

The medals and the damage done

Athletes' punishing schedules push their bodies to the limit. But what happens if they go too far? Jim Giles finds out.

The incessant drive for success can be a dangerous thing for an athlete pushing hard for the Olympics, as Michael Brennan (not his real name) discovered. In 2002, Brennan was a British national rowing champion. The following spring, he rarely finished outside the top three in any race. As the UK Olympic trials loomed, Brennan was feeling confident. But he is not going to this summer's games.



For much of the past 12 months, Brennan's performance has been eroded by constant colds, aching joints and fatigue. What seemed like minor infections refused to go away and extra training made matters worse. When the trials rolled round this April, Brennan still felt that he could qualify. Instead, he finished at the bottom of the heap. "I couldn't believe it," he says.

To an experienced sports doctor, the explanation is obvious: Brennan has 'unexplained underperformance syndrome' (UPS). Perhaps one in ten athletes will get the condition, but only now are hints emerging about the underlying causes. And although sufferers usually recover after a period of rest, it can ruin preparation for major events. "It's all over for an athlete if they get it before a competition," says Greg Whyte, sports science coordinator at the English Institute for Sport in Manchester.

Brennan was officially diagnosed with UPS after a visit to Richard Budgett, director of medical services at the British Olympic Association in London. Budgett, himself a rower and former Olympic gold medallist, sees about 50 athletes a year with the condition, and he says Brennan's story is typical.

Rowers seem particularly susceptible.



Working flat out: before competitions, rowers often force their bodies to adapt to intense exertion.

Athletes in this sport typically train twice a day, five or six days a week. When major competitions approach, they often push their bodies beyond their normal limits for one or two intense weeks, regularly covering 20 kilometres on the water a day. This 'over-reaching' leaves the athletes exhausted in the short term, but in the long term it usually forces their bodies to adapt to intense exertion, improving race performance. Usually. But sometimes the strategy results in UPS — also known as over-training syndrome. "There is a fine line between over-reaching and over-training," says Whyte. "When athletes bounce back from over-reaching they will be stronger, but some don't recover."

Feeling down last summer after a dip in form and problems in a relationship, Brennan responded by upping his training. "I felt I must do more," he says. Instead, continued infections and increasing fatigue forced him to do less. "I was feeling tired all the time," he recalls. "But I kept ignoring it."

These symptoms are typical of UPS, along with sleep and mood disturbances, loss of appetite, slow wound healing and gastrointestinal disturbances. If an athlete's performance does not recover after two weeks of relative rest, UPS is usually diagnosed¹.

Hidden menace

Gauging the prevalence of the condition is difficult, as few openly discuss it. "Athletes don't talk about injuries," says Budgett. "They don't want competitors to know." Brennan can be included in that camp, being happy to tell *Nature* his story as long as his real name wasn't used. Researching the condition is also difficult, as serious

athletes aren't willing to give regular blood samples, and it would be unethical to induce full-blown UPS in test subjects.

But, slowly, we are learning more about the syndrome. Over the past decade, a slew of studies has revealed numerous factors in the hormone and immune systems that seem to be linked with the condition, leading to tentative theories about the syndrome's cause.

One explanation was proposed last year by Lucille Lakier Smith, a sports scientist at the Tshwane University of Technology in Pretoria, South Africa². Her inspiration came from studies of victims of serious accidents,

"After being ill I would train harder to make up for it. If I had backed off for a couple of weeks it could all have been sorted out."

such as burns patients. These patients have rather extreme immune reactions to deal with the severe damage to their tissues. At the same time, levels of some cytokines — molecules used to exchange signals between cells — increase. In burns patients, levels of anti-inflammatory cytokines, such as the proteins interleukin-4 (IL-4) and interleukin-10 (IL-10), go up.

As well as calming inflammation, these molecules also suppress the ability of immune cells that usually attack pathogens. This leaves burns patients more vulnerable to long-lasting infections.

When athletes over-reach, Smith suggests, they similarly damage muscle, prompting an immune response. When she measured interleukin levels in athletes before and after a marathon, she found that IL-10 levels shot up, although IL-4 remained constant². This too could leave them vulnerable, she says.

But this is unlikely to be the whole story, as athletes with UPS often complain of tiredness and aching joints when they are apparently infection-free.



Extreme events such as the marathon may provoke an immune response that makes the athletes tired.

A possible explanation for this comes from an academic who has personal knowledge of UPS. The condition hit Paula Ansley-Robson when she was attempting to break into the British Olympic rowing squad in 1996. “I was training for over 24 hours a week,” she says. Then UPS struck.

