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Chocolate Milk and Other Strategies for Athletes at the 2010 ACSM Annual Meeting

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The annual conference of the American College of Sports Medicine was noteworthy for the domination by sports nutrition research. This year's winning strategies are chocolate milk for recovery and sustained-release β-alanine for high-intensity events. Acute Effects: warm-ups, acupuncture, Energicer, contrast therapy, garments, gliding in swimming, pacing. Nutrition: quercetin and other antioxidants, fish oil, carbohydrates, drinks, hyperhydration, hypohydration, water receptors, chocolate milk, protein, branched-chain amino acids, β-alanine, HMB, nicotine, caffeine, bicarbonate, Viagra. Tests and Technology: gymnastic tests, running shoes, GPS, accelerometry, video analysis, anaerobic thresholds, validity analyses. Training: overload, monitoring/modeling, fencer-specific, live-low train-high, kaatsu blood-flow restriction, whole-body vibration, inspiratory, interval, strength, resistance. KEYWORDS: elite athletes, ergogenic aids, nutrition, tests, training.

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I missed last year's annual meeting of the American College of Sports Medicine, but I'm glad I made it to this one, which was held in Baltimore, June 1-5. The first day was devoted to presentations of the inaugural World Congress on Exercise is Medicine, and it appears that the ACSM annual meeting henceforth is to be known as a joint meeting with Exercise is Medicine. Sedentary folk may be looking for any excuse not to exercise, so I hope the concept of medicine in this context does not put them off. The other days were full-on for those of us interested in performance of competitive athletes, which is the focus of this report. My colleagues with an interest in physical activity for health had all just been to a great conference in Toronto, but this ACSM meeting also had hundreds of useful abstracts they should peruse–see below for access instructions.

The centerpiece of the conference was the Bruce Dill historical lecture given by Brian Whipp on a topic suggested by Carl Foster, *The Self-Correcting Nature of Science*. It was a highly entertaining history of science since the time of Socrates. Brian looked at past paradigm shifts and eventual recognition of neglected contributions that represent self-correction, and I was delighted to hear him challenge one of the current paradigms, the Popperian notion of falsifiability. Now, if only he had finished the job by rubbishing the notion of falsification of the null hypothesis! Will p values soon be a casualty of scientific self-correction? Here's hoping.

There were many other valuable special presentations. Unfortunately and as usual, these inevitably clashed with each other and with the presentations of original research, which for me have to take priority. It wouldn't be so bad if the special presentations had abstracts, as they used to. Maybe the program committee thinks that we can buy the recordings, but most of us don't have time to listen or the inclination to spend more money, even if it's someone else's. An educational opportunity is being lost here–the program committee should insist on abstracts for such presentations.

You will see in my report that the most presentations by far were nutritional. I guess this kind of research is relatively easy to do: the interventions usually take only a few days, you can usually blind athletes to the treatments, you can get the extra power of a crossover with short washouts, and most importantly, coaches and athletes don't mind doing something that doesn't mean a change in training and that in

some cases might also benefit health.

So what were the most exciting strategies at this year's ACSM I can recommend for athletes? **Chocolate milk** for recovery is the winner! **β-alanine** is also a definite ergogenic aid for shorter high-intensity events, which we've known for a few years, but the breakthrough announced at this conference is a sustained-release form of the supplement that makes the month or so of loading a lot easier and probably better. Quercetin and other **botanical antioxidants** also look exciting, but more from the point of view of health than performance. These antioxidants hopefully reduce risk of cancer and the harmful sequelae of chronic inflammation and aging, such as Alzheimer's and cardiovascular disease, but they probably *attenuate* the benefits of training by soaking up the reactive oxygen species that help signal adaptive responses to exercise. Taken acutely, some antioxidants might nevertheless enhance high-intensity endurance performance, although no data directly supporting that idea were presented at this conference. **Running shoes** with "actuator lugs" that improve running economy look very promising, and **accelerometry** may be useful for monitoring training in some sports, but I didn't notice any real breakthrough technologies. Amongst the interesting training-related findings was the observation that **markers of training stress** are generally positive indicators of performance enhancement in an overload phase in elite athletes (i.e., the harder the training, the better), and that baseline values of **markers of oxidative stress** may be risk factors for overtraining.

