

## Athletic Performance at the 23rd Annual Meeting of the European College of Sport Science

Will G Hopkins

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Institute for Health and Sport, Victoria University, Melbourne, Australia. [Email](#). Reviewer: David Rowlands, Massey University, Wellington, NZ.

The venue in Dublin and the conference itself were amongst the best yet. [Elite Sport Performance](#): notes from an interest-group meeting. [Accessing Abstracts and Videos](#): links to a search engine and downloads. [The Wow! Factor](#): the seven best presentations for sport performance. [Acute Effects](#): treatments for choking; augmented feedback and grunting for tennis serves; time-zone travel in rugby; cold-water immersion on protein synthesis; warm-up for skiers; re-warmup; foam rolling; compression garments; transcranial stimulation; electrolyte drink for cramp; small-sided football games; adhesion socks. [Injury and Health](#): FIFA 11+ enhanced; programs for volleyball and field hockey; AFL risks; concussion rugby; eccentric exercise for rehab; estrogen receptor gene risk factors; bone health. [Nutrition](#): blackcurrant extract; nitrate and beetroot; re-hydration; milk; amino acids; protein; making weight. [Performance Analysis](#): momentum in rugby; unpredictability in basketball; possession, head movements and sprint speed in football; serving in tennis; scoring in basketball; take-off in ski jumpers; sample-size issues. [Psychology and Sociology](#): mindfulness for handball and golf; choking in China; coach climate; conflict in a national sport body. [Tests and Technology](#): methods for biomechanical analyses; deep learning for gait analysis; validity of player tracking systems; Clearsky for team sports; Champdas live system for football; wrist IMU for football; CFD for ski jumping; a jump app; Gymaware for barbell exercises; suite of tests for youth football; new tests for football, futsal, squash, badminton, rowers; genetic correlates of rugby and endurance. [Training](#): quiet eye for golfers; breath-holding with repeated sprints; decreasing-distance intervals; variable-intensity intervals; intervals plus cryotherapy; memory of hypertrophy; force-velocity-power profiling; sprint vs strength for cyclists; plyometrics for football; sled towing for rugby; core for basketball; block vs undulating periodization for American football; resistance plus endurance; eccentric vs concentric; prescribed vs actual in rowers; blood-flow restricted in cyclists; hyperoxia in cyclists; microcurrent plus resistance; whole-body electrical stimulation; restricted feedback for gymnasts; passing for football; spatial occlusion goggles for football and badminton; visual for tennis; sleep for rugby. KEYWORDS: competition, elite athletes, ergogenic aids, injury, monitoring, nutrition, performance, talent identification, tests, training.

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Dublin turned on warm sunny days throughout this top conference, July 4-7. The Convention Centre Dublin was one of the best venues yet, as was the conference itself. Thanks heaps to the conference presidents Marie Murphy, Colin Boreham and Giuseppe De Vito, to their team from University College Dublin and Ulster University, and to the ECSS committees. Check out the statistics and logistics in the [official debrief](#). See who won the [young-](#)

[investigator awards](#), the [GSSI nutrition awards](#), and the [best articles](#) in *European Journal of Sport Science*. The [picture gallery](#) is also worth a look (password: ECSS2018).

### Elite Sport Performance

There were several concurrent attractions on the morning of registration. I opted for a special-interest group, [elite sport performance](#), which consisted of a panel discussion by five sport-science practitioners chaired by Stephen

Seiler. Some of the opinions expressed: reliability is still a challenge with the new monitoring technologies; the technology should enhance the coach's strategies and instincts; the sport scientist should help identify the important questions; the simple but effective Norwegian model is to do the best training with minimum of technology; university courses need to include communication "soft skills" and placements at the coal face; technology, massage, and other special attention and routines may provide a placebo effect of a positive mind set, but if you took them away, there might be a nocebo effect; the bigger the group of athletes, the more you need technology to keep track; you need a mentor; you need to get to know the coach as a friend; the practitioner's job is brutal, with few holidays, too much traveling, and all the blame when things go wrong; there aren't enough  $n=1$  studies applicable to athletes (but see [Sport Performance & Science Reports](#)); spend as much time as you can on the training pitch; reach out with an authentic desire to thank, learn, and network.

