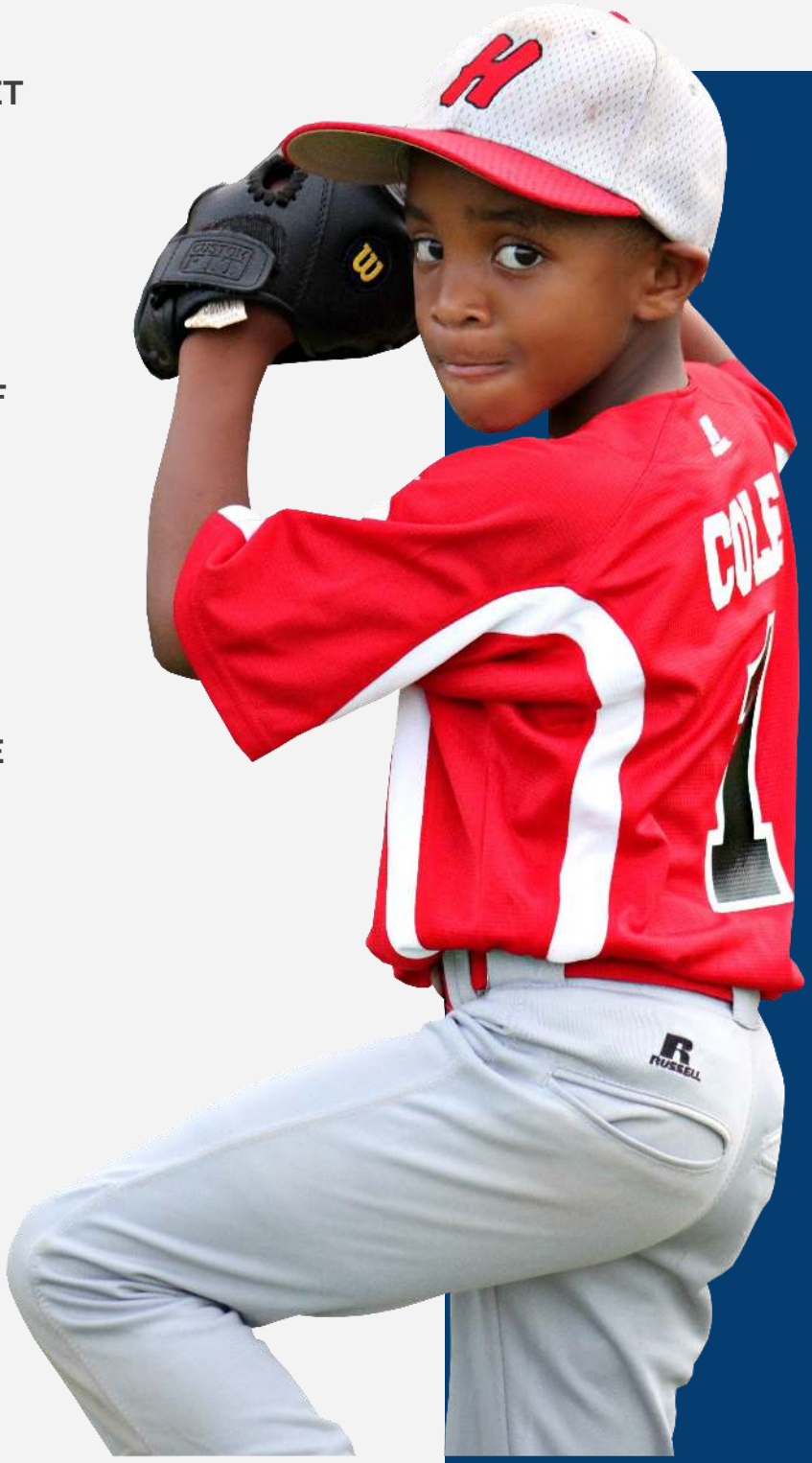
Youth Development

This month's top research on youth development.

MOVE TO GET STRONGER OR GET STRONGER TO MOVE?
Collins, H. et al. (2019) Sports Medicine-Open.

WHAT COACHES SAY TO THEIR YOUTH ATHLETES: THE ROLE OF CUES IN JUMP PERFORMANCE
Collins, H. et al. (2019) Sports Medicine-Open.

IS ONE JUMP ENOUGH? MONITORING LANDING ERROR SCORE SYSTEM OVER MULTIPLE REPETITIONS
Scarborough, D. M. et al. (2019) Sports Health.



[Abstract]

Move to get stronger or get stronger to move?

OBJECTIVE

Fundamental movement skills (FMS) are strongly related to sports participation, physical activity, and health and wellbeing. To develop FMS, resistance training has been suggested as a useful intervention.

However, little is known about the direct benefits of resistance training on FMS through research. Therefore, the purpose of this meta-analysis was to examine the effect of resistance training on FMS in youth.

WHAT THEY DID

A number of databases were searched from June 2017 (PubMed, MEDLINE, ERIC, PsycINFO, Embase, SPORTDiscus and Scopus) using the following criteria:

⇒ Participants had to be between the ages of 5-18 years.

⇒ No studies were included where a pathological condition, disability, neurological or behaviour disorder were present. Unfortunately, the aforementioned disorders or conditions may have differential adherence to a resistance training programme and require more tailored approaches which was out of the scope of this study.

⇒ Studies where plyometric, vibration, or neuromuscular training were discounted from the review.

Out of the initial 5522 studies that were identified, 85 studies met the inclusion criteria. After more detailed analysis, 22 studies were used in this meta-analysis.

WHAT THEY FOUND

The authors suggest that resistance training is likely to have a positive effect on a number of FMS in youth. From the studies analysed, sprint (Hedges' g = 0.292, 95% CI = 0.017-0.567, p = 0.038), squat jump (Hedges' g = 0.730, 95% CI = 0.374-1.085, p < 0.001), standing long jump (Hedges' g = 0.298, 95% CI = 0.096 -0.499, p = 0.004), throw (Hedges' g = 0.405, 95% CI 0.094- 0.717, p = 0.011) and vertical jump (Hedges' g = 0.407, 95% CI 0.251- 0.564, p < 0.001) performance were found to improve following resistance training.