As with previous meetings, it will be possible to access the abstracts of the original research presentations on line. You can go straight to the page for the May supplement, then browse the sessions from the Table of Contents Sections. Or to find the abstract from the number in brackets […] in my report, click on the Advanced Search link, put the abstract number into the Keywords box, limit the search to Titles, enter the volume number (42) and issue number (5), then Search. Some of the hits have a link to a large PDF containing the abstract. There are five PDFs, one each for the featured sessions, slides, clinical case slides, thematic posters, and posters. Strangely, only the first few presentations in each PDF show a link to the PDF. So, if you want the complete PDF for each type of session, put the following word in the Keywords field of the search form, with other information as above: 587 (for slides), 1094 (for thematic posters), 1158 (for clinical cases), and 1345 (for posters). The PDF of featured sessions is not available, but there were no abstracts anyway. If all else fails, email me.

A good way to review this and other conferences is to get together a small group (no more than five) with an interest in a specific sport or topic, set up the PDF of conference abstracts on a big monitor, then search for the sport or other keyword and skim each abstract containing the keyword. It's actually fun, and you will learn things from each other, as well as from the abstracts.

Acute Effects

Although it wasn't done with competitive athletes, a really comprehensive crossover study of 34 **young adults** showed substantial differences in the effects of various combinations of **warm-up exercises** (aerobic, stretching, specific activity) on **vertical jump**, which highlights the need to investigate what works best for your athletes [615]. An attempt to optimize the warm-up by aiming for **post-activation potentiation** failed in a crossover with 14 male **basketballers** [1702].

Acupuncture for performance enhancement? It's hard to eliminate the placebo effect–recall that placebo injections of saline work better for pain than placebo pills–and there are questions about the time course and the type of exercise, but this crossover study of 33 **recreational athletes** showed there could be benefits for maximum **isometric force** [616].

Forget about wearing a wristband soaked in **Energicer** alcohol-menthol solution: it might feel cool, but as you would expect, there was little effect on performance of a **2000-m time trial** in a warm environment by 18 **rowers** in a crossover [617]. The latest way to get a placebo effect, or would you prefer acupuncture?

When 11 trained **cyclists** repeated a 109-min bout of **sprints** and short **time trials**, the repeat was better when recovery from the first bout consisted of 6 or 12 min of **contrast water therapy** (alternating 1-min bouts in hot and cold water) relative to control or 18 min of contrast therapy [618].

Although it was a crossover, there is no way five endurance **cyclists** is enough to conclude

"no effect" of **compression tights** for recovery between a 60-min pre-load and a 20-min **time trial** [619]. I am more inclined to believe a claim of little effect of such garments on running mechanics and economy with 16 highly trained distance **runners** (show confidence limits and I wouldn't have to be *inclined*–I could be *persuaded*), but any assertion about individual differences in the effect is vacuous without an analysis of change scores that takes into account error of measurement [620].

Whether **titanium-impregnated garments** had a clear benefit on recovery in **cyclists** depended partly on the choice of smallest worthwhile effect, and there was the possibility of at least one negative effect [621]. So, given no plausible mechanism, I would put my money on the true effect being trivial, if not truly null. These odd-ball studies have to be published, however, on the off-chance that they're paradigm shifters.

According to the computational fluid dynamics, there's less drag when you **glide deeper** in a **swimming** start or turn, but whether you might save time thereby is not clear in the abstract [699].

Top **speed skaters** who performed worse than normal in competitions did so not because they **paced** themselves badly but rather because they were just in bad form [1150]. Nice one, Carl (Foster)!

Nutrition

There's little doubt that **dietary antioxidants** can reduce the signs and symptoms of the oxidative stress of hard or eccentric exercise, but do they benefit or harm athletic performance acutely, and do they benefit or harm adaptations to training when consumed chronically? Few of the many studies on antioxidants presented at this conference addressed these questions. One of the best was a crossover study of 23 female **runners**, who performed three 3-wk blocks of overload training each followed by a taper and performance tests, with consumption in each block of an isocaloric drink containing either blackcurrant extract, megadoses of vitamin C, or placebo, with 4-wk washouts and performance pretests before each block to adjust for individual changes in performance over the extended period of the study [2902]. The training consisted of high-intensity intervals performed competitively on a hilly course, and the performance tests after each taper were a treadmill **incremental test** and a 5-km road **time trial**. Vitamin C and blackcurrant extract *impaired* training intensity clearly by ~1%, but in spite of the large sample size and sophisticated analysis, mean effects on the performance tests were unclear (i.e., possibility of small beneficial effects but unacceptable risk of small harmful effects). Not stated in the abstract was some evidence that faster runners might benefit from the blackcurrant. It's possible that there were beneficial acute effects from the antioxidants on the day of the tests that were offset by harmful chronic effects on training, an issue with many such studies that needs to be resolved.