#### Accessing Abstracts and Videos

As in previous reports, I have focused on performance of competitive athletes. ECSS is, of course, much more, and this year a colleague at University College Dublin will be reporting on some of the other stuff in this journal.

To find abstracts in your area of interest, go to the [program page](#) at [Dublin conference site](#), where you can link to pages for each tier of presentation. Or download PDFs of the [full program](#) and the [full book of abstracts](#). To find the presentations I have reviewed, copy the presenter's name and initial shown in brackets [...] into the [search engine](#), or if you have downloaded the PDF of the abstracts, copy into the advanced search form (Ctrl-Shift-F) in the Adobe Acrobat PDF reader. Abstracts for this conference will eventually join those of previous conferences in the [EDSS database](#) (login required).

My apologies if you can't find your presentation in this report. Amongst the reasons I may have omitted yours: it was too difficult to understand your abstract (often because of an impenetrable thicket of abbreviations), the sample size was inadequate (less than 10 subjects per group, case studies excepted), there was little or no relevance to competitive athletes, and I was careless. I apologize also to the

experts who presented the state of their art in symposia that I have not summarized here: evidently I was unable to attend your symposium because of a program clash, and your abstract did not contain enough useful information to report.

#### The Wow Factor

My smallest important threshold for a worthwhile conference is at least one presentation worthy of a **Wow!** Here, in order of appearance under the headings below, are no less than seven presentations that earned this accolade: fist-clenching to [reduce choking](#); the FIFA 11+ as a [warm-up and -down](#); enhance performance and well-being with [mindfulness](#) (two abstracts); and [three training studies](#): quiet-eye with high attention, breath-holding with repeated-sprint training, and training with decreasing intervals.

None of the plenary presentations was relevant to athletic performance, but one I attended was perhaps the best presentation of the conference. The topic was determinants of population physical activity, and you can read about it in [another report](#) on the conference that will be published here soon.

The reviewer of this article commented to me that some abstracts would not have made the grade for the ACSM meeting. Maybe ECSS should have some guidelines for best practice in writing abstracts of qual and quan studies. Guidelines for abstracts of symposia might also help: too many of these were of the "results will be presented" variety. If we're going to have abstracts, we should be proud of them.

#### Acute Effects

**Wow!** "It's no **choke**" was the whimsical title of what for me was the best symposium. Choking is the impairment of performance of a skilled movement under competition pressure. Jürgen Beckmann presented his research showing that the impairment is reduced when right-handed athletes clench their left fist for ~15 s before the movement (penalty kicks in **football**, **tennis** serves, **gymnastic** routines). The effect is mediated apparently by increased alpha rhythm across the cortex. [BECKMANN, J.]. The chair, Denise Hill, presented 11 case studies of athletes who had chronic choking, some of whom she was able to help through resilience training and "by identifying and eliminating cognitive distortions". [HILL, D.]. The

abstract of the third speaker states that "theory-matched, evidence-based interventions that help athletes alleviate choking will be explained and demonstrated", but unfortunately he didn't show up. [MESAGNO, C.]

**Elite tennis** players served faster with **augmented feedback** compared with an external focus of control or augmented and external combined. Internal focus was another condition, but its effect was not reported. In a second study, players served significantly faster when **grunting**. In both studies the enhancement of service speed did not result in more service errors. [KELLER, M.]. I can't make this presentation a Wow!, because the only data in the abstract were p values, the treatments were not described, we don't know whether it was a training study or just acute effects, and the number and sex of subjects were not stated.

**Travel across multiple time zones** was associated with negative effects on sleep, well-being and match-performance indicators in 122 players from four **Super rugby** teams monitored for several weeks-months at home and overseas, but as a mediating covariate, sleep hours did not have clear effects on performance. [LO, M.]

"**Cold-water immersion** during recovery from resistance-type exercise attenuated the postprandial rise in myofibrillar protein synthesis rates" in this study of 12 healthy **males** who had one leg in cold water and the other in thermo-neutral water following the exercise. [FUCHS, C.J.] Find some other way to cool down?

Active **warm-up**, and active warm-up plus passive warm-up with a lower-body heated garment worked better than passive warm-up alone (by 2.2% and 3.2%) on 90-s cycle-ergometer mean power at  $-7^{\circ}$  in a crossover of 10 highly-trained **junior alpine skiers** (6 M, 4 F). [SPENCER, M.]

