

## Research for Athletes at the 27th Annual Meeting of the European College of Sport Science

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Spain's Seville was the setting for this successful first in-person ECSS conference since Covid. Most abstracts were marred by misinterpretations of statistical significance and non-significance. Meta-analyses based on standardization were untrustworthy. In many symposia, conclusions were "to be presented." **The Wow! Factor**: the four best presentations for athletes. **Accessing Abstracts**: links to the conference program and abstracts. **Satellite Symposia**: canoe slalom; fatigue; relative energy deficiency; soccer; tennis. **Acute Effects**: sleep; naps; post-activation potentiation; foam rolling; stretching; special masks; pollutants; environmental temperature; pacing; feedback; mental fatigue; recovery strategies; weight loss; electrostatic charge; running shoes. **Injury Risk**: headers; concussion; risk factors for various sport injuries; injury-prevention workshop. **Monitoring**: five studies of soccer, one of rugby, one of speed skating. **Nutrition**: sleep supplement; ibuprofen; mouth rinsing black-currant extract; antioxidant supplement; cherry juice; nitrate; beetroot juice; L-citrulline; caffeine; cocoa; bicarbonate; calcium carbonate; beta-alanine; ketones; carbohydrate; fructose; apple puree; cannabidiol; relative energy deficiency; high-fat; iron; diet and myokines; probiotics, prebiotics and the microbiome; protein; whey; collagen. **Performance Analysis**: tactics by neural net; basketball styles and correlations; forehand drives in tennis; small-sided games in soccer; high-intensity running in soccer; performance indicators in rugby; genes for runners and cyclists; sprint kayaking; turns in alpine skiers; the Roth in artistic gymnastics; 13 other movement analyses; 16 other competition analyses; 23 other correlates of performance. **Talent Identification and Development**: self-regulation; functional solutions; dual-career competency; early specialization; club environment; football academies; the Swedish youth strategy; youth international experience; biological maturation in Germany; relative-age effects; selected vs non-selected; swimmer characteristics; ice-hockey trend; rugby union vs 7s; bob-sleigh, skeleton and youth sports providers in China. **Tests and Technology**: markerless motion capture; baseball pitching via IMUs; sensors for shock impacts; heart-rate monitors; blood biomarkers; novel sensors; metabolomics; combat sports; reps-to-failure profiling; heart-rate variability; 34 miscellaneous items. **Training**: high-intensity interval; low-intensity sessions; hypoxia; blood-flow restriction; resistance; plyometric; flywheel; velocity-loss resistance; plyometric; consecutive vs periodic isometric; complex vs block; electromyostimulation; contrast; combat sports; yoga; time of day; decision-making; placebo training; coach substitution. **KEYWORDS**: competition, elite athletes, ergogenic aids, injury, monitoring, nutrition, performance, talent identification, technology, tests, training.

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After two years of pandemic-related online conferences, the long-postponed ECSS Congress was held in person in culturally rich Seville in the south of Spain from August 30 to September 2. One of us (Hans-Peter) braved the risks of Covid and the European heat wave to attend and

report in person, while the other (Will) timidly and safely summarized the abstracts at home in New Zealand.

The Seville Convention Center was spacious and technically well equipped, thus ideally suited for exhibitors and scientific program

presentations. Furthermore, it was well air-conditioned on an otherwise hot late-summer week. The opening ceremony was a great success, and the locals performed passionate, mesmerizing dance performances, including acrobatic shows. Following this event, a large group of participants enjoyed excellent Spanish cuisine before taking advantage of the free use of public transport included in the congress package for another meet-and-greet to spend the balmy summer evening in the bustling streets of Seville. The closing ceremony, culminating with the various award winners, was remarkably well attended, as were all the sessions I attended during the conference, some to standing-room only. We congratulate and thank the organizers, the congress presidents África Calvo Lluch and Eduardo Saez de Villareal Saez, Juan León Prados as chair of the organizing committee, and ECSS president Prof. Jørn Wulff Helge and his team for their excellent work.

There were 1825 registrations, 1393 abstracts and presentations (20% fewer than in pre-Covid conferences), including two plenary sessions, 38 invited symposia sessions, 138 oral sessions, 50 conventional print posters, and 240 not-debated e-posters. The countries with the most participants were Germany, UK, Spain, Japan and Italy, in that order. From a global perspective, the number of Europeans taking part was comparable to the numbers before Covid. The comparatively smaller size of the conference this year is therefore due to lower attendance by non-Europeans, presumably because of Covid.

Misinterpretations of significance and non-significance were as prevalent as ever this year, in spite of [an article](#) on the fiasco at the 2020 conference and in spite of a [discussion paper](#) for what we should do about it. Now you can read an update of the discussion paper published in *Frontiers in Physiology* and [reproduced at this site](#). Please, researchers, stop using statistical significance and non-significance to make conclusions about effects. Instead, interpret confidence limits, test substantial and non-substantial hypotheses, and/or assess probabilities of substantial and trivial magnitudes. These better approaches depend on values for the smallest important effect, which you will have to justify in your setting and in other settings, where relevant (e.g., the smallest important change in performance for different kinds of athlete). See the section on magnitude scales in the Appendix of the [article](#) on

magnitude-based decisions as hypothesis tests for more. In particular, use standardization only as a last resort to derive the smallest important difference or change in a mean.

Meta-analysis was popular at this conference, and 11 are summarized here. Ten of these were based on standardization to combine effects from different controlled trials and crossovers, whereby the mean effect in each study is divided by a standard deviation (SD) from the study to get a dimensionless "effect size" (Cohen's *d*, Hedge's *g*, or Glass's *g*) for subsequent analysis. But choice of the standard deviation is crucial, and none of the authors stated which SD they used. In a study of recent meta-analyses in medical journals (including *Sports Medicine*), around half used the SD of change scores, which produces biased and practically meaningless magnitudes (DS Rowlands and WG Hopkins, submitted). The use of SD of change scores will have been similar in meta-analyses at this conference, so you can't trust the meta-analyzed outcomes until you know whether the authors used the correct SD (the pooled SD in the pre-test, preferably free of measurement error). Even then, there is the problem of applying the meta-analyzed standardized effect to different athlete populations (specific team, one-on-one, and solo sports), where the SDs are bound to differ or are even irrelevant. Standardization simply doesn't work. Fortunately, there are much better approaches to combining mean effects for meta-analysis: use of original or percent units, rescaling of Likert scales to a range of 0-100, and "standardization" with the smallest clinically or practically important change in the mean (*ibid*).

Many of the abstracts of symposium presentations were of the "results will be presented" variety. Abstracts of original research aren't allowed to be written in this manner, so why isn't the rule applied to the experts? It's particularly frustrating this year, because there are no videos of the symposia or even of the plenary presentations, owing to financial constraints. We have included the relevant abstracts in this report, so you can search for recent publications by the author. We have not summarized potentially interesting original-research presentations, where the abstract was too confusing (occasionally because of silly and excessive author-defined abbreviations).

### **The Wow! Factor**

With the focus on presentations relevant to performance and injury of competitive athletes,

we found only four studies that were particularly interesting: late dinner for [better sleep](#); ibuprofen for [better performance](#) but more gut damage; a self-training neural net to identify [tactical moves](#); and efficient high-intensity [resistance training](#) for academy soccer players.

### Accessing Abstracts

This report focuses only on athlete performance and injury. If your interests are physical activity of non-athletes or the biology, psychology or sociology of exercise, check out the [scientific program](#) at the [conference site](#). These links are open to anyone, as is the list of winners of the young-investigator awards (when it becomes available). To find the abstract of the presentations we have reviewed, copy the presenter's name and initials shown in brackets [...] into the [search engine](#). The [book of abstracts](#) can also be downloaded from your ECSS account page; search it in Acrobat using advanced search (Ctrl-Shift-F).

In case we have missed some presentations with useful information for competitive athletes, we suggest you use the search engine, with your sport or topic of interest as the keyword. Do it in a small group for more value and fun. Use this report for a conference de-brief, too. If you are an author of a missing abstract that you think should be included, or if we have got something wrong, please [get back to us](#) ASAP and we will augment or amend this report accordingly.

There were many presentations and whole sessions devoted to Covid, but we have not summarized them. Search for "covid" with the conference [search engine](#) or in the [book of abstracts](#).

### Satellite Symposia

The five symposia on the day before the conference were all relevant to athletes. The links below sometimes include useful summaries and/or bios of the bigshots.