There were several studies of effects of other **botanical antioxidants** on performance or recovery. Two weeks of an "almond diet" or "almond and purple sweet potato leaves diet" resulted in 46% and 39% increases in **run** time to exhaustion respectively at 75% VO_2max compared with the ~34-min control (not placebo) in 14 male **team-sport athletes** [2905]. In contrast, 7 d of supplementing with pomegranate juice (not stated as such in the abstract) vs placebo resulted in a reasonably clear 4.5% *impairment* of mean power of 12 endurance athletes in a 10-min **cycling time trial** in the heat [2904], even though pomegranate juice reduced muscle soreness and weakness following muscle-damaging eccentric exercise in 17 (9+8?) **resistance-trained males** [1931]. Two supplements with antioxidant activity (one based on rose hips, rhodiola, and astaxanthin; the other based on ashwaganda, prickly pear, and grape seed) also reduced strength loss following eccentric exercise in 31 **healthy men** randomized to the control and treatment groups [1747]. Another herbal blend (Rhodiola crenulata and Cordyceps sinesis) might enhance the effects of **altitude** training, but statistical significance in the treatment group and not in the control group probably means nothing useful [1936].

Quercetin ("kwer-sitin") was the main topic of one of the two President's Lectures that closed the conference [no abstract]. Mark Davis painted a very rosy picture of a compound found in fruits and vegetables that at least in animal studies has all manner of beneficial effects on performance, immunity, and even colon cancer, mediated possibly through anti-inflammatory, anti-oxidant, and caffeine-

like actions. Effects on humans might not be so clear cut, according to the Wikipedia article, and at this conference there was only one arguably beneficial effect–a reduction in post-exercise blood pressure–in seven abstracts of studies of quercetin and related compounds [2567-2574]. Mark cited one study in his lecture showing an increase in VO_2max and time to exhaustion in humans, but the subjects were untrained and did not train during the 7 d of supplementation.

I was intrigued to attend Russ Richardson's colloquium on **antioxidants in exercise** [no abstract], because Russ has done outstanding work in the past on delivery of oxygen as the limiting factor in endurance performance. He has now grafted this prior interest onto the effects of **aging** and antioxidants on the delivery of blood to muscle. In summary, an acute dose of antioxidants restores the age-related loss of vascular function, but the partial restoration that occurs with training in old muscle is *antagonized* by antioxidants. His observations fit with the emerging picture of antioxidants as worth taking acutely for competitive performance but bad for training, as his co-presenter Jose Vina recommended. Russ had no answer to my question as to whether dietary antioxidants antagonized blood flow to the brain in aging professors who exercise and mega-dose on blueberries and blackcurrants.

Fish oil has anti-inflammatory properties, but supplementing for 65 d in a blind controlled trial apparently had little effect ("all P>0.05") on markers of inflammation, muscle damage and muscle **strength** following a subsequent acute bout of **eccentric** exercise [2829]. With only 10+10 "**participants**" (5 females and 5 males in each group), the study was probably underpowered for conclusions about small or trivial effects, but exact p values–or better still, confidence limits–would help savvy readers decide. This comment applies to the majority of all the presentations. Sigh…

In a **meta-analysis** of 44 studies of effects on exercise performance of **carbohydrate** ingestion during the exercise, the authors needlessly (it seems to me) excluded studies that did not meet ACSM guidelines for supplementation, thereby reducing the possibility of challenging or extending the guidelines. The studies were pooled by standardizing effects before analysis, an approach I do not recommend. Separate analyses for the four exercise protocols (time trial or time to exhaustion, with or without an exercise preload) revealed small beneficial effects of carbohydrate [1584].

By modeling curvature in the response of 51 **cyclists** and triathletes to a range of doses of **carbohydrate** at four research sites, a consortium of researchers found an optimum ingestion rate of ~70 $g.h^{-1}$ for a 20-km **time trial** following a 2-h preload [855].

A drink containing **fructose** and **maltodextrin** was absorbed more rapidly than an isocaloric drink containing only maltodextrin in a crossover with 14 **cyclists/triathletes**; performance of a 60-km **time trial** following a 2.5-h preload was substantially better with the fructose, although "no significant differences were found" [857].

