Sport Health

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SPORTS MEDICINE AUSTRALIA

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Circulation: 5000
ISSN No. 1032-5662

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**SUBSCRIPTION RATES 2006**

Australia A$35
Overseas A$50

SMA members receive Sport Health as part of their membership fee

Single copies and back copies A$15 (includes-postage)

PP No. 226480/00028

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# Contents



Cover photograph: Australian Sports Commission

# Biggest – yes, but best?

Gary Moorehead

**The annual conference of the American College of Sports Medicine (ACSM) is the largest sports medicine and science event in the world, with 2006 setting a new record of just over five and a half thousand attendees. ACSM draws delegates not just from all parts of the United States but also from most parts of the globe. Australian sports medicine and science is always strongly represented. Attending ACSM means an opportunity for me as CEO of Sports Medicine Australia to meet more SMA members face to face than a year of travelling around Australia.**

This article is a summary of impressions from the 2006 conference.

The conference was dominated by presentations on physical activity and chronic disease, with papers on every possible health condition that is affected by physical inactivity – from obesity and diabetes to arthritis and dementia – and covering the entire spectrum from genes through cells and tissues to whole populations.

But despite this quantum increase in research, the rates of inactivity and obesity in the USA continue to rise to extremely alarming levels, a fact very forcefully made by two of the Conference keynotes, Dr Steven Blair and the US Surgeon General, Dr Richard Carmona.

Like many physical activity advocates, Steve Blair started his career as a physical education teacher and from there moved through studies in sports science to become a professor of public health. The US Surgeon General was a high school drop out and street kid who, after enlisting in the US Army, became an army medic, then a nurse, doctor, trauma surgeon and before his current appointment had managed to polish all the handles so carefully that he was a Vice Admiral in the US Navy.

Two extremely diverse backgrounds produced a single message for the conference: obesity is the greatest danger currently facing the USA.

This was an especially compelling statement from the Surgeon General – whose CV also includes the facts that, as well as his military service, he has also served as a medical director of police and fire departments and is a fully-qualified peace officer with expertise in special operations and emergency preparedness, including weapons of mass destruction. Despite his military and law enforcement background and even though he was a direct appointment of President Bush, the Surgeon General took pains to stress that he considered obesity a greater threat to American society than the war in Iraq - or terrorism.

The Surgeon General also said that health disparities added greatly to the disease burden in the USA. Those at the lower end of the economic scale don't have a voice and don't have access to the same levels of health care under the American system.

"The debate about the health care crisis is really about who pays – and while we argue this, the disease burden continues to rise."

"The common currency for success in these problem areas is health literacy. We have the best science in the world, but how do we turn that into behaviour change?" *(1. Personal notes of speech by Dr Richard Carmona, US Surgeon General titled "The State of the Nation: Celebration of the 10-Year Anniversary of the Surgeon General's Report on Physical Activity and Health", ACSM conference, Denver, 31 May 2006)**

Steve Blair was quite specific about one aspect of what is needed: "No research grants should be awarded for any obesity study unless physical activity is taken into account."

For many years, Blair has produced papers detailing the benefits of physical activity for sufferers of chronic disease and for increasing quality of life and the life span. At the same time, he has railed against the tendency of many obesity researchers to take an exclusively diet-focused approach to the issue.

His 2006 ACSM presentation added new data on the benefits of physical activity for breast and gastric cancer survival (Japanese study), recovery from hip fracture (US nurses study), warding off dementia, reduced rates of ADD in children, prediction of CVD, risk of admission to nursing home, avoiding gestational diabetes and many more. On the way through Blair took a few more swipes at sacred cows, criticising an obsession with randomised controlled trials over observational studies when the evidence was obvious (pointing to smoking and thalidomide research outcomes as examples where public health interventions did not wait for RCTs) and firing off a parting shot at the US medical profession for preferring angioplasty to exercise regimes in treating coronary artery disease when exercise had been demonstrated to have a 20% better outcome. Why? Because there was less income for the medical profession in prescribing exercise.