» **Practical** Takeaways

⇒ Muscular strength supports the development and progression of motor skills.

⇒ Functional changes to muscles (i.e. changes in motor unit coordination), and structural (i.e. muscle hypertrophy) may bring about changes to skill acquisition.

⇒ An individual's stage of maturation has no effect on the development of fundamental movement skills.

⇒ The squat jump and resistance training had a large effect size on FMS, particular sprinting ability.

⇒ FMS - when combined with resistance training - should lead to improved outcomes (e.g. a goblet squat should lead to improved running speed) over just one method alone.

⇒ FMS test needs to incorporate both product-oriented assessments (such as jump height) and process-oriented assessments (such as movement skills batteries).

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

Tom's **Comments**

"FMS are the building blocks of more complex and challenging skills. Developing locomotor, stability, and object control is essential, allowing athletes to open their movement toolbox during the ever-changing landscape of sport. In the attached podcast, Sarah Williams discusses what is currently happening in Physical Education with regards to FMS, behaviour management strategies in classrooms, and how to engage the youth of today (see podcast below). This changed some of the ways I thought about youth work and gave me an idea of alternative practice, such as teaching games for understanding and some new game ideas.

The current curriculum in the UK is designed for weight-bearing activities for the purpose of improving muscular strength and bone health. Now, more than ever, children need skilled S&C practitioners to support schools in the design and implementation of quality strength initiatives. Studies, such as this one, serve as a valuable resource for parents and schools by defending our position that S&C is safe, ethical, and appropriate for young children. Many of the activities that children engage in during free-play (e.g. jumping, landing, climbing) already require strength. We should use this angle to approach schools or clubs to support our industry."

[Abstract]

What coaches say to their youth athletes: the role of cues in jump performance

OBJECTIVE

To develop a level of competence amongst athletes, coaches use verbal instruction to focus on the key performance indicators of a given movement. An internal cue directs the athlete to focus on a specific body part or specific action (e.g. "…knee below 90°…"). External cues though, has athletes focus on the outcome of a movement (e.g. "…visualise yourself sitting in a chair whilst you squat.").

Choosing the appropriate cues, at the right time, can lead to performance enhancement. The aim of this study was to compare the effects of an internal and external instruction on force-time characteristics of the countermovement jump (CMJ).

WHAT THEY DID

Forty-three well-trained NCAA division baseball players (20 ± 1.5 yr) were recruited for this study. Groups were randomly assigned to either an internal or external instructions group. The internal group were told to concentrate on extending their knees and hips as explosively as possible. The external group were told to concentrate on pushing away from the ground as explosively as possible.

Each participant performed a total of 16 CMJ's on a force platform while holding a wooden dowel overhead to eliminate arm contribution. Jump height (JH), peak velocity (PV), mean concentric velocity (MCV), and eccentric rate of force development (ECC -RFD) where measured from each CMJ performed.

WHAT THEY FOUND

Subjects who were instructed to use an external focus demonstrated significantly ($p < 0.05$) greater JH, PV, MCV, and ECC-RFD compared to those who performed the CMJ using an internal focus of attention. A moderate to large positive effect size (Cohen's d) was found for each variable. The examples of internal vs. external cues can be seen below:

⇒ Jump Height (cm), external cue (48.0 ± 5.6), Internal cue (46.4 ± 5.4).

⇒ PV (M·s_1), external cue (3.59 ± 0.30), Internal cue (3.51 ± 0.31).

⇒ MCV (M·s_1), external cue (2.31 ± 0.22), Internal cue (2.25 ± 0.23).

⇒ ECC-RFD (N·s_1), external cue (1512.5), Internal cue (1461.2 ± 1.73).

» **Practical** Takeaways

⇒ External cues drive increased force-producing capabilities, velocities, and eccentric/concentric qualities in jumping ability.

⇒ External cues load the working memory, priming the mind to perform the skill (some examples of these cues can be found in the podcast below).

⇒ Internal cues may be advantageous in supporting a child understand movement KPI's, but not necessarily performance. This can be explained in the constrained action hypothesis, where conscious attention on a movement can interfere with automatic motor control which would normally regulate movement. For further reading, page 4 of the study is recommended.

⇒ Based on the constrained action hypothesis, elite performers are more successful as they adopt "non-awareness" strategies, distancing them from conscious thought.

⇒ Performing four CMJ's with 5-6 sec between repetitions can lead to significant improvements in performance and could be programmed weekly.

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

Tom's **Comments**

"The correct coaching cue used at the appropriate time, can have a clear impact on performance. As a coach, I have found that incorporating equipment into training activities can serve as a valuable method to cue externally. For example, I will ask my footballers to jump and "…head through the ball". Anecdotally, this tends to get the athletes to jump higher and keep their motivation high.

Within finer movements (e.g. a squat), I've found that a mix of cues are advantageous when looking to refine a movement or skill. At times, asking a child to have an external focus of attention just doesn't beat the specificity of an internal focus (e.g. "…get your knees to parallel."). Nevertheless, some great cues can be seen in the video below which you can exhaust before seeking a more specific cue. In future research, I'd like to look at the periodisation of internal vs. external cues, but furthermore, understand the ratios of use with children of varied ages. For example, in the long-term, do children with more external cueing from their coaches learn and develop the same as those whose coaches only use internal cues?"

[Abstract]

Is one jump enough? Monitoring landing error score system over multiple repetitions

OBJECTIVE

Neuromuscular control plays an important role in the maintenance of anatomical alignment and dynamic control during landing tasks. An inability to hold these positions, such as collapsing after jumping, places athletes at a large risk of injury. To assess neuromuscular control, the Landing Error Scoring System (LESS) and drop vertical jump (DVJ) have previously been used.