A newly designed **hypotonic sports drink** (Mizone Rapid) was absorbed more rapidly than drinks that were isotonic (Powerade), mildly hypertonic (Gatorade) or strongly hypotonic (water placebo) in a crossover with 11 **cyclists/triathletes**; the observed effect on performance in an **incremental test** following a 2-h preload was best with the hypotonic drink (by 1.2%), but there was too much uncertainty for the outcome to be clear [860].

Hyperhydration with **glycerol** had practically zero effect relative to a water placebo on a ~1-h running **time trial** in the heat, but you'd need more than the 6 **runners** in the crossover to rule out substantial differences [1682]. A similar study of the effects of **sodium loading** with or without glycerol in 8 **endurance athletes** (a messy mix of 7 males and 1 female) was similarly inconclusive [1684].

Meta-analysis of the effects of **hypohydration** showed that it starts to affect endurance performance when loss of body mass is 3% or more, but there was no mention of ambient temperatures in the studies [1679]; hypohydration also impaired some kinds of shorter performance, but a threshold was less clear [1681]. There was one original-research study showing unsurprising impairment with hypohydration [1683].

It's reasonably clear that rinsing the mouth with sugar solutions enhances performance, and now it looks like **mouth rinsing with water** enhances **cycling** performance in dehydrated subjects. The only difference is that you have to swallow the water, apparently to activate

receptors in the throat [943]. The quantities are too small for the effect to be mediated via any offsetting of the dehydration. There's no real relevance to athletes here, of course, but it's quirky enough to include in this report.

Chocolate milk for recovery! After a fatiguing bout of exercise lasting nearly 2 h and finishing with intervals, 10 trained **cyclists** (5 M and 5 F) recovered for 4 h while drinking chocolate milk or an isocaloric carbohydrate drink in a crossover fashion before a 40-km **time trial**, which they performed an astonishing 8.4% faster on the chocolate milk [2816]. The authors opted for faster glycogen resynthesis as the explanation, but what about chocolate receptors?

Adding **protein** to a drink containing maltodextrin and fructose if anything impaired performance of a 60-km **time trial** following a 2.5-h preload, but there were only 7 **cyclists/triathletes** in the crossover, and no data in the abstract beyond "P>0.05" [1575].

Supplementing with a "water-soluble" **protein** (aren't all dietary proteins water soluble?) was claimed to reduce injuries relative to a water placebo in a 7-d intensive training camp, but the numbers of **runners** (9+8) and injuries (1+3) were way too small for the outcome to be clear, and the claim that the protein also prevented exercise-induced anemia is likely to be a consequence of inflated Type I error, in my view [2854].

In an 8-wk training study with 8+8 female **basketball players** there were no statistically significant differences in **body-composition** and **performance** outcomes for supplementation with **whey vs casein protein** [2855]. What about some confidence limits to properly address the possibility of real (substantial) differences of either sign, given the small sample size?

When 15 Aussie-rules **football players** consumed **branched-chain amino acids** with a meal 3 h before fatiguing exercise, they experienced less fatigue-related decrements in exercise and skill performance in subsequent **sport-specific tests**, in comparison with the meal alone [2864]. The effect was small but clear, so BCAAs might be worth using before important competitions. As for the mechanism, BCAAs apparently compete with tryptophan for uptake into the brain, where tryptophan is converted to fatigue-inducing serotonin. Sure enough, when amino acids were switched to a mixture aimed at enhancing tryptophan uptake, fatigue was worse. Nice one, Nigel (Stepto)!

β-alanine is an amino acid in meat that gets taken back up into meat (muscle) when you eat it. There it is converted to carnosine, which acts as an intracellular buffer. On the Friday at lunchtime Powerbar launched a new sustained release β-alanine supplement that will make loading over a month or so much easier and probably more effective. The evidence for performance enhancement in bouts of high-intensity exercise lasting several minutes is already clear cut, and a study showing positive effects that are further augmented with acute bicarbonate supplementation was presented that afternoon [930]. Useful information about dosing and time course of loading was also presented [929]: you can speed up the loading with higher doses, and it takes weeks to wash out.