- **Canoe Slalom:** physiology and biomechanics. [Read more...](#)
- **Fatigue** and nutrition considerations. [Read more...](#)
- **Relative Energy Deficiency** in Sport; from research to practice. [Read more...](#)
- **Soccer** Science: training and testing. [Read more...](#)
- **Tennis** Science for coaches and players. [Read more...](#)

### Acute Effects

**Wow!** "Evening dinner 1.5 h before bedtime led to better quality and less fragmented **sleep**

compared to evening dinner 3.5 h before bedtime" in a crossover with 12 **young rugby players** who did both conditions for five nights separated by a 2-wk washout. [LEHMANN, L.]

Participation (by an unstated number) in a "Wake-a-Thon was successful at increasing student **athletes'** ability to recognize and communicate signs of **sleep deprivation** and its effect on their performance, attentiveness and emotional state." [RICHMOND, S.A.]

In a crossover with 12 professional **male basketball** players, a "40-min **nap** opportunity reduces sleepiness, stress and fatigue and enhances physical outcomes of specific skills" (including shooting performance). [SOUABNI, M.]

Isometric and elastic-resistance exercises produced worthwhile enhancements of punch force mainly 7 to 9 min later compared with control (just a warm-up?) in this crossover study of **post-activation potentiation** in 10 **male senior elite amateur boxers**. [FINLAY, M.]

"The addition of external load conferred by wearing a swimming parachute and hand paddles during the experimental warm-up routine [to induce **post-activation potentiation**] did not result in [significantly] enhanced 50-m freestyle swimming performance" in a crossover with 12 **trained swimmers**. [LIMA, L.C.R.]. Well, the trouble is, they were actually 0.4% faster, and the smallest important for swimmers is ~0.3%. This warm-up seems a bit impractical for competitions, anyway, but other priming strategies are worth investigating, on the basis of this result, with a bigger sample size, of course.

Use of elastic-band resistance in a back-squat warm-up increased the **post-activation potentiation** effect on countermovement jump performance in a crossover with 15 **active males**. [VAN ENIS, A.J.]

"The use of heavy squat lifts or loaded countermovement jumps with elastic band resistance result in similar increases in countermovement jumps performance following a comprehensive warm-up; heavier loading resulted in a more prolonged improvement in performance" in a crossover study of **post-activation potentiation** with 15 **men**. [MINA, M.A.]

In a crossover study of **delayed potentiation** by means of resistance priming with 10 **resistance-trained men**, low-load (30–40% 1RM) ballistic exercise was more effective than high-load ( $\geq 85\%$  1RM) traditional exercise for improving countermovement jump performance 24 h later. "Practitioners should consider

prescribing resistance priming using low-load ballistic exercise rather than high-load traditional exercise when planning to enhance athlete performance on the following day." [TAKUYA, N.]

In a standardization-based **meta-analysis** of 11 studies with 46 effect sizes, **foam rolling** increased joint range of motion when applied to hamstrings and quadriceps, but no such increase was observed in ankle dorsiflexion after triceps surae rolling. [KONRAD, A.]

**Vibration foam rolling** was better than static stretching as a warm-up for hip flexion range of motion and hamstrings isometric torque of 25 **males**. [REINER, M.]

Post-stretching dynamic activities (not specified) weren't enough to offset the negative effects of proprioceptive neuromuscular facilitation **stretching** on drop-jump performance of 16 **participants**. [PATERNOSTER, F.K.]

In this symposium, the first speaker was going to present "the pros and the cons of heat and **moisture exchange masks** on airway function and sport performance" in cold environments. [KIPPELEN, P.] The second speaker was going to present effects of **pollutants** on sport performance and preventative strategies. [BOUGAULT, V.]

"An 8°C of **temperature** difference between climatic conditions [28°C simulating Qatar for the forthcoming 2022 football World Cup vs 20°C] did not significantly affect the physical and physiological responses of 24 **semi-professional soccer** players in repeated maximal efforts." [CHMURA, P.]

"Can video- and sensor-based feedback by implementing a terrain-specific micro-**pacing** strategy improve performance in cross-country skiing?" In this controlled trial of 14+12 **national-level male skiers**, the improvement of 32 s compared to control was a very substantial ~2.0% for a ~25-min race (10-km race times were not provided), but the p value was 0.34, so "no change in overall performance was observed." [SEEBERG, T.M.] Our conclusion: the strategy looks promising.

Mean power of 10 **cyclists** and **triathletes** in a 30-min cycling time-trial was massively impaired when they had multiple **feedback** (of power output, elapsed distance, elapsed time, cadence, speed, and heart rate) during the time trial compared with single feedback (of elapsed time), "despite adopting and reporting a similar pacing strategy and perceptual responses".

[BAYNE, F.]

In a symposium on **mental fatigue**, "the negative effect of mental fatigue on exercise performance is attributed mainly to higher-than-normal perceived exertion." Alas, "applied behavioral or nutritional countermeasures" are not summarized in the abstract [ROELANDS, B.] or in those of the other two speakers [RUSSELL, S.; BAILEY, S.].

A **meta-analysis** of 24 studies investigated subject characteristics that might modify the effect of **mental fatigue** on performance, but "multiple limitations still undermine the conclusions." [HABAY, J.] Use of standardization is also problematic.

**Mental fatigue** reduced time to exhaustion by similar percents in tests lasting ~30 min and ~7 min in this crossover study of 23 **highly trained triathletes**. [MARCIANO, A.]

"**Oral-contraceptive** users experience a greater deterioration [**fatigue**] of maximal dynamic strength compared to non-users following repeated bouts of resistance exercise" in a controlled trial of 8+6 **trained women**. Results with a further 26 women "will be presented at the conference." [OXFELDT, M.]

A survey of 156 high-performance **practitioners** revealed that they "perceive **mental fatigue** and **recovery** to impact on training and competition, yet their knowledge, confidence in application and current assessment and management is limited." [RUSSELL, S.]

In an "umbrella" review of 20 reviews of the (acute?) effects of exercise **recovery** strategies on performance, some strategies worked (carbohydrate, curcumin, and pomegranate supplements; active recovery; compression garments) [LI, S.]. Unfortunately the findings of many meta-analyses are based on incorrect use of standardization, so these need to be excluded from any umbrella review. Magnitudes for different kinds of athlete are also an issue, along with the possible negative effects of recovery on training adaptation.

In a controlled trial of 40 **male elite youth football** players randomized to placebo and two **water-immersion** groups, "cold-water immersion and hot-water immersion did not improve recovery of sprint, submaximal running as well as jumping performance during a 2-day recovery period following a simulated football match, while these modalities may positively affect recovery of strength during this period." [GUSTAFSSON, J.] Beware: all done with

statistical significance and non-significance.

Transcutaneous electrical **nerve stimulation** "might be effective in **fatigue** recovery in quadriceps" of 14+14 **recreational rowers** following a 2000-m time trial. [XINYU, M.]

Combining seven **recovery strategies** produced "a small but consistent increase in mean power output" compared with placebo and control in a crossover with 16 **trained men**. [BELTRAMI, F.]

"The prevalence of **weight loss** prior to competition is higher than 60% in most Olympic **combat sports**; with weight loss of approximately half of the percentage interval between weight categories (i.e., 5% to 8%) being common. The main methods used by combat sports athletes to decrease body mass include dieting, dehydration, and exercise using heavy clothes or in hot environments." [ESCOBAR-MOLINA, R.]

**Electrostatic charging** to ~6 kV on a treadmill "did not affect ( $p > 0.198$ )" several measures of endurance performance in an incremental test in a placebo-controlled crossover with three **women** and six **men**. [WIESINGER, H.]. The sample size was too small for an effect you'd expect to be trivial, but anyway, performance data with confidence limits would at least allow us to see if the effect was potentially beneficial or harmful.

"New generations of highly resilient-elastic **running shoes** may benefit the wearer by reducing active muscular work within the foot" was the conclusion in one of the talks in a symposium on muscle and connective tissue. [FARRIS, D.]

Eleven **trained distance runners** were 1.8% faster in **interval training** with Nike ZoomX **Vaporfly shoes** compared with their own shoes. [RODRIGO-CARRANZA, V.]

Nike **Dragonfly track spikes**, which include a plastic fiber plate in the midsole, improve 3000-m performance by 3.1% compared with conventional track spikes, when eight **male trained middle- and long-distance runners** took part in this crossover study. [JIMÉNEZ-ORMEÑO, E.]