However, few studies have compared multiple jump LESS scores. The aim of this study, therefore, was to further investigate if LESS landings are different between a single and multiple jump.

WHAT THEY DID

Forty-four female high school and collegiate athletes (mean age: 16.45 ± 2.59 yr) were recruited for this study, with a total of 13 gymnasts and 31 softball players. All subjects performed three DVJ from the edge of a 31 cm foam box (see video below). All jumps were recorded as a two-dimensional video and were assessed for all participants to calculate the LESS scores. To determine the variability between the first and second landings, the mean and standard deviations were calculated and compared using a Wilcoxon signed-rank test.

WHAT THEY FOUND

Significant effects were reported ($p < 0.01$) between the first and second DJV landings. All participants in this study demonstrated higher LESS scores (indicative of poorer landing mechanics) during the second DVJ landing (10.10 ± 2.25 (LESS Score)), compared to the first landing (6.97 ± 2.72). This resulted in a 45% change between the LESS scores from landing one, compared to two.

Softball players had significantly greater landing variability between the first (8.23 ± 2.66) and second (9.79 ± 2.04) scores when compared to gymnasts, whose LESS scores were more consistent between landings (Jump 1 = 6.44 ± 2.60, Jump 2 = 10.23 ± 2.35).

» **Practical** Takeaways

⇒ Performing one jump in isolation should be avoided due to the variability seen between repetitions, and therefore, performing multiple jumps may be more representative of the variety seen in sports performance.

⇒ Between jumps, there was less variability in the gymnast performance compared to the softball players. This could be partly explained by gymnast's requirement to land in a consistent manner frequently to avoid point deductions in competition.

⇒ Variability in jumping performance can be reduced by repetition, reinforced with good technique as shown by the gymnasts.

⇒ LESS testing is a valid and reliable measure of jumping ability, providing it is done for more than one repetition. For a more realistic approach, warm-up repetitions may be helpful to support a less "thought-out", and more natural performance.

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

Tom's **Comments**

"As seen in this study, the variability seen in jump performance between repetitions can be large, which can also increase during maturation. The ability for some individuals to perform multiple jumps to a high level can be difficult when the body is adapting. From these results, it is important to acknowledge that whilst gymnasts produced similar jump patterns, decreased flexion at the hip, knee, and ankle is biomechanically unfavourable, increasing ground reaction forces, and thus, increasing the risk of injury. The attached podcast by Daniel Martinez discusses this in greater detail.

In this study, the "rebound" action was instructed to be performed immediately after landing. However, with no valid method to assess ground contact time, it can become difficult to quantify jump quality with no knowledge of how long they are spending on the ground. From a height of 31 cm, ground contact time for some individual's may have been long (>250 ms), indicative of poor force absorption and production ability (see article below). Whilst the athlete may have scored well on using the LESS system, numerical data collected by a force plate or jump mat system may have indicated otherwise. An inability to absorb force from height can be a leading contributor to muscular and tendon injuries in the ankle, knee, and hip."

Nutrition

This month's top research on nutrition.

THE IMPORTANCE OF NUTRITIONAL INTAKE DURING THE ACUTE STAGES OF ACL RECOVERY

Anderson, L. et al. (2019) International Journal of Sport Nutrition and Exercise Metabolism.

DOES BONE BROTH REALLY HAVE THE BANG FOR THE BUCK?

Alcock, R. D. et al. (2019) International Journal of Sport Nutrition and Exercise Metabolism.

THE NUTRITIONAL REQUIREMENTS FOR SINGLE- AND MULTI-SPORT ATHLETICS

Sygo, J. et al. (2019) International Journal of Sport Nutrition and Exercise Metabolism.

[Abstract]

The importance of nutritional intake during the acute stages of ACL recovery

OBJECTIVE

Anterior cruciate ligament (ACL) injuries are common among team-sport athletes, often resulting in surgical reconstruction. During the progressive recovery phases following this reconstruction, athletes are likely to experience different energy expenditures, and as such, nutritional intakes should be tailored to each phase in order to maximise recovery. Indeed, previous work has shown whole-body fat-free mass losses of 5.8 kg in the first 8 weeks of rehabilitation (refer to the article below), highlighting the importance of adequate nutritional intake to minimise losses in muscle mass.

The aim of this case-study was to quantify the energy expenditure (using the gold standard method of doubly labelled water) and daily energy intake during a 7-day training week occurring 6 weeks after surgery from a single soccer player. The authors also present whole-body and regional changes in body composition during the rehabilitation period (38-weeks).

WHAT THEY DID

The soccer player was 23 years old, body mass 77 kg, height 179 cm, internationally capped, and was competing in the English Premier League at the time of the study. The player had been a full-time professional since the age of 18, engaging in daily structured soccer-specific training for more than 5 years.

The following variables were assessed throughout the study period:

⇒ Whole-body DXA assessment 6 days prior to the injury and 12-, 18-, 28- and 38-weeks following surgery.

⇒ Energy expenditure via the doubly labelled water method.

⇒ Energy and macronutrient intakes reported in week 6 by remote food photographic method, 7-day food diaries, and daily 24 h recalls.

The player's 'typical day' started at 8:30 am ending at 4 pm (Monday-Saturday) and included a comprehensive rehabilitation programme which can be viewed in Table 1 within the main manuscript (see Abstract link above). Sunday represented a non-training day.

WHAT THEY FOUND

Nutrition:

The player adopted a skewed approach to feeding where energy and macronutrients were consumed in a hierarchical order of dinner, lunch, breakfast, and snacks. Irrespective of the order of nutritional intake, the player was successful in achieving the prescribed daily energy intake on 4 of the 7 days, where mean daily energy intake was 2765 ± 747 kcal·d^{-1}.