In a study of half-time **re-warmup** for team sports with 11 **healthy men** and cycle ergometer exercise, "a 3-min low-intensity re-warmup increased intermittent sprint performance [by 4.2%] over the 10-min following half-time compared with a passive rest." The claim that it was "as effective as a moderate-intensity re-warmup", which produced a 7.1% increase, was based on statistical non-significance. [YANAOKA, T.]. My advice: use the moderate-intensity re-warmup.

**Foam rolling** in 26 **subjects** "may be useful for transiently increasing range of motion." [DAMICO, A.]

"Wearing **compression garments** during 40 min of downhill running potentially exerted a protective effect against muscle damage in the 24-h following exercise" in a crossover of 13 well-trained **trail runners**. [EHRSTRÖM, S.]

In a double-blind randomized crossover with 12 **volunteers**, **transcranial direct current stimulation** over the left dorsolateral prefrontal cortex improved cycling time to exhaustion at constant power by 13% (equivalent to ~1% in endurance power output). [MARCORA, S.M.]. Nice, but no practical application?

Consumption of an electrolyte drink may have increased the threshold for **cramp** induced by electrical stimulation relative to that of water placebo, but it was only seven **subjects** (5 M, 2 F). [EARP, J.E.]. With 10 subjects this study would have earned a Wow!

A new **football** small-sided **match format** for 10-y old boys with 4 vs 4 and 7 vs 7 players "improved the variability, frequency of game situations and individual playing time by increasing the number of ball contacts, duels, and shots on the goal per player. However, high-intensity and total distance covered were reduced." [HINTERMANN M.]

"**Man-marking** during **football** small-sided games can substantially elevate perceptual load and running distances across a range of speed zones." [KILDING, A.E.]

In a study of 24 3rd-division **handball** players, "no definite superiority of performance could be established which would promote the use of **adhesion-enhancing socks** to enhance change-of-direction or sprint and jump performance", but there were high levels of satisfaction with the socks. [PRAETORIUS, A.]

### Injury and Health

**Wow!** Split the **FIFA 11+ injury prevention program** into a warm-up and a warm-down. In a randomized controlled trial of 806 semi-professional **Australian football** players from 20 clubs, the group who performed Part 2 of the program *after* training rather than *before* (when there is less compliance) experienced 43% fewer severe injuries and 27% fewer total days lost to injury during the 2017 season. [WHALAN, M.]

Read the abstract for an exemplary way **injury-prevention warm-up programs** were de-

veloped for **volleyball** and **field hockey**. [GOUTTEBARGE, V.]

A prospective study of 55 **elite Australian footballers** over two consecutive seasons identified several **risk factors for soft-tissue non-contact injuries**, which could combine to produce extremely large increases in risk (e.g., a hazard ratio of 22 for high acute training load, recent history of a leg injury, and a substantial reduction in the adductor squeeze test score). [ESMAEILI, A.]

I had to miss a symposium on **injury risk and prevention in rugby union**. Only one of the three abstracts contained anything useful: "two recent randomized controlled trials in the United Kingdom demonstrated up to 60% reductions in **concussion** rates in youth and adult populations through a progressive exercise-based intervention that included neck strengthening." [BROWN, J.]

Several factors in **tackles** that increased the risk of **concussion** were identified in this study of 23 concussion events in 402 **rugby union** players. [SUZUKI, K.]

From a symposium on **muscle injury**: "Low-level, controlled eccentric exercises performed early in rehabilitation have the potential to reduce pain inhibition and facilitate tissue adaptation." [GLASGOW, P.]

An allele of an **estrogen receptor gene** is associated with reduced **muscle stiffness** and increased risk of muscle injury, at least in Japanese **athletes**. [KUMAGAI, H.]

Angiogenesis genes were risk factors for **ACL injury** in this case-control study of an **unstated population**. [RAHIM, M.]

**Lead dust** from the shotgun pellets gets into the blood of Korean and presumably other **shooters**, and the level was related to unwillingness to participate in education about their training environment, poor personal hygiene, and years of experience. [NAM, S.]

For those interested in **bone health**, search the book of abstracts for OP-PM14 and you will find six good original-research presentations.