β-hydroxy β-methylbutyrate (HMB) is an amino acid with likely anabolic effects in muscle, but the abstracts at ACSM were a mixed bag: it works on retaining strength and muscle mass in **aging rats** [2856–a clever study], but it didn't enhance training in **old rats** [2858], nor did it protect against the effects of eccentric exercise in **old humans** [2857].

Training for 28 d with **creatine** supplementation produced a possible enhancement of **jumping** performance in 6+6 highly trained **volleyball** players, although data of only 8 players were in the final analysis [1917].

Nicotine patches or gum appeared to produce a small enhancement of cycling performance in a ~1-h **time trial** with 10 male **cyclists** in a crossover, but the sample size is marginal and there are no confidence limits [1922].

Caffeine dispatches… It had unremarkable acute effects on repeated **running sprints** in habitual or naïve users [1913] and on performance of resistance training [1915], but included in a sports drink it helped **active subjects** complete lower-body **resistance training** at a higher intensity [1929]. Use caffeine in low doses for early-morning **shot put** [923]. Don't worry about caffeine **abstinence** for 4 d before endurance **cycling** (but I don't believe it) [924]. Caffeine also works in a dose-dependent manner for **sprints** during endurance **cycling** [925]. A **meta-analysis** revealed less of an effect when it was combined with carbohydrate [926].

Finally, caffeine appeared to enhance performance in a 40-km **cycling time trial** in the cold at a dose of 5 but not 10 mg.kg^{-1} [927].

Bicarbonate supplementation worked for short swimming **sprints**, by a massive 2% in a crossover with 6 male and 8 female **swimmers** and a test designed to emphasize competition and eliminate turns [1923].

As predicted in the ACSM report in 2006, **Viagra** (sildenafil) did not enhance endurance performance at moderate altitudes [1036, 1992].

Tests and Technology

The **10 tests** in a suite developed for **gymnastics** have modest reliability (intraclass correlations 0.69-0.91), and the total score has excellent reliability (0.97) and good validity (correlation of 0.77 with competitive level) [1847].

Running shoes with special "actuator lugs" (Google it) improved running economy by 1.0% in 12 elite **distance runners**, with a P value that represents 99% confidence limits of ±0.9% [2624]. The authors confused error of measurement with smallest effects and uncertainty in the outcome, so were not as optimistic as they should have been. The effect should translate into an improvement in running speed of 1%, which for a top runner represents a small-moderate benefit (a couple of extra medals every 10 races).

It looks to me like the latest **10-Hz GPS** (global positioning system) technology doesn't have nearly enough validity (standard error of the estimate, 14%) or reliability (typical error, 12%) to properly track short sprints in **team-sport athletes** [837]. Better luck next upgrade. **Triaxial accelerometry**, on the other hand, looks promising for monitoring **running** [840, 878] and maybe even some aspects of **resistance training** [842].

If you're struggling with **real-time video** feedback in a field setting, see how one group solved the problem on the ski field and investigated its impact on **skiers** and coaches [1145].

I'm finding it difficult to get excited about tests for the various **anaerobic thresholds** [2781, 2783, 2784, 2786, 2787, 2873, 3031]. There were also various measurement-type studies of maximal-effort tests that I don't have time to report on. I hope I didn't miss something valuable.

I did get excited about a conversational forum on **regression vs limits of agreement** for validity and other measure-comparison studies, because I was one of the speakers! See the article in this issue for more.

Training

A physiological or psychological variable might be useful for optimizing the **overload training** of high-performance athletes, if changes in the variable between the beginning and end of the overload have an inverted U relationship with changes in performance. You would then titrate the training to keep the variable at the maximum of performance. Yes, but we found little evidence of such a relationship for a wide range of variables monitored in 10 male and 10 female elite **rowers** over a 4-wk overload and 1-wk taper [873]. In fact, for most variables, the more extreme the change, the better the performance. None of the rowers ended up overtrained, so maybe they could have taken even harder training. Maybe we should also have included markers of oxidative stress, because **military recruits** who ended up over-reached after 7 wk of hard training had higher levels of some of these markers at baseline [874]. Will this finding translate usefully to the training of elite athletes?

If I didn't know that one of the PhDs at the Australian Institute of Sport was doing work with a related aim, I probably would have skipped over an abstract on using a simple performance test (a drop jump) and a questionnaire (the RESTQ) to **monitor fatigue/recovery**, in this case in 17 male **soccer players** during a season [1700]. But I think the study needed assays of more outcomes at more time points in more athletes to provide adequate evidence of efficacy of the approach.

