Genomics and more at ICSEMIS 2016 – the Olympic Conference in Santos, Brazil

Will G Hopkins

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High Performance Sport NZ, Auckland, New Zealand and Institute of Sport Exercise and Active Living, Victoria University, Melbourne, Australia. Email. Reviewers: Yannis Pitsiladis, University of Brighton, Eastbourne, UK; Romain Meeusen, Vrije Universiteit Brussel, Belgium.

The highlight of this quadrennial conference was genomics: its future role in drug testing, the Athlome Project Consortium, the history of the ACTN-3 gene, and shortcomings of current commercial genetic testing. Other presentations summarized here relevant to competitive athletes… Adaptation and Training: extreme conditions; sleep; far-infrared radiation; sprint-interval for cyclists; maximum-power for boxers; inspiratory-muscle for soccer; monitoring jump height for team sports; straight-leg for swimming; core for canoeists; biofeedback for futsal and volleyball; plyometric and phototherapy plus electric stimulation for volleyball. Correlates of Performance: hotspot Perth; problems in Shanghai; football performance indicators; ball speed in goalball; punch speed in karate; pacing in running; throws in handball; technique in table tennis; heart-rate variability in trap shooting; wining factors in Chinese artistic gymnastics; flexibility in taekwondo. Injury: functional movement screen. Tests and Technology: medal-winning enhancements; kinematics of fencing and weightlifting; kicks in taekwondo; mean jump height to monitor fatigue; best tests for basketball; scoring the decathlon; variability-based performance index. KEYWORDS: competition, elite athletes, ergogenic aids, performance, talent identification, tests, training.

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ICSEMIS stands for *International Convention on Science Education and Medicine in Sport*, a collaboration of several organizations that sponsor this quadrennial conference around the time of the Olympics. The omission of "Olympic" from the title reflects the fact that the International Olympic Committee is not one of the sponsors–a pity, because their involvement would help raise the profile of the conference, which has apparently suffered since the last IOC involvement in 2004. The 2016 conference took place in Santos, Brazil, September 30 through October 4 (between the Olympic and Paralympic games). There were about 1500 registrants, half as many as for the conference in Glasgow before the London Olympics. As happened in Glasgow, a substantial proportion of foreign (in this case, non-Brazilian) registrants either did not turn up or left early. Consequently, more than half of the posters each day were missing, some posters were not removed from the display boards from one day to the next, and one or more speakers were absent from most podium sessions. Altogether it was a disappointing outcome for the organizers, who put in a huge amount of work and expense to make the conference otherwise very professional and worthwhile. We even had a concert from the Santos chamber orchestra on the opening night, and a string quartet played at the end of one of the day's sessions. Let's hope that something is done to improve the attendance at the 2020 conference in Japan. Without IOC support it may not even take place.

As with all my other conference reports, I have summarized here the presentations relevant to athletic performance or injury. Because so many posters were missing, I photographed and summarized only those on display. A PDF of abstracts is not available, but individual abstracts can be accessed via the conference homepage. Links to the oral and poster presentations and a search form can be found here (ignore the "ePosters" stated on this page–there weren't any). Abstracts for the keynote speakers, invited symposia and additional symposia

can be found in the Scientific Programme dropdown on the conference homepage. In the following summary each conference hyperlink takes you directly to the abstract for keynotes and symposia, but for oral and presentations you reach a page where you will need two or three more clicks.

The most interesting and important aspect of this conference was genomics, so I have devoted a special heading to this topic, in addition to some of my other usual headings: adaptation and training, correlates of performance, injury, and tests and technology.

Genomics

Yannis Pitsiladis gave an impassioned opening keynote address on the topic of **Doping–Next Essential Steps**. He made it clear that the current approach with the athlete passport is not working well for blood doping, because athletes can cheat by microdosing with banned substances or transfusions. Genomics, or more broadly "omics" (transcriptomics, epigenomics, metabolomics, proteomics), are now needed to identify the drug cheats, and the necessary research will cost several million dollars. To date the IOC has not funded his grant applications for this research, while WADA's token contribution has averaged about $100K per year over the last 10 years. One can only conclude that the cheats will stay ahead in the arms race, especially with the advent of the CRISPR technique to achieve gene doping. On the positive side, this technique will eventually be used to reduce injuries and improve the health of athletes and non-athletes.