For prospective researchers, Blair listed the areas he considered the new research frontiers. These included dose response, behavioural interventions, environmental policy, a combined approach to nutrition and activity, genes and resistance training. *(2. Personal notes of the Joseph B Wolfe Memorial Lecture, "Physical Activity and Public Health: From Karvonen, Morris and Paffenbarger to Behavioural and Environmental Interventions" delivered by Dr Steven Blair, ACSM conference, 31 May 2006).*

The conference had many other fascinating papers, including:

- A study of obesity trends in industrial workers in the US which showed an average increase in weight of ten pounds per person from 2000 to 2006. In that period the number of normal weight (BMI less than 25) workers decreased by 30%, the number of overweight (BMI 25-30) remained static and the number of obese (BMI greater than 30) increased by 32%. According to the presenter, 45% of the applicants for physically demanding jobs in the USA will be obese by 2010 and, by definition, probably incapable of undertaking this type of work. *(3. Thomas B. Gilliam. "Comparing Obesity Trends from 2000 to 2005 in 72,846 Industrial Workers". Notes of presentation and abstract published in Medicine & Science in Sport and Exercise 38:5 May 2006 Supplement. Abstract 813.)* This paper was a perfect back up to the paper by the Surgeon General.
- A success story: An intervention in an Illinois primary school that restructured the school day to allow for 15 minutes of teacher-led physical activity each morning, a free breakfast for all and a reversal of lunch hour that made the children have a play period before they ate lunch. After five years of the program school attendance improved significantly: there was a 67% decline in visits to the school nurse, a 58% decrease in discipline referrals and the school moved from below average to above average on the state achievement tests (reading, writing, maths, science, citizenship). Interestingly, this presentation attracted an almost rabid level of hostile questioning seeking to attack every aspect of the purpose, method, results and conclusion. It was almost as if the questioners were upset that someone dared to present results of a successful intervention. This was an interesting illustration of Blair's point about the tendency for researchers in the field to want to live exclusively in their own silos. If the answer did not lie in their silo, the world might end! *(4. Benjamin A Sibley. "Effects of an Environmental Intervention to Improve Diet and Increase Physical Activity on School Performance." Notes of presentation and abstract published in Medicine & Science in Sport and Exercise 38:5 May 2006 Supplement. Abstract 604.)*
- Yoga is eastern religion by stealth! Two separate presentations mentioned protests from parents at proposals to teach yoga as a physical activity option. Apparently this would have been the thin edge of the wedge to the teaching of "eastern religions" to American children and this was totally unacceptable. One study managed to sneak yoga back into the program by calling it "stretching". There was also a fascinating poster detailing the significance of living close to a church for differences in physical activity. The science was a little lost on me, especially as the study didn't determine whether any of the subjects actually attended a church. The Christian deity was probably invoked less at ACSM than most American gatherings, but its occurrence is frequent enough to make most Australians realise they are in an alien society.

Australians, New Zealanders, Brits and Europeans were also represented, but often shoved in the far corners or awkward times of the Conference. Despite its international nature, for many Americans, ACSM is all about them. For the rest of us, their insularity can be a bit staggering.
This attitude is also to their detriment. A number of Australian clinicians attending reported that, for them, there was little new or innovative coming out of the US. Attendance at ACSM was all about catching up with old mates and reassuring themselves about the quality of their own clinical skills and knowledge.

However, despite this, ACSM is still a fabulous experience and should be a must for all sports medicine and science and public health practitioners. If nothing else, scale can be an awesome and beautiful thing – and you usually get to go to the baseball!

** One for the trivia buffs. The 1996 "Surgeon General's Report on Physical Activity and Health" – one of the most cited reports in the field of physical activity – was NOT issued by the Surgeon General. In 1996, the US did not have a Surgeon General. The Surgeon General appointed by Bill Clinton in 1992, Joycelyn Elders, was forced to resign after only 15 months in the position as a result of a controversial remark about sex education (the benefits of which were obviously lost on her appointer). A new Surgeon General was not appointed until 1998. The 1996 "Surgeon General's Report on Physical Activity and Health" was actually issued by the US Secretary of Health and Human Services, Donna Shalala.*

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# Helping to build our practice

Dr Michael Kenihan,

**At a recent meeting with the SMA's Business Advisors and some of the Executive, the discussion turned to the perennial question: "Why did you join SMA?"**

For me, the answer was easy: "My senior colleagues told me to." They told me also that, when you join, you then get involved in committees. From that time on, I found that being on the State Board, convening sports trainers courses, performing sports coverage and the like was what you did….