### Injury Risk

In a symposium on health threats due to **headers** in **soccer**, the first speaker presented a prospective cohort study of 22 **female** soccer players assessed before and after a competitive season, in which "a greater number of headers was associated with negative alterations in postural control, *positive* changes in working memory

performance, and fine motor deficits in a writing task" [HERMSDÖRFER, J.]. The second speaker looked for but did not find "significant" correlations between number of headers (range 146 to 943) and structural and functional changes in the brains of 14 professional (**male**?) soccer players after 12-18 months [REINSBERGER, C.]. The third speaker found "brain and brain-to-muscle changes following the routine impacts of a standard soccer heading drill." [IETSWAART, M.]

"Greater **heading exposure** was linked to negative changes in fine **motor performance**, negative alterations in **postural control**, while exhibiting concomitant changes in working **memory performance**" (beneficial, apparently) in this prospective study of a season of play by 22 **semi-professional female soccer** players. [KERN, J.]

In the 2-140 days [sic] following a sports-related **concussion**, 15 **athletes** had reduced **heart-rate variability** after a submaximal test in comparison with 15 control athletes. [DELLING, A.C.]

Olympic **combat sports** differ considerably in the rules relating to protection from **concussion**. [ARRIAZA, R.]

Low peer autonomy support was the main predictor of **health and injury** problems of 588 Norwegian **young soccer** players. [SERSLAND, A.]

**Cognitive performance** was assessed in **professional male footballers**, then compared in the 29 who subsequently developed a **non-contact injury** with the 35 who didn't during one year of follow up. There was "a significantly *faster visual screening* performance for the injury group, but no significant differences for other cognitive measures." [ŠLOSAR, L.]. The sample size is a bit too small for such a study.

Findings of a **systematic review** of 29 studies of activities associated with **acute injuries** in **female** and **male football** players: "high intensity running and kicking activities seem to be the main activities leading to thigh and groin injuries. Duels seem to be the most frequent activity leading to ankle injuries. Results for other injuries were inconsistent between the studies... It is paramount that future studies implement standardized injury definitions and standardized systems to classify the inciting activities." [AIELLO, F.]

When 88 players from German 3rd and 4th **football** league were monitored for an

unspecified period, only 51 **non-contact, time-loss injuries** occurred, so a machine-learning model to predict them using player "a panel of 12 explanatory variables (covering basic player characteristics, screening, monitoring, and exposure characteristics)" was at best "promising". [HECKSTEDEN, A.]

In the 126 injuries recorded in matches and 89 in training over 8 seasons in an unspecified number of players in English **men's international football** teams, there were "no differences in the patterns and specific diagnoses of injuries in matches compared to training", but lateral **ankle ligament injuries** were more severe in matches and hamstrings and quadriceps **muscle/tendon injuries** were more severe in training. [SPOUSE, B.]

The title states "effects of sprint, strength and muscular endurance training on the risk factors for **hamstrings injuries**", but the effects are a work in progress in the abstract of this symposium speaker. [DELESTRAT, A.]

**Skin temperature** over injured **hamstrings** in 25 **professional soccer** players was colder and gradually returned to normal as the injury recovered, "showing potential if infrared thermography to support return-to-play decision." [FERNANDEZ-CUEVAS, I.]

In a study of 94 **females** performing unanticipated **cutting maneuvers**, doing them "without a crossover of right foot may be associated with an increased biomechanical loading of the ACL compared to other strategies, possibly placing these **females** at risk for **ACL injury**." [BLASCHOVA, D.]

In a symposium on **female athlete** research... "To uncover the mechanism behind peaks in **injury incidence** during the menstrual cycle, it is important to understand that it is not exclusively the estrogen level that varies with different phases of the menstrual cycle." LEGERLOTZ, K.]. "Both positive and negative effects of using **oral contraceptives** have been reported on markers of health, performance and injury risk." [HANSEN, M.]

"Low **bone mineral density**, which is associated with fracture incidence, was highly prevalent in 93 **male** and **female elite cyclists**." [HILKENS, L.]

A lower **duty factor** (ratio of contact time and stride time) was an injury risk factor, especially when using softer shoes, in this 6-month study of 848 **recreational runners**. [MALISOUX, L.] Whether injury rates differed for soft vs hard

shoes is not stated, and the confidence intervals seem too narrow for only 128 injuries.

Higher compliance with **foam rolling** and **neuromuscular exercises** was associated with lower risk of **running-related injury** in the 228 **male** and **female recreational runners** of the intervention group in this 18-wk controlled trial. [JUNGMALM, J.]

A systematic review found alterations in lower-leg function and biomechanics in **athletes and runners** with **Achilles tendinopathy**, but as the authors state, "it is difficult to discern whether these factors are causative or consequential." [QUARMBY, A.]. Would inclusion of time since injury help resolve this issue?

A one-season longitudinal study of 44 adolescent **handball, basketball** and **volleyball** players showed that "high levels of **tendon strain** could be an important risk factor for the development of **patellar tendinopathy**". [MERSMANN, F.]

A new measure of **training load** for **volleyball** players, based on height of jumps, predicted **injuries**, even though only 11 national-level players were monitored for only 5 months. [BOUZIGUES, T.]

In spite of monitoring only 18 German **youth handball** athletes (9 **men** and 9 **women**) for 6 months, a low pre-season **rate of force development** in a countermovement jump was a predictor of **lower-limb injury**. [LEWIS, S.]. Unfortunately, the numbers in the abstract don't add up.

Increase in incidence and decrease in severity of **injuries** in Australian **rugby union** over several years may have been due to "changes in data collection processes". [RUBIO DEL CASTILLO, E.]

Conclusions from surveillance of injuries in **rugby union** in South Africa... "Attempts to reduce speed into contact and contact intensity may not be worthwhile **injury prevention** strategies. Rather, rugby stakeholders should focus injury prevention efforts on player **tackle technique** and **conditioning**." [HENDRICKS, S.]

This prospective epidemiological study documents medical-attention **injury rates** in 6768 players in US **women's Rugby-7s** (e.g., 84 injuries per 1000 player hours, 67% during a tackle). [LOPEZ JR, V.]

It was an underpowered **injury** study (one team of 52 **rugby union** players monitored for one season), but there were reasonably clear substantial associations between injuries and high values of **acute-to-chronic workload ratio**,

high values of **high-speed running**, and low values of **aerobic fitness**. [YAMAMOTO, H.]

Seventy-two **Australian Football and rugby-league** players who sustained non-contact **lower limb injuries** had larger quadratus lumborum cross-sectional area in pre-season tests than 166 uninjured players. [DUHIG, S.]

In an online survey with a high response rate, **experienced researchers** deemed **training-load, neuromuscular-training** and **psychological interventions** to be the most important for future research and research reviews on reducing sports **injuries**. [MACMILLAN, G.]

"A bespoke 2-h [online interactive] **workshop** can increase knowledge and confidence of grass-root coaches to deliver **youth-athlete injury-prevention programs**. The workshop resulted in significant adoption, implementation and maintenance of the program." But only 27% completed the follow-up questionnaire. [DE STE CROIX, M.]

### Monitoring

Any effects reported in the following studies do not seem to be particularly useful. The means and SDs might provide useful norms or reference values for your athletes.

- Wellness, sleep, readiness to play and the effect of **training load** in 31 **elite male football** players over two seasons. [SPENCER, M.]
- **Physical demands** in training and matches over 3 months in 21 under-10 and under-12 **amateur (male?) soccer** players. [HERNÁNDEZ-MARTÍN, A.]
- Evolution of **physical performance** over a season in a team of 27 **female soccer** players.
- Positional differences in **training loads** in 24 **elite (male?) academy soccer** players over one season. [DOUCHET, T.]
- Changes in **physiological measures** from an incremental VO<sub>2</sub>max test in 221 **elite youth soccer** players in four age groups tested 1-10 times over 4 y. [JI, S.]
- **Pre-season training** of 32 (**male?**) players in a **professional rugby** team before and after a pre-season period. [HU, X.]
- External and internal **training load** in 17 elite **short-track speed skaters** monitored for a season. [KEMPE, M.]

### Nutrition

**Wow!** A novel supplement reduced time to fall asleep by 24 min and extended time asleep by 22 min in a placebo-controlled crossover with 16

**male and female participants**, who were blinded to the effects on sleep as the primary outcome. "These improvements may be caused by the inclusion of the **sleep-enhancing ingredients tryptophan and glycine**." [LANGAN-EVANS, C.]