## Nutrition

Twenty experienced **climbers** performed better by ~10% (it's a bit ambiguous) in climbing-specific time-to-exhaustion tests after consuming **blackcurrant extract** vs placebo for 7 d in a crossover with a 14-d washout. Such tests show large percent effects, and there are no between-subject standard deviations in the ab-

stract to assess magnitudes, but it looks promising. [POTTER, J.A.]. See also [PERKINS, I.C.] for a mechanism.

"Short-term dietary **nitrate** supplementation did not increase the tolerance to supramaximal intensity intermittent exercise in **elite endurance athletes**", providing further evidence that "dietary nitrate supplementation with beetroot juice is ineffective to improve performance in subjects with high VO<sub>2</sub>max." [PAWLAK-CHAOUCH, M.]

There were gains of up to 5% in various measures of explosive power following supplementation with **nitrate-rich beetroot juice** compared with nitrate-depleted juice in a crossover with 15 recreationally **active males**. [HILKENS, L.]. I expect the effect will be negligible in resistance-trained athletes.

In a **meta-analysis** of 21 studies, "**hypotonic carbohydrate-electrolyte drinks** ingested continually during exercise provide very likely benefits to hydration vs hypertonic and isotonic, with benefits also possible relative to non-carbohydrate waters." [ROWLANDS, D.]

Compared with a carbohydrate drink, **goat's milk** and **cow's milk** had similar beneficial effects on recovery from repeated sprinting and jumping in a parallel-groups trial with 24 **team-sport athletes**. Some comparisons of goat with cow were unclear but were otherwise trivial. [CURRISTIN, M.]. Compared with carbohydrate, milk "attenuated losses in muscle function and perceptions of stress following repeated simulated team-sports games" with female athletes. [RANKIN, P.]

Time to swim 8x 50-m sprints in their preferred stroke was 1.4% faster after 16 **high-school swimmers** (8 F, 8 M) consumed a cocktail of **branched-chain amino acids, arginine, and citrulline** in this placebo-controlled crossover. [HSUEH, C.]

The abbreviations were too dense for me to decode the claim that "a higher **protein** intake (2.0 and 2.4 g/kg) may help **elite cyclists** to improve performance and to increase muscle mass." [PAOLI, A.]

This case study of **making** (reducing) **weight** gradually in a male **taekwondo** athlete might be useful. [LANGAN-EVANS, C.]

## Performance Analysis

Deep learning neural networks have been used to define **momentum** in **rugby union**, but the database that was used and the relationship

with scoring are not in the abstract. I'm sorry I missed this one! [WATSON, N.]

A measure of **unpredictability** derived from ball trajectories in 60 women's **international basketball** games had modest associations with success. "Playing unpredictable basketball is advantageous." [HOBBS, W.]

Analysis of spatiotemporal characteristics in the 5 s prior to the initiation of 250 successful and unsuccessful **possessions** in the first half of a professional Dutch **football** match showed that gaining territorial advantage before gaining ball possession and pressuring the opponent are essential for successful possessions, apparently via "the prevention of successful possessions of the opponent." [GOES, F.R.]

The frequency of a **football** player's **head movements** before receiving the ball was related to what the player subsequently did with the ball in this study of 15 competitive young players in match play. No inferential statistics were provided. "The development of these behaviors in training should be a high priority." Perhaps. [MCGUCKIAN, T.]

Not surprisingly 20-m **sprint speed** predicts peak running speed in **football** matches. [MAHLER, H.]

Analysis of performance statistics of 248 **tennis** matches from Wimbledon in 2015-16 indicated that "players should optimize their **serving strategies** instead of chasing for a higher speed or a quicker-finish in the net." [CUI, Y.]

Various **basketball scoring strategies** (e.g., fast break points) did not significantly predict match outcome in 31 close matches of the Eurobasket 2017 season. [CONTE, D.]. You need at least 10x as many matches for this kind of analysis (logistic regression).

Some of the parameters of the take-off correlated with competitive ranking of 16 **ski jumpers** doing "a number of imitation jumps". [MUENCH, M.]