The question why did you SMA though is even more relevant today as peak bodies in the different disciplines and a plethora of others try to get us to spend our membership dollars.

If we leave aside the "why" and look at the "what" question for a moment it gets a little more complicated: "What do I get out of SMA if I do join?"

I get to imbibe the multidisciplinary concept.

I get to build networks that might help my practice to grow. I expect that this network will make my practice grow, ie, someone else will do things for me.

I get an organisation that will represent my interests and inform me through policy statements, journals and so on.

Let's assume that we join and that what we do get is growth of our practice, then how would this happen?

The SMA membership directories in their different forms shout to people that I am here and ready to receive their referrals. My direct colleagues will learn that I am pretty good because I lecture at SMA events and look after certain sports teams, etc. Sports trainers will refer to me.

The above will be true, no doubt, but let us look at this from another perspective.

I work in a network of practices and we have some systems and processes to assist in building this network. One of these systems is marketing.

Those of you who are clinicians will take a deep breath at this point, but please stay with me!

What is marketing?

The corporates will tell you it is the "identification, attraction and retention of profitable customers". When this phrase is said, it is not only a turn off but it also speaks of something that one must devote time to studying and it is too hard.

Let's simplify.

Marketing of a service is no more than beginning, then developing and nurturing a relationship. Hence we in our network call marketing "Relationship Development".

How does all this fit into SMA and being or not being a member, you may now ask?

SMA is a group of committed professional people from a variety of disciplines. Each discipline brings something unique to the organisation and can actually contribute to the development of someone's practice. But how well someone develops relationships will determine the success of the development.

Back to the start now.

I mentioned sports trainers courses.

Yes, many years ago I ran such a course in the eastern suburbs of Melbourne. I discovered that the participants wanted to engage after the course. We kept in touch.

I ran extra teaching sessions for them at a sports medicine centre and was in contact with them regularly to lend a hand. To this day, because they were engaged and we had a relationship, they still refer their injured footballers to that sports medicine centre.

This story is about the concept of local networks. It's about "clusters" of referrers. Such clusters are under our nose. Many of them live in SMA too. They live in directories, sports clubs, local gymnasiums.

This story is about "thinking global, acting local".

The act part is essential. Strategy only fails because it is not executed. You see, no one does it for you; they just show you the way. You build relationships by doing.

The sports trainers are still there, but here come the fitness professionals, the osteopaths, the soft tissue therapists. How we engage with them rather than enrage them will be about relationship development. It just might help them embrace us and refer to us. It just might help build our practices because they see us as helping them, not fighting them.

For the first time at the annual SMA conference, the Organising Committee this year is going to look at some business development concepts as a part of the program. I will present about marketing and how the "cluster" can help you. (This may even provide that elusive answer to why you joined SMA.) We will try and broaden the discussion by inviting our Business Advisors -- who help kick start this commentary -- to contribute to it from the world of business consulting (Warren Mundy: Melbourne Airport, Port of Melbourne, Forests Victoria, Port of Cairns) and the minefield of getting human resource administration right (Judy Barnesby: CUB, Coles Myer).

Another reason to come to Fiji in October?

You bet it is.

**Michael Kenihan is SMA Financial Director**

# How much medical care does a professional sports team need?

Dr J

**The title of this article is a question which has fascinated me ever since I moved from working as the club doctor for the Sydney Swans in the AFL nine years ago to a similar position with the Sydney Roosters in the NRL. On the outside you would have expected these two jobs to be quite alike, both clubs being fully professional organisations in the same city in different football codes. In terms of overall responsibility on paper, the jobs were similar but, in terms of hours at the coalface, I would have done 60% more work at the Swans than at the Roosters (with the difference in pay corresponding).**

It felt like one extreme to the other; attending every training session (including for hours before and afterwards) at the Swans to my (current) situation at the Roosters where I basically work on game days and as a consultant at the sports medicine clinic, rarely being asked or even encouraged to go to training. If I describe this transition to the staff I worked with at the Swans, their impression is that rugby league teams are "not professional". On the other side of the fence, the Roosters organisation generally has a belief (observing from the outside) that the players in AFL teams are "soft", "wrapped in cotton wool" and "over-managed". Based on progress so far in 2006, an outsider may look at the setup at the Roosters and say we don't have the right approach, but it can't be too bad as an approach that has taken us to four NRL Grand Finals this decade.