**Wow!** In a crossover, 11 **males** consumed **ibuprofen** or placebo, then ran for 45 min on a treadmill at 75% of their individual VO<sub>2</sub>peak followed by an incremental test to exhaustion. Perceived exertion was lower and run time to exhaustion was longer (by 1.5 min) on ibuprofen, but markers of intestinal damage were higher. [WESSNER, B.]. There are insufficient data in the abstract to assess the clinical and practical importance of these effects on performance and damage, but it's still a Wow!

"**Mouth rinsing** and ingesting salty or bitter solutions after heavy intensity cycling [to induce a fatigued state] did not influence sprint performance or neuromuscular function" in a crossover with eight **trained male cyclists**. [GRAY, E.]

Mean time in a crossover study of 34 mainly **male cyclists** in a 16-km time trial was a marginally beneficial 0.6% faster following **acute** consumption of **blackcurrant extract** vs placebo, with some evidence that there was a bigger effect in slower riders and no beneficial effect in faster riders. [MONTANARI, S.]

Total and high-intensity running distance in an intermittent high-intensity treadmill test were 8.7% and 8.4% greater following **acute supplementation** with **blackcurrant extract** compared with placebo in a crossover with 16 **males**, with a predicted type-I muscle-fiber subgroup showing greater improvements compared to the type-II subgroup. [PERKINS, I.C.]

There were no statistically significant differences (and no data shown) in several measures of climbing performance after 10 **male recreational rock climbers** consumed **blackcurrant extract** for 7 d in a placebo-controlled crossover. [POTTER, J.]

Two weeks of **supplementation** with an **anti-oxidant** (TetraSOD) improved time to exhaustion in a crossover with 15 recreationally **active males**. [COCKSEGE, S.P.]. But it was a difference in significance.

In a crossover with 10 **males**, "tart **cherry juice supplementation** [for 7 d pre and 2 d post] significantly increased expression of antioxidant genes and proteins in human skeletal muscle, increased plasma phenolic acids, and improved functional muscle recovery from muscle

damage" [WANGDI, J.T.]

Consensus of 12 experts: "effects of dietary **nitrate** are reduced in individuals with higher aerobic fitness ( $VO_{2peak} > 60$  ml/kg/min); **athletes** hoping to benefit from dietary nitrate supplementation should consume 8–16 mmol nitrate acutely or 4–16 mmol/d nitrate chronically (with the final dose ingested 2–4 hours pre-exercise); and from a safety perspective, athletes may be best advised to increase their intake of nitrate via vegetables and vegetable juices." [SHANNON, O.M.]

Acute **supplementation** with **beetroot juice** had trivial effects on jump performance in a crossover (?) with 11 **competitive female volleyball** players. [LÓPEZ-LEÓN, I.]

On the other hand, 11 **female professional volleyball** players were 2.5% and 1.9% slower on sprint speed and agility with **beetroot-juice supplementation** in a crossover. [MORENO-LARA, J.]. Interestingly,  $p=0.046$  with a small standardized effect was deemed "not significant", an example of confirmation bias?

Seven days of **L-citrulline supplementation** (expected effects similar to those of nitrate) "did not alter performance responses to running in the heat whilst hypohydrated" in a crossover with 8 **male** and 1 **female endurance runners** [CABLE, T.G.]. As usual, not significant was interpreted as no effect, but the mean times for a 3-km time trial following a preload showed a potentially important 3.0% enhancement.

"There were no significant effects" of acute **citrulline supplementation** on high- or low-load bench-press performance in a crossover of 10 **male** and 9 **female resistance-trained participants**. [NULTY, C.D.]

**Acute caffeine supplementation** enhanced 100-m sprint time in a crossover with 13 **male collegiate sprinters**. [MATSUMURA, T.]

**Caffeine** and **post-activation potentiation** enhanced reactive sprinting and diving times in 25 **soccer goalkeepers**. [IMPEY, J.]. Details of the design are sketchy.

"The ergogenic benefits of **caffeine** [on bench-press performance] still persisted after 22 days of chronic ingestion in a placebo-controlled crossover with eight **strength-trained men and women**. [GIRÁLDEZ COSTAS, V.]

"Cognitive fatigue, but not exercise-induced fatigue, may be reduced by flavanol-rich **cocoa**" when 15 **young men** did 50 min of cycling and 50 min of Stroop tests in a crossover. [SUZUKI, A.]. P values.

**Bicarbonate supplementation** improved the latter stages of sprint-interval training in a crossover with 14 **competitive swimmers**. [GOUGH, L.]

"To maximize alkalosis and minimize gastrointestinal symptoms, **sodium bicarbonate** should be ingested 2-3 hours prior to exercise, and sodium citrate 3-4 hours prior to exercise" is the conclusion in this crossover of eight **males** and eight **females**. [URWIN, C.]

In a placebo-controlled trial with 15+15 **participants**, **supplementation** with amorphous **calcium carbonate** for 3 wk before a bout of hard resistance exercise was very likely and likely to have a beneficial effect in attenuating the decline in performance 24 and 48 h later, respectively, "possibly due to the carbonate component." [HOFFMAN, J.R.]

In a controlled trial of 7+7 **well-trained tennis players**, **beta-alanine supplementation** (which increases muscle buffering capacity) for 28 d "may improve repeated-sprint ability capacity" ( $p=0.04$ , no times reported), while "no differences were reported" ( $p>0.05$ ) for other fitness tests. [QUINTANA-MILLA, I.]

In a crossover study of acute **ketone monoester supplementation** with or without sodium bicarbonate to offset the acidosis in **trained adults** (11 **males**, 4 **females**), " $VO_{2peak}$  was not different between conditions ( $p=0.2$ )." [MCCARTHY, D.G.] Oh, really? The means were 4.55 and 4.34 L/min in control and ketone conditions, a massive impairment of 4.6% with ketones!

"The aim of this [symposium] talk is to present the current knowledge on how **carbohydrate feeding or restriction** affects exercise performance and adaptations to training." [MORTON, J.]. There is no useful information in the abstract.

"Addition of **fructose** to a carbohydrate-rich breakfast improves cycling endurance capacity" in a crossover with eight **trained cyclists**. [PODLOGAR, T.]. The effect was by 5.4% in a ~2-h time-to-exhaustion test, which is probably a trivial ~0.3% in a time trial.

In a crossover with 2 **female** and 9 **male runners**, "**apple puree** as a natural fructose source was as effective as artificial **fructose** in supporting half-marathon running performance without increasing GI symptoms." [REYNOLDS, K.M.] Actually they were 1.3% slower on the apple puree, so you'd better stay with fructose for now.

In three controlled trials of the effects of **cannabidiol supplementation** on recovery and



performance of 8+8 (?) **resistance-trained athletes** after intensive resistance training, there were "faint but significant" reductions in serum markers of muscle damage, but "no significant effects on performance parameters." [DIEL, P.]. P-value inequalities only.

Conclusion in a crossover with 9 **male** and 5 **female participants**: "inhalation of **cannabis** containing the psychotropic cannabinoid THC, reduces [endurance] **cycling** performance irrespective of inhalation method." [CHEUNG, C.P.]

A nutritional intervention with 34 **female athletes** (from four European countries) with symptoms of **relative energy deficiency** appeared to be successful with most of the 29 athletes who completed a questionnaire at the end of the study. [FAHRENHOLTZ, I.L.]

"**Energy intake** relative to fat-free mass did not meet the proposed threshold of 40 kcal/kg to ensure optimal energy availability for physiological functions" in nine **semi-professional developmental rugby union** players. [ROBERTS, C.]

Absolute VO<sub>2</sub>peak and VO<sub>2</sub>peak relative to body mass increased by 1.7% and 2.7% after three days on a **high-fat diet** in a controlled trial of 20+20 moderately **trained men**. [TARRY, E.K.]. But it's a difference in significance: changes in the control group were not significant and not reported.

Most of the 26 studies in this systematic review showed "physical performance improvement of iron deficient or anemic **young women** of different training status, following oral **iron supplementation**." [NAKAMOTO, F.]

"Daily **dietary intake** may influence some **myokines** responsible for maintenance of muscle mass for recovery of muscle mass and function" in a correlational study of pre-race diet with pre- and post-race myokines in 61 **amateur marathon runners**. [CURY-BOAVENTURA, M.]

"There are now numerous studies reporting... a reduction in the risk for **upper respiratory symptoms** (including infections), asthma and exercise-induced bronchoconstriction following **probiotic** and **prebiotic interventions**." [WILLIAMS, N.]