Interestingly, the mean daily energy expenditure during this period equated to 3178 kcal·d^{-1}, thus highlighting that the player was likely in an energy deficit on 6 of the 7 days.

Anthropometric Developments:

⇒ During the first 6 weeks, total body mass decreased by 1.9 kg, including a loss of 0.6 kg and 1.2 kg of fat-free mass and fat mass, respectively. In particular, the injured and non-injured leg lost 0.9 kg and 0.6 kg of fat- free mass, respectively.

⇒ Between weeks 7-38, fat-free mass increased by 1.0 kg in both the non-injured and injured legs, largely due to the fact the player had been advised to increase daily energy intake. This also resulted in an increase of 0.7 kg of whole-body fat mass.

» **Practical** Takeaways

The results of this case-study provide great insights into the energetic cost of repairing injured tissues. Indeed, how many athletes going through rehabilitation from injury, lower their total daily energy intake, and as such, decrease carbohydrate and protein intakes because of concerns regarding unfavourable body composition changes, for example, gaining fat mass?

The results of this study show the importance of matching nutritional intake to the expenditure demands placed on the injured athlete. For example, in this case study, the player was in a mean deficit in 6 of the 7 days (energy expenditure: 3178 versus 2765 kcal·d^{-1}), possibly slowing down the recovery process during his rehabilitation.

Over many weeks, injured athletes can actually spend more time at the training facility, more time in the gym, and more time receiving treatment than non-injured athletes. These extra demands can result in increased energy expenditures, with the injured player in this case-study actually expending 300 kcal·d^{-1} more than that a non-injured goalkeeper from the same team (see **HERE**).

To this end, practitioners working with athletes during rehabilitation should individually plan a nutritional strategy that aligns closely with the progressive phases of recovery and therefore increases in energy expenditure.

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

James' **Comments**

"Case-studies, in particular, those that are performed on injured athletes, tend to always lack power of sample size. However, credit should be given to Anderson and colleagues on collecting gold standard energy expenditure data and very tightly controlled energy intake data throughout a specific week during rehabilitation.

The results of this study provide readers (and me) with really powerful take-home messages regarding the importance of nutritional intake and recovery from surgical injury. During this recovery phase, the energetic cost of repairing injured tissue is high and advising players to decrease total energy intake too much may actually prolong the total duration of the rehabilitation period and have a negative effect on the rehabilitation of your athlete.

In my own experience, the rehabilitation period is a time in an athlete's career where education around energy balance, meal timing, meal composition (further information in the podcast and infographic below), and overall importance of nutritional intake can really be embedded. Lastly, the successful return-to-play projects I have personally worked on have always been performed by working closely with the medical team and this would be highly recommended to readers."

[Abstract]

Does bone broth really have the bang for the buck?

OBJECTIVE

Collagen is the most abundant protein in the body, playing a role in force transmission and joint stability, providing resistance to forces, and sudden directional changes that might otherwise contribute to injury. As such, many sports nutrition professionals are recommending increased intake of collagenous protein sources (such as gelatine) to aid repair and accelerate return-to-play following injury, with common recipes including bone broths.

However, to date, the composition of amino acids in bone broths recipes has not been investigated. Accordingly, the aim of this study was to assess the amino acid composition of typical bone broth recipes and then compare these compositions to a 20 g dose reference supplement.

WHAT THEY DID

The authors developed standardised broths which were made to the same recipe each time whilst non-standardised broths varied by:

⇒ Source of the bone (i.e. chicken vs beef).

⇒ Type of the bone (i.e. standard soup bone vs. marrow bones).

⇒ Cooking methods.

Additionally, two separate samples of gelatine, a collagen peptide powder, as well as, one sample of liquid collagen and a hydrolysed collagen powder were purchased, resulting in a total of 28 samples being analysed.

Full amino acid profiles were then analysed to compare home bone broths and pre-prepared purchased supplement samples.

WHAT THEY FOUND

The main findings of this study were:

⇒ A typical serve of bone broth, made according to standardised protocols, were consistent in amino acid profile, but were below those found in supplement products supplying 20 g therapeutic dose.

⇒ Although some of the non-standardised bone broths has comparable amino acid profiles to the supplement products, their composition was varied.

⇒ Both bone broths and supplements targeting collagen synthesis were low in leucine, the amino acid that has been proven to promote muscle protein synthesis.

Therefore, it is unlikely that a single serve of bone broth alone can provide both reliable and high levels of key amino acids that are required to target collagen synthesis. Furthermore, all dietary or supplemental sources of collagenous tissue are inadequate in providing the key amino acid leucine, which is known to promote the activation of new proteins within skeletal muscle.

» **Practical** Takeaways

Bone broths appear to still be very valuable with an athlete's diet, with beef broths providing higher amino acid concentrations for all amino acids compared to chicken. However, the variability in amino acid concentration between one broth to the next is reported to be rather high, and as such, it may be more beneficial to consume a therapeutic dose.

Indeed, for those practitioners working with both injured and non-injured athletes, consideration of adding in both whey protein and a commercially-purchased collagen would be of benefit in the prevention of injury and recovery following an injury, rather than just a simple bone broth recipe made at home which naturally is a poor source of leucine (the main driver or muscle growth and recovery).

The three key messages here are:

1) Make home bone broth from beef rather than chicken.

2) It should be consumed alongside a known supplement dose of collagen.

3) Whey protein should be consumed at regular times throughout the day.

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

James' **Comments**

"I think the results this study, if used in the correct way, can be applied very practically for those readers working with most athletes. This really is a topic area that has gained lots of attention over the last few years. Research from Keith Baar's lab (refer to the video and podcast below) was work that I personally read and cited when adopting the use of bone broths with the rugby players I used to work with for injury prevention, and to help accelerate return from injury. What I like most here, is how the authors have taken a topic that many practitioners are currently adopting, investigated the efficacy of certain food types, and have compared it to a known therapeutic dose for comparisons.