The invited symposium on **Genetics of Sport Performance** brought us up to date with this topic. The abstract by the chair, João Pesquero, summarizes a recent genomics invited symposium of movers and shakers that has resulted in the Athlome Project Consortium, which aims to "develop the specialist knowledge to inform personalized training and injury prevention, as well as doping detection." The material presented by the three speakers in the symposium is not summarized in the abstract.

Jane Seto gave us the history of research ("20 years in 20 minutes") on the gene for alpha-actinin-3 (ACTN-3): absence of this protein in muscle due to a defective variant of the gene is beneficial for endurance and appears to have been advantageous (for unclear reasons) when Homo sapiens migrated out of Africa.

Masashi Tanaka reported on the early stage of the 1000 Athlomes Project, the aim of which is to sequence the entire genome, not just the protein-coding exomes, of the large number of individuals that are needed to make any sense of associations between genotypes and phenotypes; current cost, US$2000 per genome.

Finally Yannis Pitsiladis envisaged the not-too-distant future of gene chips to diagnose propensities for sprinting, distance running, tendinopathy, concussion, sudden death, and so on. Unfortunately the genetic testing currently on offer from commercial companies appears to be practically worthless. A recent study in *Biology of Sport* on a genetic-based algorithm for personalized resistance training was sponsored by one such company and is deeply flawed, in his opinion. (Alas, I accorded this study a wow factor in my report on this year's ECSS conference.) He also presented a case study of his own: when he sent one of these companies a tissue sample of a double Olympian and endurance world-record holder with a history of chronic injury, the diagnosis came back as "70% power, 30% endurance, medium aerobic potential and medium injury risk"! In another example of how "things are much more complex than initially envisaged", the I and D alleles of the ACE gene have opposite frequencies in Caucasian and Asian short distance swimmers. Yannis concluded by endorsing the need for studies of thousands of athlete genomes by the consortium of experts. See his comment below.

In an original-research study presented later in the conference, there were clear associations between the allelic frequencies of four **genes** previously associated with athletic performance (ACTN3, AGT, ACE, BDKRB2) and playing positions of 154 elite Brazilian **basketball** players. Neither the abstract nor the poster contained any information about the two dimensions used in the multiple correspondence analysis, but height of the players in the different positions appears to be involved. Would it be useful to allocate players to playing positions on the basis of genotyping, taking into account height?

Adaptation and Training

The abstract for the symposium on preparing for **extreme conditions** (traveling, heat, pollution, altitude) is not particularly informative, and it refers to one of the speakers as being Ron

Maughan, who definitely was not present! Owing to a program clash, I got to the symposium only for question time, which *was* informative. Effects of pollution on athletic performance have been investigated only in short-term studies, and Romain Meeusen does not advise trying to adapt to pollution, because the state of chronic inflammation it would induce has got to be harmful for performance. The best strategy for trans-meridional travel, according to Marco de Mello, is *not* melatonin, which apparently impairs performance next day; instead use light, and start eating and sleeping in the hours of the new location as soon as possible.

I missed what must have been a very useful presentation summarizing three studies of **sleep** with ~12 elite **team-sport athletes**. A 1-h sleep-education session increased sleep time by 22 min and produced small improvements in sleep efficiency and latency, a nap for <20 min on competition day produced unspecified improvements in physical and perceptual performance compared with no napping or longer napping, and training and performance had unspecified effects on sleep quality and quantity. Unfortunately the abstract is short on details and long on p values.

Can **far infra-red radiation** enhance performance? It seems extraordinary to me that wearing a track-suit impregnated with borosilicate nanoparticles for 4 d can somehow absorb heat from the legs and re-emit it as far infra-red radiation with ergogenic effects in performance tests. At this stage it was only on 16 **unfit men**, and the enhancement in cycling time to exhaustion in a crossover was 23% (equivalent to ~1.5% in a time trial). Read the abstract and this review of effects of far infra-red radiation, but wait to see if it works with athletes.

It looks like 6 wk of twice-weekly **sprint-interval training** works better with decreasing numbers of reps in each set (8+6+4+2) than with constant numbers (5+5+5+5) in this controlled trial of 14 male **cyclists**, but the outcomes on sprint performance are presented as a difference in significance, not a significant difference, and the non-significant changes are not presented. How about some confidence limits? Abstract.