In a "real-world" (i.e., uncontrolled) trial, 35 **athletes** volunteering for or referred to a program of **probiotic supplementation** experienced improvements in cognitive performance, stress, sleep quality and energy levels.

[SORENSEN, K.]

From a symposium on the **microbiome**... "It is important that commonly used dietary approaches that are applied to enhance **athletic** performance are carefully monitored and managed to ensure that the microbiota is appropriately nurtured to maximize the available benefits from nutrition." [BURKE, L.]

"**Protein ingestion** prior to sleep stimulates both mitochondrial and myofibrillar protein synthesis rates during overnight recovery from endurance exercise" in this post-only (?) controlled trial with 12+12+12 **young men**. [VAN LIESHOUT, G.]

Eight weeks of supplementation with either a novel **plant-based protein** or **whey protein** in a controlled trial with 40 **futsal** players resulted in "no time\*group interactions in any of the studied variables (p>0.05)". [TEIXEIRA, F.J.]. With no other data in the abstract, one can't assess the evidence properly.

"**Collagen peptide supplementation** (15 g twice daily) did not further increase myofibrillar or muscle connective protein synthesis during 1 wk of intense resistance exercise training" in a controlled trial of 25 **male recreational athletes**. [KIRMSE, M.]

**Supplementation** with **collagen peptides** increased patellar-tendon thickness following 14 wk of high-load resistance training in this a randomized placebo-controlled trial of 50 **males**. [JERGER, S.]

"Neither **whey** nor **collagen protein ingestion** increase muscle connective tissue protein synthesis rates during the early stages of post-exercise recovery" (p=0.09) in a controlled trial of 15+15+15 **male** and **female recreational athletes**. [AUSSIEKER, T.]. The actual rates tell a different story: compared with control, rates of synthesis increased by 24% and 17% with whey and collagen respectively. Sigh...

### Performance Analysis

**Wow!** Rather than view and label 1000s of **tactical moves** in order to train a **neural net** to recognize them, a hugely time-saving method is to get the network to identify and group similar moves itself, then a representative move in each group is viewed and labeled appropriately. "Based on the spatiotemporal data of 275 attacks, three different clustering approaches have been compared... Using these clustering techniques, 22 clusters of offense tactics and 15 clusters of defense tactics have been identified and a representative of each cluster has been extracted

to be classified by a professional **handball** coach." [SCHWENKREIS, F.]

Principal components analysis of 20 **team-performance indicators** from 244 matches in world **women's basketball** top-level competitions produced five team-performance "styles" (not described) which were used to predict match outcomes with general and generalized mixed linear models. [XING, W.]. It's hard to understand the outcomes in the abstract, which seems to include analyses of some of the original performance indicators.

There were significant (and substantial) correlations between various **anthropometric** variables and measures derived from the **force-velocity profile** in three age-groups of **youth basketball** players [JIMÉNEZ-DAZA, P.], but to what extent were these correlations confounded by sex and body size? The observed correlation between force-velocity imbalance and maturity offset in the youngest group (12-15 y) might be useful.

Analysis of 10 **forehand drives** by 12 **male club-level tennis** players off deliveries by a ball-throwing machine "shows that experienced trainers' consistent warning *do not be late to open your racket* is clearly true." [BAYRAM, I.]

A **meta-analysis** of 104 studies of **small-, medium- and large-sided soccer games** did not use standardization but instead provided estimates of high-speed running, very high-speed running, and sprinting (in meters per min of play). [DELLO IACONO, A.]. It's not clear in the abstract which game sizes had highest values, and whether large-sided games are assumed to be like real matches. There were substantial differences between study settings (as shown by wide prediction intervals). Game-to-game within-player variability pooled from six studies was a coefficient of variation of 23%, but is that also the variability in real matches?

**High-intensity running** was less in training than in matches in 10 **under-23 semi-professional soccer** players. [HIDALGO-DE MORA, J.]

Amongst the 27 **performance indicators** taken from all 96 matches of the 2020-21 season of the United **Rugby** Championship, winning was associated with increased kicks from hand, meters made, clean breaks compared to the opposition, less scrum penalties and less turnovers conceded. "Simplifying to a smaller number of key variables did not degrade model accuracy, allowing for a more manageable approach to

training and monitoring." [SCOTT, G.]

In a **review** 55 studies of **factors affecting performance** in **women's road cycling**, only one study focused on biomechanics and only one on sociology, the majority being on nutrition, physiology and training. [HERRERO-MOLLEDA, A.]

In a systematic **review** of 43 studies, **competitive "runners and cyclists** have a higher probability to carry specific **genetic variants** compared to controls." [KONOPKA, M.]

In a **review** of 25 observational studies of correlations between various types of **physiological or physical variables** and **sprint kayak** performance, VO<sub>2</sub>max and anaerobic threshold had consistently high correlations, especially for longer race distances, but "the relationship between peak power, anaerobic capacity and aerobic threshold to race distance [sic] was unclear". Half the studies "suggested the importance of both upper-body pulling and pushing strength in improving sprint kayak performance, but literature concerning the relationship between lower body strength and sprint kayak performance is lacking." [DINGLEY, A.]

In a study of 77 runs by five **elite alpine skiers** down a course with four slalom settings, "small differences in **turn cycle structure** assessed through an inertial measurement unit could be decisive to enhance descent performance." [PÉREZ-CHIRINOS BUXADÉ, C.]

This abstract has details of the coaching of the "**Roth**" of **artistic gymnastics** on the pommel horse. [KIYORA, I.]

In a symposium of **climbing** as an Olympic sport, the three abstracts contained very little useful information. [SANCHEZ, X.; SEIFERT, L.; ESPAÑA-ROMERO, V.].

#### Miscellaneous movement analyses...

- **Seasonal training** of 89 **elite, female cross-country skiers and biathletes**. [OSBORNE, J.O.]
- Case study of analysis of **aerodynamic forces** acting on a **ski jumper** from takeoff to landing using computational fluid dynamics. [YAMAMOTO, K.]
- Effect of speed on **lower extremity coordination** in cross-country skiing in nine **experienced male skiers**. [ZHAO, S.]
- The effect on "space exploration" of putting **wall barriers** on the **football** pitch. [COUTINHO, D.]
- Biomechanical assessment of high and low **diving saves** of 19 **young football**

- goalkeepers.** [DI PAOLO, S.]
- A case study of a novel **smartphone app** to analyze **baseball hitting.** [TANAKA, T.]
  - Kinematics and fatigue during repetitive **throwing** of 12 **baseball players.** [ASO, T.]
  - Predictors of throwing **ball velocity** of 32 **male handball** players. [ALNEAMA, A.]
  - **Spike movement** in 48 **female elite volleyball** players with and without the ball. [CATALA, J.]
  - **Inertial measurement units** were good enough to determine sprinting velocity and **force-velocity-power profiles** in 19 **well-trained sprinters.** [MILLOT, B.]
  - Efficiency and kinematic analysis of initial **step patterns** for multidirectional acceleration of 22 **team and racquet-sports athletes.** [VUONG, J.]
  - Kinematics and kinetics of left and right legs during landing of **grand jeté** performed by **professional ballet dancers.** [KUROMARU, A.]
  - **GPS** was as reliable as other methods to derive **force-velocity profiles** from 40-m sprints of 18 **participants.** [FORNASIER-SANTOS, C.]
- Various competition analyses...**
- **Time-motion and heart rate** analyses of 27 under-15 and under-19 **male rugby-7s** players in seven games.
  - **Physiological demands** of 31 **male academy rugby** players in 11 matches. [DELFORGE, E.]
  - "**Mental fatigue** reported by 53 **semi-professional soccer** players was significantly higher during the play-offs phase than during the regular season." [DIAZ-GARCIA, J.]
  - External and internal **match load** of international **female field hockey players** across quarters of match-play. [SPARKS, M.]
  - Playing **intensity** in 65 matches of a **men's handball** European championship. [VENZKE, J.]
  - **Motion characteristics** and metabolic power of 290 **elite male handball** players in 77 games. [BASSEK, M.]
  - Characteristics of specific **intense actions** of 30 **male top-level handball** players in six matches. [PANDURO, J.]
  - Match **characteristics** of "pilota valenciana", a **traditional Spanish handball** sport. [LARRÉ-CASAÑA, A.; PALACIOS-NEVADO, D.]
  - **Physiological demands** of a simulated beach **volleyball** tournament on **elite male** and **female** athletes. [HARAT, I.]
  - Weighting of possession-ending **free throws** in a **men's basketball** world cup. [LAN, Y.C.]
  - **Activity profile** and physical performance of match play in 11 **female** and 11 **male elite korfball** players. [WAWRZYNIAK, S.]
  - Prediction of outcome of **judo** fights from **scores** during the fights. [MOUSSA, I.]
  - Match **intensities** of 48 **females** and 48 **males** in the various weight divisions of **judo.** [SANTOS, L.]
  - **Pacing** in the **men's 1500-m run**, but of only 12 athletes at one competition?! [CASAL GARCÍA, N.]
  - Contribution of each **stage** in prediction of success in **triathlon mixed relay.** [LEDANOIS, T.]
  - World Cup and Olympic Games **analysis** of 3-m and 10-m **diving.** [BRATTA, C.]
- Various correlates of performance...**
- Peripheral muscle **strength asymmetries** across a repeated change-of-direction task were associated with muscle **fatigability** in 249 **male professional soccer** players. [FERIOLI, D.]
  - In 147 **male professional football** players, those with **fast typology** in their soleus muscles (assessed with proton magnetic resonance spectroscopy) were "worse at maintaining their **high-intensity performance** from the 1st to the 2nd half compared to those with slow typology." [VAN DE CASTEELE, F.]
  - Differences in **fitness** tests between five age groups of 232 **male elite youth soccer** players. [SCHWIETE, C.]
  - **Fitness** tests in 83 **male** and 58 **female youth football** players in three age groups. [TINGELSTAD, L.]
  - Positional differences in **anthropometric** and **fitness** measures of 41 **interprovincial female rugby union** players. [CALLANAN, D.]
  - Predictors of basketball **skills** in 244 university-level **female** and **male basketball** players. [TAGATA, S.; AOYAGI, O.; NAGAMINE, K.; OHYAMA, Y.]
  - Differences in **anthropometric** and **fitness** measures between under-16 and under-18 **national-level female handball** players. [CARVALHO, A.M.]
  - **Physical performance** tests and external