Readers should now apply the take home messages to support the athletes they work with and also may want to consider other means of combining the intake of collagen and whey together. One example of a recipe can be found in the article below, whereas, this is one that I've used extensively for protein jellies:.

⇒ 84 g Gelatin (Dr Oker).

⇒ 200 g whey protein.

⇒ 1.2 L semi skimmed milk.

⇒ 300 ml hot water."

[Abstract]

The nutritional requirements for single- and multi-sport athletics

OBJECTIVE

Elite athletics places unique demands on athletes depending on the event being performed. For example, throws, jumps, and combined events (e.g. decathlon) all require individual qualities (speed, strength, power, and technical skills), and when combined with specific nutritional guidelines, can be used to support winning performances.

This scholarly review aimed to update the International Association of Athletics Federation (IAAF) nutrition consensus statement, focusing on ergogenic aids and nutritional strategies to support performance and health in these events.

WHAT THEY DID

Considering this is a scholarly review, the authors gathered new research to update previous nutrition strategies (see article below). Using this new evidence, the authors have written guidelines to support training adaptations, the use of ergogenic supplements for training or competition, and strategies to periodise body composition for jumpers, throwers, and combined field-event athletes.

WHAT THEY FOUND

While all these athletes represent a wide range of different somatotypes, they share similar emphasis on Type IIa and IIx muscle fibre activation, biomechanical (e.g. increased tendon stiffness), and favourable body composition profiles specific to individual events.

Athletes who benefit from expertly tailored nutrition interventions (e.g. strategic pre-competition strategies that use ergogenic aids), and with consideration of the athlete's performance goals, are more likely to improve their chance of winning performances.

Across all sports, while alterations to energy intake varies across the season and may be required to achieve optimal body mass and body composition for performance (e.g. to optimise power-to-weight ratio), this should be taken with care to prevent health consequences such as low energy availability.

» **Practical** Takeaways

I think its key for the readers to appreciate that although athletes in both track and field events differ substantially in both training demands and in competition format, they share somewhat similar nutrition strategies. Further, athletes competing in track and field events can benefit from nutrition strategies that are tailored to individual needs to support health and performance. With this in mind, nutrition strategies should be periodised over each training cycle and focus on high-quality nutrient-dense foods which is discussed well in the podcast below. Specifically, the review suggests:

⇒ Jumpers tend to have a lower body mass and benefit from higher protein (1-5-1.8 $g kg^{-1}$) and lower carbohydrate intake (3-6 $g kg^{-1}$). While, throwers tend to have a higher body mass with small differences between events, yet their nutritional needs are similar to jumpers.

⇒ Seven-event heptathlon and ten-event decathlon may benefit from 1.5-2 $g kg^{-1}$ protein and moderate carbohydrate intake (5-8 $g kg^{-1}$) to support a wide range of different training sessions and low body mass for jump and middle-distance events.

⇒ Ingestion of certain nutritional aids (e.g. caffeine, creatine, beta-alanine) at particular times would be beneficial to both practitioner and athletes.

For readers who would like to read further practical sports nutrition information for athletic athletes, then they are guided towards the article below.

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

James' **Comments**

"The review provides and emphasises valuable and updated practical applications to coaches and the nutrition practitioner working with athletics. This includes translating research-based recommendations to a combined events menu and showing what this looks like at major competition for IAAF. Furthermore, the authors have highlighted the key supplements that have a theoretical evidence base for performance enhancement across each event and the importance of having a nutritional expert under guidance for such usage. Indeed, guidelines during training, competition, and transition periods vary wihtin environmental and psychological conditions.

Overall, the paper could provide the practitioner with the appropriate nutrition programming for performance and health. The podcast below by Sophie Killer provides an insight into supplements for immune function, meal timing strategies, especially during travelling, and how to monitor and assess a large number of Olympic level athletes. The video below shows what some of the Canadian Olympic athletes eat during the Rio Olympic games."

Injury Prevention & Rehab

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

AVERAGE RETURN-TO-PLAY TIMES FOLLOWING COMMON FOOTBALL INJURIES

Ekstrand J. et al. (2019) British Journal of Sports Medicine.

DO CERTAIN PHYSICAL FITNESS ATTRIBUTES HELP DECREASE THE RISK OF INJURY?

Motte, S. J. et al. (2019) Journal of Strength and Conditioning Research.

ARE ISOMETRIC EXERCISES THE BEST OPTION FOR PATIENTS WITH TENDINOPATHY?

Silbernagel, K. G. et al. (2019) British Journal of Sports Medicine.

[Abstract]

Average return-to-play times following common football injuries

OBJECTIVE

One of the first things every athlete wants to know after sustaining an injury which impacts their ability to take part during match-play, is when they can play again. The return-to-sport (RTS) decision making process can often be difficult to navigate by the support staff and the athlete, with (in most cases) no clear and valid criteria.

This study, determined the typical RTS times for the most common injuries in men's professional football, to provide sports medicine staff with relevant prognostic information.

WHAT THEY DID

Utilising prospectively collected data from the Union of European Football Associations (UEFA) Elite Club Injury Study (ECIS), a post-hoc analysis was performed to determine the average RTS times for the most common football-related injuries.

The data set included 22,942 total injuries from 116 teams from 24 different countries, over the course of 1-16 seasons, for a total of 494 team-seasons.

WHAT THEY FOUND

Over 75% of all injuries were made up of 31 diagnoses. Most injuries were mild, which meant they had an average RTS time of less than 7 days. Moderate injuries (8-28 days RTS) accounted for >60% of all absence from sport participation amongst these elite football players. The six most common diagnoses for moderate injuries included:

⇒ Structural hamstring injuries (median 13 days RTS).

⇒ Groin pain (median 8 days RTS).

⇒ Lateral ankle ligament injuries (median 8 days RTS).