Please don't look for **correlates of performance** with only ~10 athletes! [**bobsleigh** CONDLIFFE, R.; **handball** ERIKSRUD, O.; **artistic swimming** VIANA, E.]. The only clear correlations you will get will be so large that they are almost certainly obvious to you and/or the coach before you do the study. You need more than 20 times as many to discover smaller but useful hidden relationships. By the way, the usual magnitude thresholds for correlations

don't apply to correlates of competition times or distances. You should instead evaluate the magnitude of the effect of 2 SD of the predictor, using magnitude thresholds derived from within-athlete variability of top athletes between competitions.

### Psychology and Sociology

**Wow!** **Mindfulness training** for 6 wk improved cognitive and physical performance in a controlled trial of 12+12 elite young male **handball** players. In addition to usual training, the mindfulness group did 15-20 min a day of the mPeak mindfulness program using an app at home, while the control group did breathing exercises. The mindfulness group also became more social and even slept better. [STAIANO, W.] Fabulous findings, but presented with illegible graphs.

**Wow!** Even 4 d of a **mindfulness-based intervention** was enough to improve putting performance in this controlled trial of 9+7 amateur **golfers**. [O DONOGHUE, C.]

In the ECSS-CSSS (China Sport Science Society) exchange symposium, Liwei Zhang from the Beijing Sport University gave a comprehensive account of three "microscopic" inter-related theories of self-control in relation to peak **athletic performance** and **choking**: (a) the theory of ironic processes of mental control, whereby the monitoring process takes over the operating process; (b) the strength model of self-control; and (c) the attentional-control theory, in which anxiety inhibits the goal-directed attentional system. Practical applications of these theories to reduce choking: (a) self-suggestions on what should be done instead of what shouldn't be done; (b) simulations, competition plans, behavior routines; (c) quiet-eye training. He then presented two "macroscopic" perspectives: integrated psychological construction, in which there is a hierarchy of training objectives with positive self-image at the apex, and a Chinese hierarchy with an enlarged cultural vision inspired by Buddhism and Daoism and promulgated in lectures and on posters. Mindfulness training is an obvious application of this perspective. [ZHANG, L.]

You can't determine causality in this study of 333 **university athletes**, but correlations between scores from questionnaires assaying **autonomous motivation**, perceived **coach empowering climate** and **burnout** led to the conclusion that coaches should "promote em-

powering climates in order to favor quality of athletes' motivation". [LOPEZ-WALLE, J.]. There was a similar result from the same group with a longitudinal study of 385 young **football** players. [CASTILLO-JIMENEZ, N.]

The effect statistic "IE" was not defined in this correlational study of 77 male young **football** players from four teams, but the finding is still worth summarizing: the coach-created **motivational climate** perceived by the players was related to their motivation, external regulation, physical-emotional exhaustion, and even their perceived exertion in some aspects of an interval-training session. The conclusion about the importance of getting coaches to set the right kind of motivational climate was apparently too obvious to state. [PÉREZ-XIMÉNEZ, M.]

In an action-research qualitative study of implementation of a **talent-development** program, "we found that the national governing body experienced a fragmented sporting community, which they had alienated by imposing a centralized performance program. This program forced athletes to break with their club resulting in diminishing belief and trust in the NGB and club coaches actively combating the program... power relations and short-term goals may limit the efficacy of a talent-development system." [FEDDERSEN, N.B.]

### Tests and Technology

In a symposium on recent **methodologies for biomechanical analysis**, we heard of two related developments that are on the verge of enhancing **athletic performance**. Katja Mombaur is taking what might be called the kinematic perspective of digitizing specific movements, using the data to develop models to reproduce the movement in robots, and then optimizing the movement for some performance outcome. As yet she is several years away from incorporating "physiological limitations" to predict realistic (achievable) optima. When she succeeds, "if you've got the money, I've got the time" to work with individual elite athletes. [MOMBAUR, K.]. The kinetic perspective was presented by Silvio Lorenzetti, who is modeling the forces and torques in the muscles and joints during resistance-training movements, with the aim of subject-specific optimization via developing the highest forces over the largest range of motion. At this stage he is applying the models only to simple "quasi-dynamical" move-

ments. He was able to check on the accuracy of the models by directly measuring forces via sensors implanted in a subject with an artificial knee. Unfortunately the prediction error over a limited range of knee flexion was  $\pm 20\%$ , so this is also still a work in progress. [LORENZETTI, S.]. The third speaker, Drew Harrison, introduced us to the technique of functional principle components data analysis, a dimension-reduction technique akin to factor analysis, in which families of functions are fitted to the data stream representing a movement in space and time. Certain stages of the analysis seem to be more art than science; for example, getting the right amount of smoothing, such that "if it looks right, it is right". He provided no direct application of the technique to performance enhancement, but "it might be a useful and sensitive for the analysis of sports movements". Another work in progress. [HARRISON, A.J.]