An article from the *Courier-Mail* earlier this year by Mike Colman described an encounter he had with Brisbane Lions player Jason Akermanis, "[after a training session one day]….Aker showed me a tiny graze on the inside of his elbow. If my six-year-old son had complained of it I would have told him to stop being a sook. Aker called in the medical team and wasn't happy until he had a giant bag of ice strapped to it. I laughed at the time but driving back to the office I had second thoughts - this bloke's body is his Formula One race car and he wasn't taking any risks."

How can you reconcile that one professional football team expects a doctor to be watching every move the players make whereas another one adopts a philosophy that it may actually be detrimental for a doctor to spend too much time with a football team? Is the hands-off approach unprofessional or is the hands-on approach overkill? I'll try to summarise the differences between the two in this article and maybe convince you that more is not always better, and in fact the amount of medical care you need may depend on the sport you play.

Former AFL coach David Parkin was once quoted as saying that, as head coach, he was only the third most important staff member of his team's football department. His view was that the most important was the recruiting manager, followed by the club doctor. He may have seriously meant exactly what he said, but his viewpoint that almost everyone would agree with is that, if you don't have talented players in your squad or if you do but they aren't fit to play, then you don't win many games. The traditional value of the half-time vein-popping coaching address is probably as overrated as the decisions at the trading and draft tables are underrated.

A problem with recruiting (and with injuries) is that it is a far more difficult proposition to quantify key performance indicators. At the time when Michael Jordan was drafted at number 3 in the NBA draft, probably no one in the teams who passed on Jordan at picks one and two got sacked on the spot. Recruiting is a very inexact science and MJ at a young age probably looked no better or no worse than the other young guns around him; he just happened to mature into the best basketball player of all time. It was obviously a deep draft that year as Hakeem Olajuwon was selected at number one, but whoever read out Jordan at number three probably made every coach, manager, doctor, trainer and psychologist at the Chicago Bulls look like a genius for the next 15 years.

Injuries (or lack of them) at professional football teams can turn a solid squad into a Premiership team or into a disappointing outfit that misses the finals. This is undisputed fact. What we don't know (or can't prove) is how much influence good (and by comparison 'bad') training staff and medical staff actually impact on the injury rate at a football club, if at all.

Bar room opinion is that St. Kilda has had the 'most talented' list in the AFL but it hasn't won a flag because injuries have cruelled it. (Curiously, in the NRL the 'Saints' at St. George are in the same boat). No one really knows if different management would have made St Kilda players less injury prone, but human nature would like to think so (even if it isn't necessarily true). Chris Jones used to be head of conditioning at St. Kilda and -- perhaps this is related somewhat to its results -- isn't there any more. Now he is working with the Melbourne Storm and it is flying at the top end of the NRL table. Who knows whether this is all random, more a reflection of coaching staff or player fragility, or whether somehow his training methods are miraculously better suited to rugby league players than AFL players?

Let's look at the variation in AFL medical teams at the moment and whether there is any difference between input and output. In this sense I can specifically refer to a table which was published in the Melbourne Age on 9 June this year (Table 1). This was (presumably leaked)

data about club medical expenditure for AFL teams in 2005. From what I can gather this did not include salaried payments to players who missed time because of injury. My personal breakdown on what these budgets might include is listed in Table 2. Obviously there is a huge scope in any given year for variations in these budgets – for example, if a club decides in a given year to buy an altitude chamber or hyperbaric oxygen room and include it in the medical and fitness budget, it is going to blow things out of the water.

At first glance, the top three teams on the medical and fitness expenditure ladder have won all of the 2001 to 2005 premierships between them, so it is tempting to say that the more you spend on medical and fitness in the AFL, the better your team will perform. That may possibly be true (ie, that there is a cause and effect relationship between the two) but in science we know about the phenomenon of confounding. Brisbane and Sydney may have also been getting better on-field results than the rest of the competition over the last five years because they get to spend more on players (due to salary cap concessions), and the extra expenditure on medical may be incidental.