- **load** variables from simulated games in an unstated number and level of **ice-hockey** players. [BYRKJEDAL, P.T.]
- Performance **characteristics** of top-5 versus not-top-5 races [racers?] in **female professional cycling**. [LAMBERTS, R.P.]
- **Reactive bounding coefficient** and 60-m sprint time in 9 **male** and 6 **female sprinters**. [WASHIF, J.A.]
- Relationships between starting-block performance and **dynamic-strength index** in 11 **male elite sprinters**. [CAVACA, M.L.]
- Determinants of performance during **paced** and maximal **middle-distance running** events. [BELLINGER, P.] The paced trials seem a bit unrealistic.
- **Physiological parameters** and time-trial performance in 20 **male runners**. [SCHWARZ, Y.M.]
- **Hemoglobin mass** and critical power (both per kg of body mass) in 17 **male** and **female provincial-level speed skaters**. [MARINARI, G.]
- "**Lactate threshold** (% of max) was similar between **elite, national** and **regional endurance athletes**" (total sample size 292). [STØA, E.M.]
- Age-related differences in **spacing** determined from the 50-m splits in 200-m freestyle swimming of 9797 **male** and 6848 **female swimmers** (or is it swims?) of age 12-18 y. [MENTING, S.G.P.]
- Field-based **inhibitory control** with on-field experts' ratings of performance by 25 **senior high school taekwondo athletes**. [HSIEH, W.L.]
- Tennis-test performance, **perceived skills** and **self-regulatory skills** in 13 **male** and 8 **female elite youth tennis** players. [KOLMAN, N.]
- The relationship of **backswing** phase movement smoothness and swing performance in 30 **collegiate golfers**. [PENG, Y.C.]
- The relationship of **backswing** phase movement smoothness and swing performance in 30 **collegiate golfers**. [PENG, Y.C.]
- The II/ID/DD **genotypes** of the ACE gene were related to the physical performance of **athletes** in 17 of 21 studies. [VELANDIA, F.]
- GALNTL6 **gene** polymorphism is associated with strength and power output performance in **Japanese athletes**. [KOZUMA, A.]
- Mitochondrial transcription factor and

myoglobin **gene variants** are associated with endurance performance in Lithuanian **elite athletes**. [GINEVICIENE, V.]

### Talent Identification and Development

In a symposium on "crossing boundaries in talent development..." "**Athletes** who **self-regulate** well, take [more] responsibility for their own development and score better on adherence to their rehabilitation once they get injured. Successful athletes are able to apply this skill not only when they are injured but also during regular sports training and competition." [ELFERINK-GEMSER, M.]

In a qualitative study of strategies of 12 experts to promote **soccer**-specific competencies in players on a talent pathway, "the experts recommended strategies that encourage players' **exploration of functional solutions** to presented problems." [BERGMANN, F.]

"**Dual career competencies** and resilience were the strongest predictors for general, emotional and psychological well-being, while Scandinavian background was the strongest predictor for social well-being" in 1175 **student athletes** from six European countries who completed an online survey as part of an Erasmus+ Sport project. [KEGELAERS, J.]

Conclusions from a cross-sectional survey of 88 **boys** and 90 **girls** attending a **football** winter camp in China: early **specialization** increases the odds of injury and sport devaluation; excessive **training** volume is associated with reduced sense of accomplishment; and paucity of **leisure activities** increases emotional/physical exhaustion. [FENG, R.]

The "stories" of 13 **male** and 12 **female** present and former **elite football** players "suggest that the value of non-club talent development environments appears to be of minor importance for their path towards elite football. The essential environment for the players is the **club environment**." [SÖDERSTRÖM, T.]

If **football academies** are assessed in your country, this analysis of the Norwegian Academy Classification Model will be useful. [NILSEN, A.]

Removal of **soccer league standings and playoffs** for **children** of age  $\leq 12$  y in Sweden "increases the participation rate of individuals who are usually not considered as competent as other participants." [WAGNSSON, S.]

Under-17, under-19, and under-21 **international experience** is a limited predictor of senior success in Norwegian **male football**,

based on this study of 1482 players. "Sport governing bodies need to re-consider their strategies for talent identification and development: before players reach adulthood, fewer resources could be spent on helping a limited number of selected players gain competitive international team experience." [HERREBRØDEN, H.]

From an online survey... "Practitioners in German **football youth** academies assign high significance to the assessment of **biological maturation** and **load monitoring** for a sustainable youth player development. Nevertheless, there is only a limited application and consideration for various training content. Despite the rise of bio-banded soccer tournaments by the Premier League, such a regularly implementation has not been found in Germany so far." [ARENAS, L.]

The **relative-age effect** in **female long jump** was greatest in under-8s and became negligible in under-19s. [JAVET, M.]

These authors have developed "a coefficient allowing to rebalance [i.e., offset] the performance by considering the **relative-age effect**" in over 5 million performances of French **swimmers aged 10 to 18**. [DIFERNAND, A.]. A similar coefficient has been developed for French **alpine skiers**. [DELAROCHELAMBERT, Q.]

A "relocation" method offset the large **relative-age effect** on fitness and anthropometric measures in 236 **elite youth soccer** players aged 12-14 y. [RUBAJCZYK, K.]

The **relative-age effect** "is much more pronounced in elite level than in sub-elite level" in this study of 1728 **football players** from age groups **under-10 to under-19**. [BREUER, J.]

There were **relative-age effects** in the "pre-selection" of 69 Andalusian **youth padel** players. [MARÍN-GALINDO, A.]

Fifteen **male** under-16 and -17 **academy soccer** players **selected** for the national team had higher speed abilities than the 17 players not selected. [KALATA, M.]

Players **selected** for the German **youth national basketball** teams "outperformed their non-selected counterparts in all investigated tests (except for **male** players in the 10-m sprint)." [ROESCH, D.]

"High-performing **male** and **female swimmers** scored higher on physiological (sprint velocity and countermovement jump) and psychological (reflection) **characteristics** compared to lower-performing swimmers" in

this study of anthropometric, physiological, technical and psychological characteristics in relation to performance level of 207 talented youth swimmers over a 3-year period. [POST, A.K.]

A nine-year trend study of the Swiss **under-18 men's ice hockey national team** showed the players are becoming **faster** and **stronger**. [BIELMANN, C.]

**Physical characteristics** differ between **women's** international **rugby union** and **rugby-7s** in an unstated number of French players. [DAUSSIN, F.N.]