⇒ Structural quadriceps injuries (median 13 days RTS).

⇒ Structural calf injuries (median 13 days RTS).

» **Practical** Takeaways

This paper is useful for clinicians because it provides prognostic information of the most common injuries seen amongst footballers. This study also showed that the RTS times for a re-injury were generally longer than for the initial injury. This shows the importance of aiming to reduce the risk of injury recurrences.

Recent studies have shown that there are specific exercises that can be done to help prevent some of these common injuries. A number of studies have shown that performing the Nordic hamstring exercise as part of a dynamic warm-up and injury risk reduction program in football teams can significantly reduce the risk of hamstring strain injury, as well as, re-injury amongst male football players (see **HERE** and **HERE**). Another example of an effective exercise that can help to reduce injuries amongst football players, this time with regards to groin injuries, is the Copenhagen adductor exercise (see **HERE**).

It is also recommended that support staff who work with footballers should look to implement the FIFA 11+ Program, as this has been reported to reduce the risk of common soccer injuries (see **HERE**).

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

Nicole's **Comments**

"In this study, all subjects were male professional soccer players with access to high-quality care. For those who work with other populations, the RTS times would likely be longer. Those working outside of the professional sport environment can still utilise these median RTS times as a guideline, but should recognise that the male professional soccer players included in the data from this study, were able to attain early diagnoses, and make rehabilitation their top priority. They more likely had greater access to more advanced technologies such as isokinetic dynamometers, GPS monitoring, underwater and Alter-G treadmills.

The general population and amateur athletes most likely do not have the same access to this quality and have commitments outside of their rehabilitation such as jobs, schooling, and other priorities that might detract time away from their rehabilitation."

[Abstract]

Do certain physical fitness attributes help decrease the risk of injury?

OBJECTIVE

Physical fitness assessments are typically completed amongst military personnel and for athletes in order to determine their level of fitness and screen for modifiable risk factors of musculoskeletal injuries. This is based on the assumption that being more physically fit will lead to fewer musculoskeletal injuries.

However, the exact relationship between physical fitness and injury risk has not been clearly established. This article - part 3 in a series - examined the association between several key components of physical fitness and musculoskeletal injury risk amongst the military and athletic populations.

WHAT THEY DID

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and searched for articles from 1970 up to 2015 on EMBASE, Ebsco, MEDLINE, and the Defense Technical Information Center.

Studies were included if they:

⇒ Reported participants' physical fitness and musculoskeletal injury data.

⇒ Included military or civilians aged 18-65.

Studies were excluded if:

⇒ They utilised self-reporting for injury data or if they reported any injuries other than musculoskeletal injuries.

⇒ Were a systematic review, case study, case series, or a literature review.

From this inclusion and exclusion criteria, 27 studies were identified, of which 16 studied athletic populations and 9 used at military personnel. The authors were specifically looking for studies done on flexibility, power, speed, balance, and agility. None of the included studies assessed agility and injury risk, so that aspect of fitness was not able to be analysed .

WHAT THEY FOUND

Flexibility

⇒ Limited evidence that decreased quadriceps flexibility was a risk factor for hamstring strain injury.

⇒ Moderate evidence supporting the association between hamstring flexibility and hamstring injury risk, but some studies showed that greater flexibility was a risk factor, whereas others showed that decreased flexibility was.

Power

⇒ There is an association between power and injury risk.

⇒ While some studies showed that increased power led to a decrease in injury risk, others found that those with greater power had an increased risk of injury.

Speed

⇒ Moderate evidence supporting that slower speed during sprints is associated with increased risk of injury.

Balance

⇒ There is moderate evidence to suggest that poor balance is associated with increased risk for ankle sprains.

» **Practical** Takeaways

This study shows us that there is at least some evidence to support that flexibility, power, speed, and balance, are associated with musculoskeletal injury risk in both athletic and military populations. We can utilise this information in both injury screenings, and in programming.

While items such as cardiovascular fitness and muscular endurance are often tested in both the military and athletic populations, this systematic review highlights that we should also be looking at sprinting speed, balance, power, and, to a lesser extent, flexibility. These components of physical fitness can also be included in injury risk reduction interventions.

We can utilise the information from this systematic review to create athlete, team, or activity-specific injury risk reduction programs and including speed, power, balance, and flexibility training.

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

Nicole's **Comments**

"It was interesting that although flexibility was associated with injury risk, the studies analysed in this review found that both longer and shorter hamstring length were predictors of injury. However, the studies included in this review that found an association between greater hamstring flexibility and injury risk utilised a sit-and-reach test to assess hamstring flexibility which may not have adequately isolated the hamstring muscles. Other studies (see **HERE**) have found that shortened biceps femoris fascicle length is associated with increased risk of hamstring strain injury.

It was also interesting that some studies found that greater lower-body power led to increased risk of injury. One particular study analysed within this review looked at soccer players and found that those who jumped higher were at an increased risk of injury. This may simply be a proxy for those players who find themselves in more dangerous situations while playing, such as going up for headers. I would still assess and train lower-body power in athletes despite the finding from that one study."

[Abstract]

Are isometric exercises the best option for patients with tendinopathy?

OBJECTIVE

Ever since the work of Ebonie Rio which showed that isometric exercises can help decrease pain that is associated with patella tendinopathy (see **HERE**), the results of this research have been applied to various different tendons by clinicians in an attempt to decrease pain and load the pathological tendon.

The authors of this study wanted to examine the strength of the literature supporting the use of isometric exercises for the management of tendinopathy.

WHAT THEY DID

The authors of this review and editorial addressed three key questions:

1) How strong is the evidence to support the use of isometrics for tendinopathy?

2) Should we be trying to alleviate acute pain in patients with chronic tendinopathy?

3) Is an isometrics-based protocol superior to other treatments?