Suppose for a minute that the 'average' medical team *should* comprise doctors on a combined salary of $150 K and physios who together also get a similar amount. But the reality is that most AFL teams pay less than this. If you are on the Lions, Power or Swans medical staff, you walk into the CEO's office just after your team has won the competition and you get granted the pay rise you have passionately argued that you deserve. If you are in a Melbourne-based team that keeps missing out on the top eight, you get told that the club can't afford the extra money and you must either quit or stay on for the same paltry amount next year.

Speaking of Melbourne versus non-Melbourne teams, we have good evidence from the AFL injury survey that the northern teams have a consistently higher average injury rate than the Victorian teams (in fact every single year from 1988 to 2005 inclusive this has been the case). My personal view is that variations in ground conditions (especially grass type and density) are most likely to be responsible for this discrepancy, although not everyone agrees with me.

From Table 1, you can see that the average medical and fitness expenditure is higher in the non-Melbourne teams. This suggests that either the money isn't delivering the results, or perhaps more accurately that the extra injuries require more spending on things like radiology and surgery. It is also fair that, if your team travels interstate 11 times per season, you are working greater hours than if your team travels interstate five times per season, and hence you deserve a greater salary.

### Table 1 – club spending on medical and fitness in season 2005, reproduced from *The Age* newspaper

| |
|---|
| Brisbane $1343 K |
| Sydney $888 K |
| Port Adelaide $806 K |
| St Kilda $755 K |
| Collingwood $740 K |
| Adelaide $731 K |
| Essendon $728 K |
| Geelong $672 K |
| Hawthorn $623 K |
| Carlton $587 K |
| Melbourne $569 K |
| Western Bulldogs $545 K |
| Richmond $475 K |
| Fremantle $472 K |
| West Coast $456 K |
| Kangaroos $453 K |

### Table 2 – rough club medical and fitness budget

| |
|---|
| Salary for 0.75 doctors $60-150 K |
| Salary for 1-2 physios $80-180 K |
| Salary for 1.5-2 conditioners $90-200 K |
| Surgical payments $20-50 K |
| Radiology payments $30-70 K |
| Tape/braces/consumables $30-70 K |
| Pharmaceuticals/supplements $20-50 K |
| Training staff/masseurs $30-120 K |
| Other expenses incl. capital $50–500 K |

There is one team down the bottom of the medical and fitness expenditure table (the Kangaroos) that runs a tight budget in this area as it does in every other area (because of lack of income). It has also tended to have below-average missed games through injury over the past decade. However, I have heard that it doesn't tend to skimp on salaries to medical staff, believing this to be an important area to put money into. Superficially it appears to be an accountant's dream, getting comparatively good outcomes with low expenditure. In the real football world it would probably be the last team that other clubs are trying to emulate. Cost seems to be less important to football clubs than position on the ladder (which seems to be the *only* item of importance!). For those of us that think that club doctors, physios, fitness and training staff are underpaid, Table 1 is 'Happy Days' as club CEOs will be looking to do what the Swans and Power and Lions have been doing. Collectively these teams do *not* appear to have had fewer injuries than the rest of the AFL competition, but they *spend more* on medical and fitness and have won *more* premierships, so this is going to be the way of the future!

Back to rugby league vs. AFL. The Roosters are representative of most NRL teams in that it doesn't see the necessity of having a doctor at training (and as part of a substantial minority it also doesn't require a physiotherapist at most training sessions). Its logic may partially revolve around saving money but, even if it cost it nothing extra, it may even still prefer to keep medical staff away from training. The mentality works as follows:

(1) Rugby league is a tough game where almost every player is injured and where good players must be able to play and train with injury.

(2) Despite (1), many rugby league players are intrinsically lazy at both training and in general life.

(3) NRL players work for their club for 3-4 hours a day, so they have plenty of time to make appointments to see their doctor and physiotherapist at the clinic if they have a significant injury and know that they really need to miss training.

(4) If a doctor and physio are available at training then many players will take the option to declare minor injuries on the spot and the medical staff will tend to err on the side of caution and recommend that the player only do limited training.

(5) Therefore, some of your squad will drop off their fitness levels because of the presence of medical staff at training, leading to a more conservative training load.