In an uncontrolled study of 11 male and female **boxers** of the Brazilian national team, 7 wk of twice-weekly bench-press and jump-squat training sessions with weights that elicited **maximum power** produced improvements of 13% and 8.6% respectively in the maximum power of these movements. Abstract.

Inspiratory muscle training produced a difference in significance in endurance time to exhaustion and repeated sprint ability in a placebo-controlled trial of 18 elite female **soccer** players. There are no data in the abstract.

By **monitoring countermovement jump height** and prescribing **training** accordingly during a period of overload and taper, these researchers were able to achieve an apparently greater jump height in a controlled trial of 18 **team-sport athletes**. Abstract.

This **swimming** researcher/coach presented two talks that were a follow-up of the case-study of the performance enhancement resulting from using a **straight leg** in the butterfly that he first presented at the swimming conference in Oslo in 2010. He also presented a poster showing similar enhancements with straight legs in a case study of the backstroke.

If you are interested in a set of **core-training** exercises for **canoeists**, check out the details in this abstract for what was done with the nine athletes in the Chinese national kayak team prior to Rio.

The 11 professional **futsal** and **volleyball** athletes who were randomized to **biofeedback** consisting of 15 30-min sessions of "breathing exercises and concentration techniques" over 5 wk experienced lower state anxiety and lower cortisol than the 11 athletes in the control group. The biofeedback group "was able to get more points and presented lower number of mistakes", but neither the poster nor the abstract showed any performance data.

Plyometric training tended to produce greater gains in jump performance in the 12 **volleyball** players who trained on a wooden surface than in the 12 who trained on a synthetic surface (not described in either the abstract or the poster), according to my interpretation of the results in the poster, anyway. Both groups did much better than a control group of 12 who did no plyometrics.

I somehow missed the presentation, so the absence of units and detail in the abstract prevent me from properly assessing the claim that **phototherapy** and **neuromuscular electric stimulation** enhanced strength performance in a 6- to 8-wk controlled trial of 36 **volleyball**

athletes.

Correlates of Performance

Kristy O'Neill identified the factors that made Perth, Australia, a **hotspot for Olympic medals**. Some factors are not modifiable or transferable to other locations: success in one sport was due in part to immigration; Perth's isolation led to feelings of being a big fish (in a small pond) and consequent confidence in achievement; Perth's Mediterranean climate and even its location on a sand plane were regarded as beneficial; the Olympians came from garden suburbs with relatively high socio-economic status, and the developing athletes were immersed in a culture of high achievement. Factors that could be fostered elsewhere include easy access to facilities, the frequent interaction of developing and elite athletes, and hosting of international competitions.

A city getting **less medals** these days is Shanghai, so the authors searched the literature, conducted interviews, and did field trips to find the reasons: insufficient reserve of talent, and coaches insufficient in number and in qualifications. The suggested solution: "establish rational development orientation with specific goals; create good environment for the improvement of mass sporting or physical activities; stress on school sports, integrating athletic training and routine physical education; build up reserve talents market and corresponding league matches system; establish rational sport events arrangement… Shanghai [needs] sports branding in the market like NBA, F1 and ATP." Abstract.

Effects of **team performance indicators** on chances of winning in the Chinese **football** super league should be useful for pre-match training programs, in-match tactical strategies, and post-match tactical feedback. See details in the abstract.

Goalball is a Paralympic team sport where visually impaired players are completely blindfolded and block the ball using sound cues only. A computer-vision system to track the ball showed that **ball speed** was an important predictor of scoring, especially with female players, and that ball speed did not decline during matches. Hence "training of explosive strength abilities should be preferred compared to endurance training." Abstract. In another statistically old-fashioned presentation by the same authors, there were differences in the way points were scored by men and women. Abstract.

Brown and black-belt **karate** athletes have higher **punch speeds** than those of lower levels, as determined by an accelerometer worn on the wrist. Abstract.

The average **pacing** profile of medalists in the 1500-m **running** event in six world championships and two Olympics produced poorer performance than a self-paced profile in 21 national-level Chinese runners–not surprising, given the slow pace of the first half in the competitions. Abstract.