A deep-learning neural network was highly successful in characterizing **gait patterns** of 57 **healthy participants** (29 F, 28 M). [HORST, F.]. Will this be useful for biomech analyses of athletes?

Only a small proportion of **player tracking systems** in this study of a **football** match "achieved satisfactory concurrent validity against computer vision for instantaneous velocity. No systems obtained satisfactory concurrent validity for mean acceleration." Naming of the systems was barred in this FIFA-funded study. [AUGHEY, R.J.]

"Measures of position, distance traveled, and average speed from the Clearsky **local positioning system** show low errors and can be used confidently in time-motion analyses for indoor **team sports**, provided that the placement of anchor nodes is appropriate. For calculating instantaneous speed, the raw data is not valid." [LUTEBERGET, L.S.]

This methods study of a live **performance analysis system** (Champdas) for **football** lacked only a description of the system and confidence limits for the validity and reliability statistics. The observed values were high to extremely high on my scales. [GONG, B.]. I couldn't find a Champdas website, but its CEO (not one of the authors) is Chinese.

The presenter claimed that an **inertial measurement unit** worn on the wrist of **football** players allowed parsing of daily activity into warm-up, group, tactics, personal, and game,

but he didn't explain how. [MAGOME, T.]. Machine learning?

At this stage it's just modeling an "average man", but this "numerical study" (actually **computational fluid dynamics**) of **ski jumping** looks like it might eventually pay off with optimizing take-off and gliding parameters for individual skiers at specific venues. [HU, Q.]

Don't use wrist-worn **activity monitors** to measure heart rate. [FLOOD, T.]

The MyJump app had a typical error of 7% (unspecified re-test time) in **jump height** in **subelite athletes**. [LOH, T.C.]. I think that's too high. Averaging multiple jumps would bring the error down.

The Gymaware was the best of four linear **position transducers** to measure free weight barbell exercises. [MITTER, B.]

If you are responsible for **testing youth football** players, the experience of this Scottish group with players at three levels might be useful. [DUGDALE, J.H.]

New **performance tests**: **football**-specific agility [RAGO, V.]; repeated-sprint on a non-motorized treadmill for **football** [TRISKA, C.]; sprint for **futsal** [BARBIERI, R.]; on-court for **elite squash** players [JAMES, C.]; shuttle run for **elite badminton** [SCHNEIDER, C.]; heart-rate recovery in adolescent **elite rowers** [PELZER, T.]

New **genetic correlates** of athleticism: **elite rugby** [ANTROBUS, M.R.; BRAZIER, J.; HEFFERNAN, S.M.]; **elite endurance athletes** [SEMENOVA, E.A.].

### Training

**Wow!** **Quiet-eye training** works! In this controlled trial, 36 novice **golfers** were assigned to three training groups for putting: low-attention quiet-eye (expert examples and instructions of where to gaze), high-attention quiet eye (as for low-attention, but with a tone-recognition task), and technical (control). "Quiet-eye training, specifically under high attention, can help to prevent significant decrements in performance under high-attention and high-anxiety situations." [WATTS, M.]

**Wow!** After 4 wk, 11 **rugby** players who performed seven sessions of **repeated-sprint training in hypoxia** induced by holding their breath at low lung volume performed 64% more sprints in a 40-m all-out repeated-sprint test, whereas a control group of 10 players performed only 6% more. "This 'on-field outdoor'

hypoxic training strategy can be easily integrated in a conditioning program." [FORNASIER-SANTOS, C.]

**Wow!** The subjects were only **physical education students**, but after 40 were randomly assigned to 12 sessions of either increasing- or decreasing-distance **interval training** of running over 6 wk, the percent gains in VO<sub>2</sub>max, anaerobic peak power and anaerobic mean power were nearly twice as great in the decreasing group (15 vs 8, 16 vs 9, and 11 vs 7 respectively). [MECKEL, Y.]