The authors cited several key papers pertinent to isometric loading for tendinopathy and gave their best clinical reasoning based on their extensive experiences in both research and clinical practice.

WHAT THEY FOUND

In response to their three primary questions, the authors suggested:

1) Isometric exercises were not found to provide acute pain relief in patients with Achilles tendinopathy, plantar fasciopathy, or lateral elbow tendinopathy (of the common extensor tendon). Furthermore, the original study by Ebonie Rio has not been able to be replicated in future research.

2) Patients with tendinopathy experiencing pain during exercises is not detrimental to their recovery, and may even be helpful.

3) As evidenced from a particular study the authors make reference to within the review (see **HERE**), there is no difference in pain relief between isometric and isotonic exercises amongst athletes with patellar tendinopathy.

» **Practical** Takeaways

This literature review and editorial suggests that there may still be a role for isometric exercises in the management of tendinopathy, but that it has been too readily adapted without full and proper investigation into its clinical utility.

The use of isometric exercises for acute reduction in pain may actually be more harmful then beneficial, as the aim of the rehabilitation program should focus on long-term function rather than just short-term pain relief. In fact, it may be more beneficial to perform exercises that actually cause some degree of discomfort.

Clinicians and patients may be getting the wrong message in simply trying to decrease pain in the immediate future as the process for longstanding tendinopathy is a lengthy one, and we should not be making short-term pain relief the goal of the rehabilitation program.

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

Nicole's **Comments**

"I personally will still occasionally prescribe isometric exercises for patients with tendinopathy. Usually, I find it beneficial to prescribe isometrics to patients who are fearful of or otherwise avoiding performing near-maximal contractions of the involved structures. For example, I will often prescribe submaximal isometrics for patients who have just undergone anterior cruciate ligament reconstruction in order to get them more comfortable performing quadriceps contractions again.

I will also prescribe isometrics when I still want to load the involved tissue, but not too much. An example of this would be when an athlete is beginning to increase their running mileage. On a running day, I may prescribe isometrics to still selectively load the target tissue and will save heavier isotonic loading for a day in which they are not running."

Infographics

A round-up of our monthly research infographics.

PLOYMETRICS

Solomon, M. (2019) Science for Sport.

TACTICAL STRENGTH AND CONDITIONING

Solomon, M. (2019) Science for Sport.

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PLYOMETRICS

SCIENCE for SPORT

Key information

Plyometric training involves the usage of jumps, hops, bounds, and/or skips. This form of training is governed by the stretch-shortening cycle (SSC), and therefore should not be confused with ballistic training.

SSC

In the SSC the muscle undergoes an eccentric contraction, followed by a transitional period (amortisation phase), prior to the concentric contraction.

Short vs Long

Plyometric exercises can be classified as short (<0.25s) or long (>0.251s).

Performance

Plyometrics can improve physical characteristics, including but not limited to:

- Strength
- Power
- Speed
- Jumping

Neurophysiology

There are many potential mechanisms underpinning the performance enhancing effects of plyometrics including but not limited to:

- Storage and use of elastic energy
- Motor coordination

Caution

Plyometrics are highly coordinated and potentially high intensity movements they therefore require careful attention.

Our Summary

Plyometric training develops the neural and musculotendinous systems of the SSC to generate maximal force in the shortest amount of time. Therefore plyometrics are often used in strength and speed training.

For the full article check out the Science for Sport website

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Tactical Strength & Conditioning

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What is it?

Tactical S&C is the application of S&C principles in a tactical (e.g. military, law enforcement, etc.) training environment.

Importance

Not only is tactical S&C important for physically preparing the athlete for the high-operational tempo, but it also plays a role in protecting the athlete from injury.

Unique

There is often a misguided attempt to directly apply the traditional sport model of S&C principles to the warfighter. This may be inappropriate when preparing soldiers for today's organic and fluid battlespace and deployment schedule.

Goals

Tactical S&C can be thought of as a multidisciplinary approach to the repair, maintenance, and performance optimisation of the tactical athlete in order to maximise their effectiveness on the battlefield.

Periodisation

Tactical periodisation requires great creativity and adaptability.

Recovery

Strength and endurance are basic and linear, metabolic conditioning tends to be higher volume at lower intensities, rehab work is reactive.

Transition

A short phase where focus shifts from the previous deployment to preparing for the next one.

Base

Intensity is preferred to volume. Complex movements and/or circuits are introduced to address 'tactical' training (e.g. speed, agility, and work capacity).

Tactical

Programming becomes almost exclusively sport-specific. Volume and intensity should both be high.

Our summary

As the demand for high-level operators increases around the globe, and as high-operational tempo takes its toll on tactical athletes, the role of tactical strength and conditioning will only increase in the future.

For the full article check out the Science for Sport website

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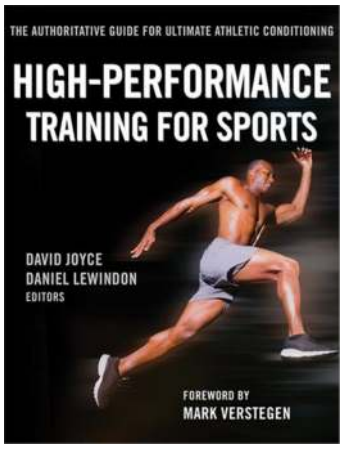