Accuracy of 7-m **throws** at the goal for 10 regional-level men's **handball** players differed depending on the position of the goalkeeper and the corner the player was aiming for. The data in the abstract are ambiguous, but it looks like aiming for the bottom of the lower part of the goal was more successful than the upper part.

A case study of the **technique** of the top Chinese **table-tennis** player Ma Long will be useful for practitioners in this sport. Abstract.

Getting his body under control of the parasympathetic nervous system rather than the sympathetic was important for success in **trap shooting**, according to this case study of **heart-rate variability** before unsuccessful and successful shots. Abstract.

The five **winning factors** of Chinese men's **artistic gymnastics** in this qualitative study were strength, difficulty, stability and accuracy of dismount, aesthetics and novelty. Abstract.

Advanced-level **taekwondo** athletes are more **flexible** than those of basic level. Abstract.

Injury

The symposium on **injury prevention and return to play** was informative and entertaining, but my impression was that there have been no recent insights or controversial issues in research on injuries. The abstract contains little information.

In the only original-research presentation that I could find worth summarizing, the researchers provided many diagnostic statistics but not the most important: the proportions of athletes injured and the risk (hazard) ratio. However, it's very obvious in this 1-y prospective study of 217 elite Chinese **athletes** in 22 sports that a score on the **functional movement screening** tests of ≤17 was associated with a much higher risk of injury (odds ratio 8.0). It would be nice to know how much of the risk was due to injury

history. Abstract.

Tests and Technology

In a symposium on elite performance, I spoke on the topic of recent research on **medal-winning enhancements** of performance in non-interactive sports, interactive non-team sports, and team sports. The slideshow is available here. The other speakers presented in Portuguese, and although their words were translated live, I was unable to take useful notes. The abstract does not contain the interesting details presented in the talks.

If you are interested in **kinematic analysis** of the lunge in **fencing**, check out the abstract of this case study of a developing junior.

Microsoft's Kinect real-time motion-capture system has been adapted very successfully to provide **kinematic analysis** and feedback to athlete and coach in **weightlifting**. The system has been used at world championships, but it was not permitted at the Olympics. Abstract.

The number of turning **kicks** that **taekwondo** athletes can perform in five 10-s sets appears to have high reliability, in spite of the uniformly high caliber of the athletes (all black belts). Individual differences in fatigue in the test should also be useful for corrective training. Abstract.

The mean height of a multiple **counter-movement jumps** declined when the **athletes** were **fatigued**, but the maximum height showed little change in this meta-analysis. So if you are monitoring for fatigue and recovery, make sure you use the mean. Abstract.

They provided no data, but on the basis of monitoring junior elite women's **basketball** players every 6 wk for one year, the authors opted for the following **performance tests**: three-quarter court (rather than full-court) shuttle sprints followed by "step as quickly as possible" (sorry, no idea what this means) for speed performance; 1 min of double-rope jumps and 1 min of six-side (?) jumps for agility; an adapted shuttle run consisting of 13x 15 m, 4 reps, 1.5 min intermittent (?) for speed-endurance; and continuous shooting from >4.5 m, 1 shot every 4 s for skill. Abstract.

I couldn't understand the statistics in the poster or the abstract, but apparently the current **scoring** of the events in the (men's?) **decathlon** favors sprint and jump disciplines and penalizes four others.

The authors of this abstract suggested a new **performance index** based partly on the career variability of the athlete's performance relative to other athletes, using **triathlon** as an example. Unless I have misunderstood, this approach would appear to penalize an athlete showing a rate of improvement relatively higher than that of other athletes.

Reviewer's Comment

Yannis Pitsiladis

Sport and exercise genomics needs to abandon the current practice of focusing on candidate genes defined by authors' preference or biases and the reliance on small, statistically under-powered, observational studies. There is an evident need for larger collaborative efforts involving clearly defined phenotypes, control of sources of variability, and rigorous replications in order to produce any meaningful results, which has led to the formation of the Athlome Project Consortium. This international collaborative initiative brings together a large databank, expertise and state-of-the-art "omics" technologies from around the world, aiming to understand genetic variation underlying athletic performance, adaptation to exercise training, and injury predisposition. It is hoped that this initiative will encourage a new standard of excellence and motivate more international collaboration in sport and exercise genomics.

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