Shorter higher-intensity **interval training** for 12 wk was generally less beneficial than longer lower-intensity intervals for 6-min performance in this controlled trial of 28 competitive **rowers** (10 F, 14 M) leading up to the competition season, but there was a clear, likely beneficial effect of the shorter intervals for the minority of rowers with a sufficiently low aerobic contribution (<77.5%). [BAUER, A.M.]

"High-intensity **interval training** protocols with large proportions of time spent at a high fraction of VO<sub>2</sub>max might be more effective for improving VO<sub>2</sub>max and performance." Hence this crossover study of 14 well-trained male **cyclists**, which showed that variable-intensity interval training session resulted in more time above 90% VO<sub>2</sub>max than a constant-intensity session, even though the mean intensity and perceived exertion were similar. [BOSSI, A.H.]

In a 4-wk controlled trial of high-intensity **interval training** with 11+11 **males**, the group who recovered with **whole-body cryotherapy** improved 20-km time-trial time by  $2.1 \pm 2.5$  % (mean  $\pm$  SD), whereas the passive-recovery control group improved by  $3.4 \pm 1.5$  %. The authors claimed the comparison was not a substantial difference. I disagree, and I would be wary of cryotherapy recovery pending more evidence. [POIGNARD, M.]

I opted to network rather than attend a plenary presentation on "**muscle memory**", because the abstract summarizes the main points really well: during hypertrophy, nuclei are recruited from satellite cells that fuse with pre-existing muscle fibers, but these nuclei are not lost during atrophy, and the muscles therefore grow faster with retraining, even after years of detraining. "It might be beneficial to do early strength exercise, since myonuclei are more easily recruited in younger than in old individu-

als." [GUNDERSEN, K.]

Owing to a clash, I missed a symposium on using the **force-velocity-power profiles** to enhance training for **explosive and sprint sports**. The profile can be characterized adequately with a simple field test and then targeted to maximize power output. [SAMOZINO, P.; JIMENEZ-REYES, P.; MORIN, J.B.]. One of my own protégés presented her study of the effect of high-resistance vs high-cadence **cycle** training on the profiles [RUDSITS, B.]

Two studies from the same lab compared short **sprint training** on an ergometer with heavy **strength training** in controlled trials with well-trained **cyclists**, but the effects on performance in the two groups were not presented in enough detail for me to evaluate. [BOVIM, L.P.; KRISTOFFERSEN, M.]. It looks like the cycle-ergometer training had the edge.

"Eight weeks of an in-season **plyometric training** in addition to regular **football** training induced larger increases in measures of physical fitness [especially repeated sprint] in prepubertal male football players compared with regular football training only. [CHAABENE, H.]. See also effects of plyometrics in junior elite female players [WALSH, G.] and in elite youth players [BEATO, M.]. None of these authors presented enough data.

Sixteen sessions of **sprint sled towing** over 8 wk by 13 semi-professional **rugby league** players resulted in a 5.6% improvement in 5-m sprint time, compared with only 2.5% in 13 players who did un-resisted sprint training. "Though not statistically significance, the greater improvement is expected to be an important enhancement for game performance." [BENTLEY, I.]

Four weeks of heavy **sled training** additional to normal training improved 10-m sprint time in 10 **rugby union** players by 2.4% in comparison with the change in 11 players over the same period in the previous season. The authors also presented evidence of individual responses. [ROE, G.]

In a controlled trial of 17+17 female **elite basketball** players, **core muscle training** with the TRX suspension equipment twice weekly for 8 wk produced an 8.6% improvement in a leg lowering test for stability, whereas the control group training with Swiss balls improved by only 2.9%. Scores in another test of core

strength and stability increased by 2.8x and 2.6x respectively. [LIANG, I.J.]

Block and undulating **periodization** for 12 wk in 8+10 trained male adolescent American **football** players "may be equally effective for increasing performance and muscle thickness." [GAVANDA, S.]

Nine weeks of a **concurrent** training program of **resistance + endurance** or endurance + resistance produced gains in leg-press strength and total lean body mass similar to resistance-only training, while also improving aerobic fitness. [LEE, M.J.]. It was only **active males** with <10 in each of the three groups, so the findings may not apply to well-trained competitive athletes. The same caution applies to a study showing greater gains in strength with **eccentric** damage-inducing vs **concentric** exercise in **sedentary young men**. [NOSAKA, K.]