“After that, a 5-kilometre run felt like a marathon.”

Now an exercise physiologist at the University of Portsmouth, UK, Ansley-Robson is interested in another cytokine, interleukin-6 (IL-6), levels of which often rise when someone has a cold or flu. It makes the sufferer

feel tired, and is one of the signals that helps the body to slow down while fighting off an infection. It is also involved in regulating glucose energy stores during exercise. Levels of IL-6 can rise 100-fold during a marathon and are partly responsible for feelings of tiredness during a race.

Studies have shown that injections of IL-6 into healthy individuals will make them tired within a few hours. Some people are more sensitive to the cytokine than others. Chronic fatigue sufferers, for example, will become more tired more quickly, and for longer, than control subjects after injections of IL-6 (ref. 3). Injecting a runner before a race will likewise have tiring effects; an experienced club runner typically has a minute added to their time for a 10-kilometre run³.

Sensitive issue

Ansley-Robson suspects that over-reaching itself sensitizes athletes to IL-6, making them more likely to feel worse effects from natural bursts of the cytokine. She plans to put runners through a gruelling test of this idea. Runners will first do a timed 10-km run after an IL-6 injection. They will then ‘over-reach’ by running an incredible 90 kilometres — more than twice as far as a marathon. After a few weeks of rest, they will have an IL-6 injection and run a second 10-km race. If over-reaching sensitizes them to IL-6, they will perform particularly poorly in this last test, she predicts.

In the meantime, athletes can take some precautions. Michael Gleeson, a sports scientist at Loughborough University, UK, recommends a minimum six-hour rest between training sessions, as IL-6 levels are significantly higher among subjects who rest for only three hours⁴. He also emphasizes the need for coaches to monitor athletes’ mood. Psychological stress is thought to contribute to UPS, although no one knows why.

For Brennan, careful monitoring of his mood and health could have made all the difference. “After being ill I would train harder to make up for it,” he says. It’s an understandable reaction from an athlete dedicated to the idea that training produces results. Yet Brennan now recognizes that less is sometimes more. “If I had backed off for a couple of weeks it could all have been sorted out,” he says.

But he didn’t. So when the rowers take to the water in Athens, Brennan will be watching on TV — although his thoughts have already turned to the 2008 Olympics in Beijing. For those games, he fully intends to qualify — after a good, long rest. ■

Jim Giles is a reporter for *Nature* based in London.

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4. Ronsén, O., Kjeldsen-Kragh, J., Haug, E., Bahr, R. & Klarlund Pedersen, B. *Am. J. Physiol. Cell Physiol.* **283**, C1612–1620 (2002).

Cooling off

When forcing their bodies through the trauma of extreme sport, athletes are grateful for any tricks that will help them to recover more quickly. For the Australians — an Olympic team that has turned the art of damage control into a real science — this means a strict regime of cold baths. “What we are doing differently this Olympics is a shift towards cold immersion,” says Shona Halson, a fatigue and recovery scientist at the Australian Institute of Sport.

The Australian team has set up an entire health centre in Athens devoted to recovery, complete with mobile plunge pools. After an event, athletes will submerge themselves in water at about 12 °C for up to a minute, jump out for a minute, and repeat the cycle three to five times.

Most people who have done a hard day’s sport know that an ice pack can calm swelling and

soothe aches. But does it do any real good for the body? Surprisingly, the evidence is largely anecdotal. Australian swimmers report that it cuts the time they have to spend doing warm-down laps by about 25% — they do these laps until their lactate levels are below a critical level, measured by pinprick blood samples by the side of the pool. But no proper studies on the effect have yet been done with the swimmers, simply because none of them will give up the baths to be in the control group — at least, not until the Olympics are over.

One theory about how cold baths work is that repeated constriction and dilation of blood vessels helps to flush out lactate — an acidic by-product of the body’s combustion of sugars that can stop muscles from contracting properly. And, Halson says, the baths dull pain, giving athletes a psychological edge in subsequent events.

The icy baths used by the Australians may sound a little extreme, but they are not as bad as the ‘cryochambers’ popular with some European nations such as Germany and Poland. For these, athletes don socks, gloves and face masks before braving air at –110 °C to –150 °C for up to several minutes. Such chambers may or may not work better than ice baths, but they require constant medical supervision, says Halson.

The more casual sports-person may think that heat should be the way to unwind, but saunas and spas, says Halson, are definitely out. “They dehydrate the body,” she says. And that’s the last thing an overworked athlete needs. **Carina Dennis**



Cold comfort: ice baths may help athletes recover.