Use of perceived exertion to calculate **training "impulse"** (load) seems to have been as successful as the use of heart rate in predicting **running** performance from training logs, but I don't think a prediction error of 2.4% can be regarded as successful [2645].

In a controlled trial of 8+8 top **junior fencers**, 6 wk of an experimental **sport-specific training** produced substantially better gains in sport-specific **field tests** than usual training [1701]. Will it help competitive performance?

The Chinese have revealed their successful **training program** for **speed skaters**, at least for 2005-2007 [1148]. The secret is apparently polarized training, in which athletes do most of their training above and below–but not at–the anaerobic threshold.

I report the following **training studies** for the sake of completeness rather than for any obvious practical application. Sessions of intervals produced similar gains as continuous exercise in various maximal **cycling** tests in 7+7 male subjects [1029] and in various maximal canoe ergometer tests in 7+7 male **canoeists** [1033]. More intervals produced unsurprisingly greater gains in the lactate threshold in **cyclists** [1030].

Live-low train-high at supraVO2maximal intensities for 4 wk apparently improved part of performance in a Wingate **sprint** test, but there are no data in the abstract [1988]. This form of altitude training also enhanced **isometric** endurance but had unclear effects on intense **dynamic** exercise [1993]. Something is seriously wrong here: a **meta-analysis** based on standardized effects favored live-low train-high over the other three forms of live/train low/high altitude training [1991]. A more sophisticated **meta-analysis** by Bonetti and me (Sports Medicine 39, 107-127, 2009) showed a reasonably clear advantage for live-high train-low.

Training with **blood-flow restriction** is the latest craze, apparently, and it even has a Japanese name: *kaatsu*. An entire poster session was devoted to it [2757-2767], along with a smattering of abstracts in other sessions. In kaatsu, limb exercise is performed while arterial blood blow is occluded with a cuff. The gains in **muscle mass** and **strength** after 2 and 4 wk of such training in 14 **untrained subjects** (no control group) were correlated with the metabolic changes in the muscle induced by the cuff [2072]. Fine, but performance improvements in best-practice controls are about equal to [2758] or even better than with kaatsu alone or with kaatsu in combination with best practice [2761]. Remain skeptical.

In a **meta-analysis** of nine controlled trials, **whole-body vibration** for 10 d to 47 wk had small-moderate effects on **jump** height; larger effects were observed with higher frequencies, higher amplitudes, and longer session durations [1555]. We have to allow something for placebo effects and publication bias, though, so it's reassuring to see an acute effect of whole body vibration on objectively measured post-activation potentiation [1558]. But it didn't seem to work on **softball** batting speed [1559].

Inspiratory muscle training had varying degrees of failure [847] and success [848] for performance of **non-athletes**, but of course these outcomes don't necessarily apply to highly trained athletes.

Either of two kinds of **high-intensity sprint training** twice weekly for 4 wk was more effective than continuous running for improvements in **aerobic** and **anaerobic tests** in a randomized controlled trial of 26 collegiate male **soccer** players [1857].

Super-slow resistance training was probably less effective than traditional resistance training for **1-RM strength** in 14+13 (+8 control) previously **untrained** women [2081].

There were some potentially useful differences in outcomes with low vs high speed **strength training** in a powerful (24+25) study of **high-school athletes**: "high speed may be preferential when the performance goals reflect agility and upper-body power" [2083].

In a controlled trial with 74 **army cadets**, repeated sprint training for 7 wk improved 40-m **sprint performance** by 2.2% compared with a non-training control group, but the added resistance of a **parachute** led to a much bigger 5.1% improvement [2634].

Five novice **tennis players** improved the speed of their **swing** in forehands, backhands and serves after training with **resistance** in the form of a racket with vanes. Would the gains translate into faster ball speed without loss of technique? Worryingly, outcomes in three skilled players were partly negative [2637].

Six subjects in each of three training groups is such a pity, because the **rowers** who added high-load low-repetitions **resistance** exercises to their usual training improved their **2000-m** rowing ergometer **time** by a non-significant but promising 0.7% relative to control training and a suggestive 0.4% relative to low-load high-repetitions group [2887]. You shouldn't do a study with six in each group. Nine in each of two groups would have been better, but still not enough. The magic minimum is 10 per group, and that's only for representativeness. Adequate precision for trivial or small effects on performance requires many more.

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