This appears to be a study about development of a talent-identification **inventory** for **bob-sleigh** and **skeleton** in China, consisting of physiological, biochemical, kinematic and subjective indicators. [ANQI, L.]

These authors have developed an inventory to assess the athletes' perceptions of the quality of service of **youth sports training providers** in the Chinese environment. [ZHU, Y.]

### Tests and Technology

The Theia3D **markerless motion capture** system seems to be fit for purpose in this reliability and validity study comparing it with a marker-based system. [MASAKI, K.]

Ball speed in **baseball pitching** can be estimated without use of a radar gun by combining data from two **inertial measurement units** with the pitcher's height, in this study of 25 youth pitchers. [GOMAZ, L.]

Conclusions of a review of 20 validation studies: "**wearable sensors** at present do not provide the necessary accuracy as a stand-alone method for assessments of **shock impacts** in the field." [EITZEN, I.]

The Polar Verity Sense **heart-rate monitor** inside the goggles of **swimmers** is an alternative to the usual chest-strap monitor, but in this validity study of 36 swimmers, "measurement error can be unacceptably high in some athletes or during specific training periods." [GOEBE, L.M.]

The ECG247 **Smart Heart Sensor** had a high rate (62% of tests) of false-positive arrhythmias when 13 **professional cyclists** were monitored continuously during a 14-day training camp. [AUSLAND, Å.]

From a symposium on quantifying training load, fatigue and performance... "Up-coming **blood-based biomarkers** for monitoring load, fatigue, and recovery [include] heat shock proteins, cell-free DNA, blood cell ratios.

However, most of these markers have not been extensively studied, and the cost, time, and effort associated with measuring these variables on a regular basis remain high, making them unsuitable for monitoring purposes to date." [HALLER, N.]. "The introduction of **novel sensor data** as near-infrared spectroscopy, power meters, sensor patches (e.g. glucose, lactate) but also modern training software applications open up a new world in the field of performance diagnostics and training load management." [STÖGGL, T.]. For continuous-exercise sports (**running**, etc.), "the assessment of the relationship between **established laboratory test parameters** and performance outcomes over different durations is of great practical relevance." [WAHL, P.]. For intermittent-exercise sports (**football**, etc.), this presenter claimed that it is "difficult to systematically study stress and fatigue on an individual basis." Hans-Peter's notes... In the presentation, this claim referred to the failure of machine learning on an individual basis. Other important aspects of the presentations were that they do not know much about the physiological background of most biomarkers, their origin, time course, best sampling time, confounders, and importantly the clinically relevant changes in terms of injury, well-being, overload or performance. Are the changes just a sign of changed metabolism, hormonal status etc. necessary for adaptation, or do they have adverse biological consequences?

"This symposium presentation will demonstrate how **metabolomics** can reveal novel insights allowing practitioners to develop appropriate interventions to influence performance and recovery whilst raising critical considerations for study design." [OWENS, D.]. Sorry, no details.

In a symposium on **combat sports** performance optimization, "the main combat **sports-specific tests**, their validation process, sensibility, and applicability will be presented." [MORALES, J.].

If you want a **profile of repetitions to failure** vs percent of 1RM max, doing 70%, 80% and 90% on the same day will give different answer to doing them on different days, at least for the bench press with this sample of 10 **resistance trained men**. [MITTER, B.]. Maybe that doesn't matter, depending on what you want the profile for?

The **stress score**, a new measure of

sympathetic stress derived from **heart-rate variability**, is not provided by most existing apps, but can be estimated validly from other measures. [SALAZAR-MARTÍNEZ, E.]

#### Miscellaneous tests and technology...

- Yet another novel **chest-based wearable device** (VitalProbe) for continuous measurement of physical activity, heart rate and respiration rate. [SAVLA, R.]
- Reliability of an **isotonic sprint device** (Exer-Genie) in recreationally trained **individuals**. [OSTERWALD, K.]
- A novel device for measuring isolated **lumbar extension strength**. [DOMOKOS, B.]
- Reliability of leg press **power-force-velocity profiling** outcomes using the Isomed 2000 dynamometer. [DIRNBERGER, J.]
- Validity and reliability of the **jump height** measured with the Polar Vantage v2 **sports watch**. [BARZYK, P.]
- Methodological considerations for **near-infrared spectroscopy** assessment of skeletal muscle **oxidative capacity** in 18 **untrained** and 18 **trained males and females**. [RASICA, L.]
- "To estimate on-ice shooting performance in **ice hockey** players using general off-ice strength tests, **handgrip measurements** should be run with the arm abducted, externally rotated and with the elbow flexed at 90°." [KURZ, E.]
- Reliability and validity of a **horizontal squat jump test** to measure peak push-off velocity. [VOLK, N.R.]
- Squat-jump and isokinetic leg-press **force-velocity profiles** differed substantially in 13 **male ski jumpers**. [FESSL, I.]
- Reliability of ski-specific **performance tests** of 17 **male** and 10 **female highly trained cross-country skiers**. [BUCHER, E.]
- "Using a **neural network** approach to classify the **poses** within frames in **cross-country skiers** leads to highly accurate classifications for frontal and lateral videos. [HOLLAUS, B.]
- A smart **ski**, with an **inertial measurement unit** embedded during fabrication. [RUIZ-GARCÍA, I.]
- Use of a **drone** to pace junior **1500-m runners**. [VAN SON, B.L.]
- A **third ventilatory threshold** was identified in 25 of 39 **cyclists**. [TEALE, J.]
- A field-based **visuomotor reaction-time test**, especially for **football goalkeepers**.

- [PUS, K.]
- Reliability of a **hip extension speed test** for **teamgym gymnasts**. [NEISS PALLISDAL, A.]
  - A **skill-time-related test** for **basketball** players. [JÒDAR-PORTAS, A.]
  - A new test to assess the **endurance** of **rotator cuff muscles** [TOOTH, C.]
  - The Jammer Press, a functional upper-body, unilateral, **horizontal exercise test** for **rugby** players. [DRURY, B.]
  - An updated **men's artistic gymnastics fitness test battery**. [KOLIMECHKOV, S.]
  - A **digital running coach**, providing **runners** with feedback on cadence and duty factor and guiding them through different running styles. [NIJS, A.]
  - A **muscle-load feedback app** for **strength training athletes** to improve training-session muscle-load balance. [NOTEBOOM, L.]
  - **Form Smart swim goggles**: OK for timing, but not for stroke rate. [TSAI, T.C.]
  - Use of a single **inertial measurement unit** to monitor performance and technique of four **swimmers**. [BOUVET, A.]
  - A device ("robot") for **finger-strength training** of **climbers** to avoid shoulder injuries from hanging on a board. [WOLF, P.]
  - A lower extremity **inertial sensor** to quantify biomechanical **load** during **soccer** training. [BASTIAANSEN, B.J.C.]
  - A **smartphone application** for self-measuring of active **shoulder range of motion**. [SHIMIZU, H.]
  - Validity of time of flight during **single-leg jumps** measured with **smartphone accelerometers**. [GALLINA, A.]
  - Key performance indicators in **boxing**, based on **3-D markerless analysis** of videos. [PAGNON, D.]
  - **Kinetics** from the **3-D kinematics** of the upper limb in Ultimate **Frisbee** throwing. [UENO, T.]
  - Positional relationship between ball and fingers from **3-D analysis** of 30 fast balls by each of 14 **skilled baseball pitchers**. [KUSAFUKA, A.]
  - Validity and reliability of the Perception Neuron system to quantify **upper body kinematics** in seven **males**. [WU, Y.]
  - Adapting a **virtual reality system** to reproduce the shots a **badminton** player has difficulty receiving and thereby "realize effective receiver training". [TANAKA, S.]

- Development and validation of a new **over-use injury questionnaire** for **youth athletes**. [LAU, R.]

### Training

**Wow!** In a controlled trial of 8+7+7 **academy soccer** players (18 y of age), "one **high-intensity resistance session** a week is an efficient method to improve lower-limb strength and power in-season compared to moderate-intensity resistance training and pitch-based soccer training only. Importantly, the high-intensity training achieved this with 58% less training volume than moderate-intensity and with similar muscle soreness to soccer training alone." [MCQUILLIAM, S.]. Great to see means and SD in percent units, but not good to see p values.

Amazingly, gains in VO<sub>2</sub>max were similar when **12-year old cross-country skiers** did either **high-intensity interval training** (n=22, 6 ± 6 % mean ± SD) or **strength and coordination training** (n=12, 5 ± 7 %) for 8 wk. Improvements in a control group of sedentary kids were similar (n=29, 5 ± 13 %). [GRENSTAD, H.] Some of the control kids probably trained in secret, judging by their much bigger SD. Means ± SD (%), great! P values, ugh!