Obviously one potential flaw in the logic of argument (1)-(5) is that there may be some players who can't be bothered to see the doctor and physio during their hours off, are too tough for their own good and train with an injury that really should be rested, thereby worsening the injury. This is where the differences in demands and injury profiles of the football codes are probably relevant.

In the AFL, hamstring and groin injuries are two of the 'top' injury categories and both are injuries where it may often be best practice to hold players back from both training and playing matches whilst carrying injury. Hence, in a sport where these injuries are rife, it makes sense to have the doctor and physio overseeing training loads and return to play decisions. In the NRL, injuries such as shoulder instability, rib injuries and knee medial injuries are relatively far more common than hamstring and groin strains. The 'contact' nature of the NRL injury profile may be better suited to players 'toughing it out' in both training and in matches. It might be better for a doctor or physio who has just tested a player's hamstring strength and found it to be very low to say he isn't fit to play AFL football. But who is better placed to say if someone is fit to return from a rib cartilage injury – the player who has to feel the pain or the doctor prodding on the rib? Rugby league has long had a culture of "if you are fit to train you are fit to play" and it may indeed be generally the best practice of determining return to play decisions *in that sport*. In the AFL it is far more likely that you can do a full week on the training track coming back from a hamstring strain, but in the extra intensity of a match you can break down (1).

Extending the AFL vs NRL analogy, I have visited the medical teams of NFL franchises in the United States and professional soccer organisations in Europe.

Although things may have changed in recent years, my recollection is that most NFL medical teams are fairly low key and many training sessions take place without a doctor being present. The athletic trainer supervises everything during the week with a team of doctors (who are often all sub-specialists) on call if the player or trainer requires an expert opinion. As you would know, NFL teams aren't short of money but they do have a contact-oriented injury profile like rugby league. In professional soccer, where there is a more non-contact overuse injury profile, doctors and physios (both plural) tend to be present at every session and check every single niggle within seconds of the player's pain receptors going off. Admittedly there are many players of Latin and Mediterranean descent in soccer, with a penchant for theatrics, but the need for on-site medical assessment may come down to the prevalence of hamstring and groin pain in soccer, which like the AFL is very high.

One very relevant factor with respect to the high demands on AFL medical staff is managing the work-life balance. I'm not sure whether it is true or myth, but there is a perception out there that medical staff working closely with professional sport teams have a higher rate of relationship breakdown than would otherwise be expected. This makes some sense, as the time you would normally spend with your partner on the weekend is often eaten up by work at the football. A doctor or physio who then does a full week at the football club plus clinic during the week and also suffers from the job insecurity of everyone who works in the professional football industry, may not be the best person to live with during the winter months. Because doctors and physios are getting more aware of this, some are insisting on apparently radical job sharing arrangements in order not to suffer from long-term burnout. There are doctors and physios who work one week on-one week off, others who split half the season, and others who primarily work alternate seasons. This sort of structure may become the norm in the future as clubs want to hold on to successful experienced medical staff but those same staff want to hold on to their marriages.

I'll finish with a diversion to talk about a different sport, involving Australia's most successful national team of recent years, that being cricket. It is the world's number one, it has a very good medical director (Trefor James) yet it not only trains without the doctor present, it plays most of its *games* without him there. There is always a local doctor at the matches, but not the *team* doctor who knows the history of the players. It has been a pretty successful set up, but it is one that may need to change now that an Australian player can be suspended for two years if the doctor completing a WADA form doesn't put down the correct details after giving a player an asthma puffer or cortisone injection. You would think that Trefor would be the best person for the job if the Australian cricket team started to travel with a doctor, but would he (or for that matter anyone else suitably qualified) want to do it, given the amount of time away from home and the clinic? I was once treating Daniel Vettori (who being a professional cricketer was away from home without his team doctor being present) and tried to explain to him why the national cricket boards didn't tend to appoint travelling team doctors. I said something along the lines of "the administrators probably don't want to pay a big wage for someone who is going to do 2-3 hours of important work a week and then spend the rest of the time sitting around watching a cricket game or in a hotel room". Daniel replied, "…and how would that be any different from most of the players?!"