Only one of 11 national and **international rowers** had a lower **training load** than intended by the coach in 6 wk of pre-season training, and the change in VO<sub>2</sub>max was *negatively* correlated with the excess training. "It is important that rowers and coaches are aware of intended and actual training duration." [OTTER, R.T.A.]

From a symposium: **blood-flow restricted exercise** may not be as good as heavy-load resistance training, but "because of the low load, it is often used in early rehabilitation after injuries and in deloading periods when athletes want to maintain muscle mass while reducing the stress on bones and tendons." [RAASTAD, T.]

Adding 2 min of **blood-flow restriction** following sprint bouts increased VO<sub>2</sub>max by 4.7% in nine trained **cyclists**, whereas it decreased by 1.3% in another nine without the restriction. Blood-flow restriction may have been relatively less effective for critical power: improvements of 3.5% and 4.4% respectively. [MITCHELL, E.A.]

Training in **hyperoxia** vs normoxia (30% vs 20%) allows you to reach higher intensities and therefore potentially greater enhancement of performance, hence this controlled trial of 12+11 trained **cyclists**. "Six weeks hyperoxic-supplemented high-intensity interval training on a cycle ergometer was not superior to conventional training at sea level in improving cycle performance in already trained cyclists." [CARDINALE, D.]. Really? The effects on 20-min mean power were 6.0% and 2.4%, respec-



tively, which is actually a *moderate* difference on my scale (1%=small, 3%=moderate, for cyclists), not *small* as the authors claimed using standardization. And of course, "not superior" is based on a p value of 0.07, whereas it is very likely (90% chance) that hyperoxia was superior using magnitude-based inference (sorry, I mean *objective Bayesian inference with a dispersed uniform prior*).

"Wearing a commercially available **micro-current device**, Arc4health, during 3 h post workout may maximize upper body hypertrophy outcomes and reduce DOMS in **recreationally trained males** following 8 weeks of **resistance** training." [SEIJO, M.] But there were only six subjects in each group.

Eighteen male **sports students** were randomly assigned to two groups for 8 wk of twice weekly resistance training sessions, in which one group received **whole-body electrical stimulation** of muscles during the sessions. Of the many outcome measures at the two post time points, data were shown for only the one difference in the changes that was apparently significant. Hence skepticism is warranted for the conclusion that "the combination of dynamic exercises and superimposed submaximal electrical stimulation seems to be effective in order to improve leg strength and power". [MICKE, F.]

"**Verbal feedback** on errors about [only] the key elements of movement was more effective than 100% feedback" in this controlled trial of unstated frequency and duration of 14+14 female **top-level gymnasts** learning the salto backward stretched, performed after the round-off flick-flack on the balance beam. [NIZNIKOWSKI, T.]

In a controlled trial with an unstated sample size, "the fundamental skill of passing a moving ball could be improved in **elite women football**

players by a 2-week training period focusing on improving **side foot-kick** performance." [CARLSSON, M.]

"Using **spatial occlusion goggles** to remove vision of an incoming **football** showed a significant improvement for performance", but goodness me, there were only five players in each of three groups, no data were shown in the abstract, and all outcomes were based on p-value abuse. [DUNTON, A.]

Here's another good study crying out for more subjects. Ten **top-level badminton** players (unspecified sex) were assigned to 4 wk badminton-specific visuo-motor tasks either wearing **shutter glasses** or under normal visual conditions. The abstract shows no data for the changes in performance, just a comparison of p values. To their credit, the authors found a substantial correlation between change in performance and change in a neurophysiological measure of visual processing speed, which gives the training effect more trustworthiness. "Badminton training under stroboscopic conditions may be more effective than conventional visuo-motor training." [HÜLSDÜNKER, T.]

**Visual training** for three 30-min sessions per week for 12 wk "improved specific tennis performance" in a controlled trial of 10+8 junior **tennis** players, but I can't understand the data. Are they change scores or post-test scores? [GATTI, C.]

A program aimed at improving the **sleep** of 50 professional **rugby** players reduced the proportion of poor sleepers from 72% to 52%. [MAHONY, L.]

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