Findings of a **systematic review** (not a meta-analysis?) of 14 studies of **high-intensity interval training**: "Whereas short intervals and long intervals seem to be equally effective for improving endurance performance, sprint-interval training and repeated-sprint training are more adequate for improving sprint performance. In accordance with previous research, the reported performance improvements decreased with increasing training status." [QUITTMANN, O.J.]

Sessions of **high-intensity interval training** were "highly variable" between the 92 coaches of field-based **invasion team sports** who responded to an on-line survey of their training practices. [GRASSICK, S.]

**High-intensity interval training** when done uphill reaches higher intensity than when done on the flat, in 19 **well-trained distance runners**. [GIESEN, R.]

Should you do **high-intensity interval training** with intensity relative to race pace or relative to an unspecified measure of physiology? In this controlled trial of 8 wk of training with 16+15 mostly **male distance runners**, the race-pace group improved 10-km time more (by 3.6% vs 0.7%), but oddly, VO<sub>2</sub>max and peak speed in an incremental test improved more in the physiology group. [MAZZOLARI, R.]

"No significant differences in sprint, counter-movement jump and change of direction performances were detected after 6 weeks of three **resisted sprint training** programs" [LIZANA, J.A.], not unexpectedly, with only six **amateur soccer** players in each group.

There were "no significant differences" between the changes in sprint performance following 4 wk of **resisted vs maximal-velocity sprint training** in 8+7 **elite male Gaelic football** players. [WARD, C.]. No data in the abstract, and sample size is too small.

Nine sessions of **sprint interval training** following inhalation of carbon monoxide (to induce hypoxic training) vs placebo resulted in "no significant changes in VO<sub>2</sub>max and endurance performance" in this controlled trial of 23 **endurance trained men** and **women** with modest VO<sub>2</sub>max. [CARDINALE, D.A.]. No data in the abstract.

In a symposium on high-intensity **hypoxic training**, "this presentation will summarize and discuss the last [latest?] living low-training high-based evidences related to performance or health enhancement." [BROCHERIE, F.]

The abbreviations make it hard to understand, but it looks like biochemical adaptations to **sprint-interval training** are potentiated by brief **occlusion** of blood flow to the legs after each sprint. [GALLEGO-SELLES, A.; MARTINEZ-CANTON, M.]. We await effects on performance in competitive athletes.

Wait no more! In a similar study of **sprint-interval training** with 12+8 **trained males**, "**blood-flow restriction** did not augment increases compared with control ( $p \geq 0.101$ )" [PEDEN, D.L.], but the observed improvements in VO<sub>2</sub>peak and two lactate thresholds were 3.2% vs 1.9%, 9.0% vs 6.1%, and 5.6% vs 5.1%. Promising, at least.

Conclusions of a huge **meta-analysis** using standardization (caution!) and "P-scores" (probability of benefit?) to combine and assess effects: training with **blood-flow restriction** "provides notable effects on maximal strength, hypertrophy and the aerobic capacity, especially when low training intensities are used. While a **high resistance training** load seems to be most important for the gain of maximal strength, a **high training volume** regardless of the load seems to be most beneficial for hypertrophy. High intensity endurance training or low intensity endurance training with blood-flow restriction seem to be most beneficial for the improvement of the

aerobic capacity." [WIEDENMANN, T.]

"Shorter, daily **low-intensity sessions** seem superior for anaerobic threshold power compared to longer 3-day low-intensity blocks" in this 8-wk controlled trial with 4 **female** and 17 **male moderately trained cyclists**. [RÖHRKEN, G.]

In spite of major limitations in the current literature, the conclusion of a **systematic review** of 38 studies was that "**resistance training** to set failure is likely not superior to non-failure resistance training to maximize muscle hypertrophy, but the optimal proximity to failure for muscle hypertrophy remains unclear." Non-failure resistance training therefore seems to be preferable, because it results in less fatigue and muscle damage. [REFALO, M.]

In a **meta-analysis** using standardization to combine 22 studies, "**resistance training** over 10 weeks or longer and with heavy load will be more effective in improving **running** economy and running time-trial performance as compared to **plyometric training**." [EIHARA, Y.]

Moderate volume of **resistance training** resulted in faster and similar or even greater strength increases than low or high volume in a controlled trial with 36 already **resistance-trained men**. [PÁEZ MALDONADO, J.]

Standardization was the method for combining 36 studies in this **meta-analysis** showing that **plyometric training** combined with other training was "useful" to improve the vertical jump. [LEÓN-MUÑOZ, C.]

**Heavy** and **plyometric strength training** for 8 wk enhanced 3-km run time by 5.2% and 5.9%, while controls improved by only 1.5% in a controlled trial of 8+9+7 **runners**. [STORNILOLO, J.L.]

From a symposium on **flywheel resistance exercise**: "there is no evidence about what conditioning activity (flywheel vs. traditional protocols) may be superior in enhancing **athletic** performance." [BEATO, M.]

In a standardization-based **meta-analysis** of **velocity-loss (VL) resistance training** in eight studies, "muscle strength was found to increase over a wide range of VL (0-50%), muscle hypertrophy over a medium to high VL (15-50%), and sprint and jump performance over a low to medium VL (0-25%). The new finding of improving sprint and jump performance at the VL 0-10% has an advantage of less exercise volume and is therefore an effective tapering method." [MOCHIZUKI, Y.]



"A 20% **velocity-loss** threshold produced similar or even greater gains [in leg strength and jump height] than 40%" when 25 **strength-trained men** were randomized to the two **resistance-training** groups with **blood-flow restriction**. [SÁNCHEZ-VALDEPEÑAS, J.]

A standardization-based **meta-analysis** of 17 studies reached the conclusion that "**plyometric training** is an effective method to improve **soccer** players' kicking performance". [ZHANG, Y.]

When 24 **elite floorball (male and female?)** athletes were randomized to 24 wk of either control training, added **consecutive isometric training**, or added **periodic isometric training**, "inclusion of isometric training was beneficial to strength and dynamic performance, and consecutive training seemed to result in greater positive effect on 20-m sprint and countermovement-jump performance. [LUM, D.]

Eight weeks of **complex training** (high-load strength exercises with plyometrics) wasn't quite as good as **block training** in this controlled trial of 17+17+13 **young men**. [BOURGEOIS, H.]

"Superimposed **electromyostimulation** with relatively low-volume, high-intensity and outcome-specific movement pattern appeared to be the most promising and beneficial training approach in **trained athletes**" [MICKE, F.], but unfortunately this **meta-analysis** of 36 studies was based on standardization.

An individualized **contrast training** program improved several measures of physical performance after 8 wk in this randomized controlled trial of 30 **senior basketball** players [BARRERA-DOMINGUEZ, F.J.], but data for the control group weren't presented.

In a symposium on **combat sports** performance optimization, "**sports-specific exercise modalities** will be suggested; with the overarching aim to provide evidenced-based suggestions for appropriate training protocols."

[FRANCHINI, E.]

There were substantial differences (in the changes?) in muscle contractile properties between groups when 21 **1st-division football** players were randomized for 12 weeks to **yoga** or control. "Yoga shows a significantly higher evolution" (?). [PEREIRA, A.]

Does **time of day** for training make a difference? In this standardization-based **meta-analysis**, "there is little evidence that exercising at a specific time of day is more beneficial in increasing jump height or maximum strength as compared to another time of the day. However, morning exercise seems to improve morning performance and evening exercise improves evening performance to a higher extent." [BRUGGISSER, F.]

A program to foster **decision-making** was partially successful in this uncontrolled qualitative-quantitative study of 15 **female youth volleyball** players. [MUÑOZ LLERENA, A.]

When 31 **male** and 9 **female athletes** were randomized to "optimal training" (placebo training) and "control training" (identical control training), the **placebo effect** worked not only for 1RM squat performance but also for muscle thickness. It was  $p > 0.05$  (so who knows?) for countermovement jump height, 20-m sprints, or leg press power. [LINDBERG, K.]

**Coach substitution** in seven **professional Spanish football** teams resulted in improvements in technical-tactical and physical performance. [MARTÍN CASTELLANOS, A.] At least part of the improvements could be due to regression-to-the-mean and novelty effects, but regardless, if your team keeps losing, you have to go.

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