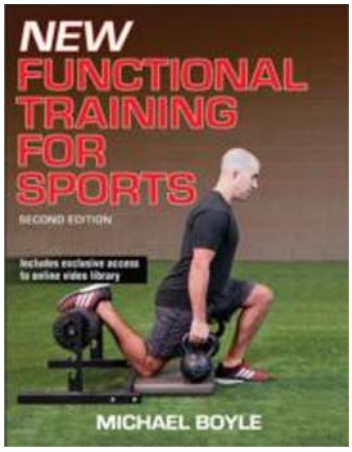

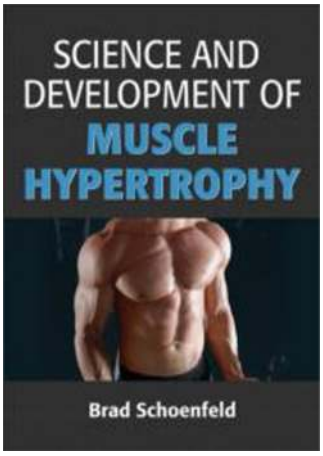

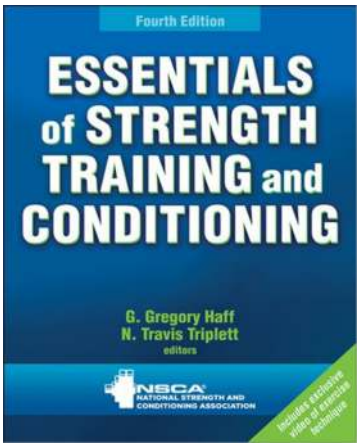

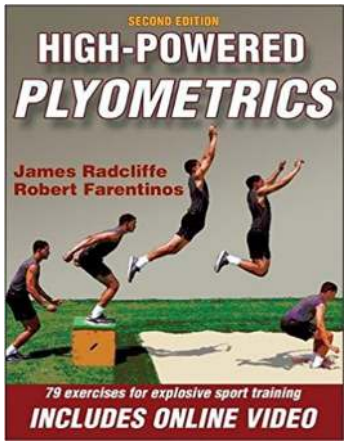

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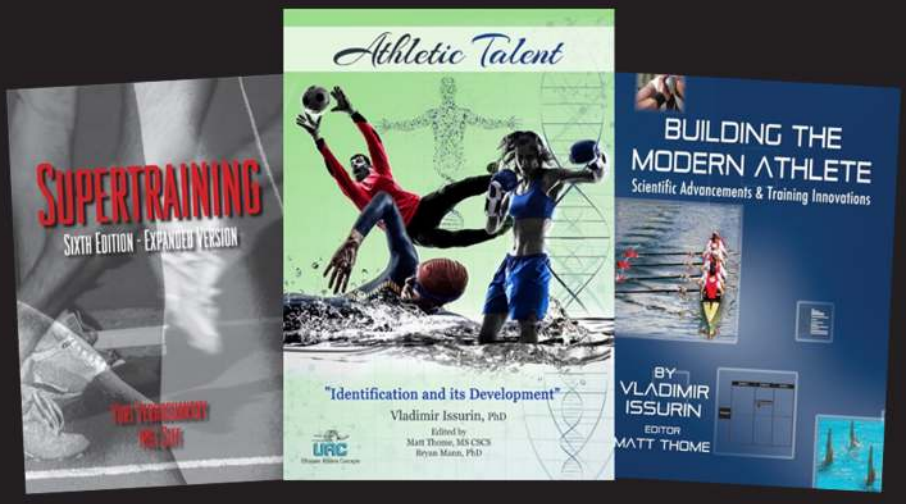

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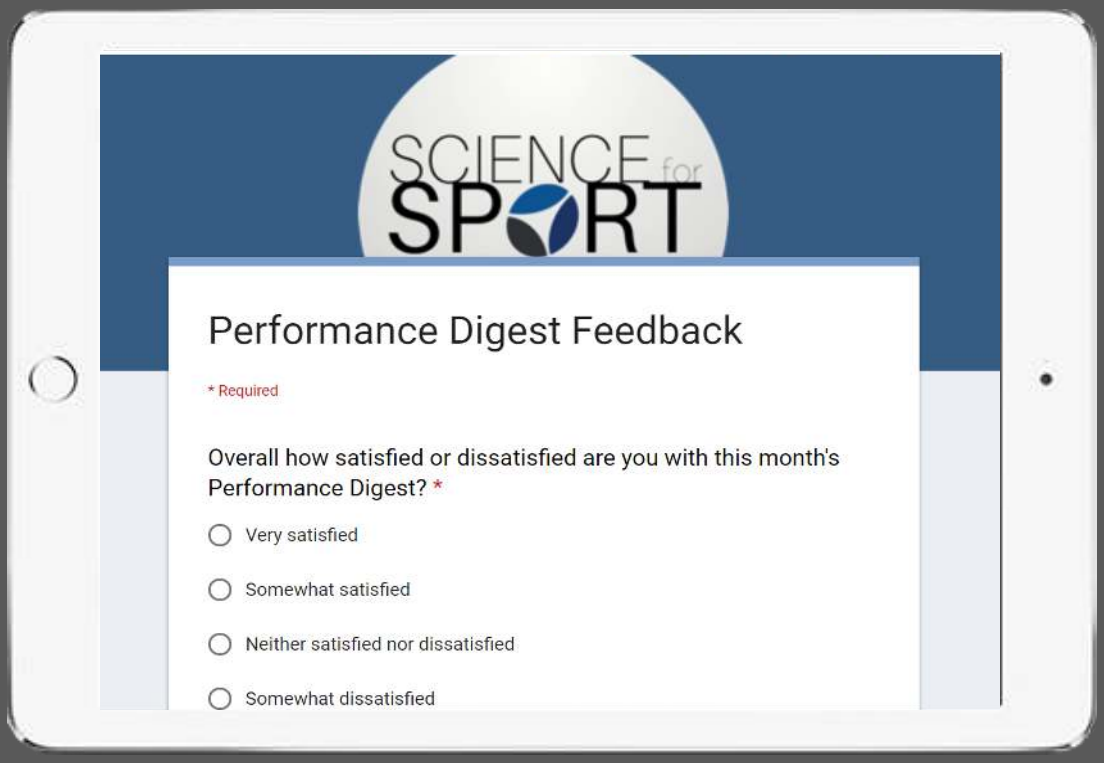

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Warm Regards
Science for Sport