1. Orchard J, Best TM, Verrall GM. Return to play following muscle strains. Clin J Sport Med 2005; 15: 436-441. Available at: http://www.injuryupdate.com.au/images/research/CJSMRTPmusclestrains.pdf

# The effects of training on growth?

From time to time, Sport Health hopes to publish articles by promising young researchers. In this issue: articles by Tyson Aquilina and Lauren Burt, Bachelor of Exercise Science graduates from the Australian Catholic University in Sydney, New South Wales. In their final semester of 2005, they were encouraged to explore the literature on a topic of great interest to them. Their efforts in these papers were deemed to be of a high quality. Lauren is now completing an honours year that complements her strong interest in gymnastics and Tyson is working in rehabilitation with people of all ages.

## Does intensive training in elite gymnastics affect growth?

Lauren Burt

Debate has continued for many years as to whether or not participation in elite level gymnastics during childhood and adolescence adversely affects the physical growth and maturation of individuals[1]. The concerns focus on delayed growth and maturation and possibly the reduction of final adult stature.

Several studies have reported that participation in high-intensity gymnastics training, when combined with low energy diets, may alter the timing and tempo of growth and maturation among some female gymnasts. However, the cause and effect relationship between gymnasts' training schedule and reduced growth potential cannot be confirmed, because there is great difficulty in eliminating the environmental factors from the individual's genetically predetermined patterns of growth and maturation[1].

Gymnasts, both male and female, are naturally smaller in stature than their non-athletic equivalent and often display delayed pubertal growth and maturation. These principles form sports-specific selection practices. Females with a smaller, lighter somatotype typically demonstrate selection bias towards aesthetically-based sports, such as artistic gymnastics, diving and figure skating. The growth of elite gymnasts is consistent with patterns of growth expected for a short, normal, late maturing non-athletic individual[1].

Young gymnasts undertake high intensity training programs of progressive volume and intensity from a very early age, habitually for 12 months of the year. It is normal for talented gymnasts to begin training at five to six years old and train for between 20 and 30 hours per week[2]. For this reason, it has been suggested that female artistic gymnasts should decrease their training volume during periods of rapid growth such as puberty[3]. It is during this developmental period that gymnasts are most susceptible to injuries and other psychological stressors.

It is important to consider the positive influences of intensive training along with the suspected negative effects that are associated with delayed development and maturation. Claims have been reported of positive influences of intensively training athletes in terms of growth and maturation. One encouraging gain from gymnastics training includes an increased bone-mineral density; this is up to 85% greater in gymnasts compared with non-gymnasts[4].

### Definition of Terms

High intensity gymnasts are those who train more than 18 hours per week. They are not necessarily national or elite level athletes, as many state level gymnasts train more than 18 hours per week, twelve months of the year[1].

*Growth* refers specifically to the increase in the size of the body as a whole, and of its parts[5]. For example, as girls grow, they become taller and heavier, they increase in lean and fat tissue and their organs increase in size. Growth can be further classified into three components: infancy, childhood and puberty.

*Maturation* is the process of progressing towards the biologically mature state. It differs from growth in that, although various biological systems mature at different rates, all individuals reach the same endpoint and become fully mature 6). However, there are wide variations in endpoints of growth, such as adult stature and physique.

Maturation can be classified into two components: *timing* and *tempo*[4]. Timing refers to the time when specific maturational events occur: eg, the age when menarche is attained, at the beginning of breast development, at the appearance of pubic hair or at maximum growth during the adolescent growth spurt. Tempo refers to the rate at which maturation progresses: ie, how quickly or slowly a person passes from initial stages of sexual maturation to the mature state. Timing and tempo may vary among individuals.

*Development* refers to the acquisition of behavioural competence, the learning of appropriate behaviours expected by society[5]. It is concluded that development is therefore culture-specific.

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# More is not always better: training the child athlete

Tyson Aquilina

From a young age, all young athletes at some time, dream of one day making it to the top level of their sporting or athletic competition[1]. Today, when elite sport is a lucrative business, many young competitors strive to reach a level of fame and perhaps fortune that only comes with the success of being a part of a professional sporting organisation.

Sharing this dream are significant others in the sporting structure, especially the parents and coaches of these children. As with the athletes, though, the attitudes of older people involved in some children's sport may gradually shift from an emphasis on sporting enjoyment and physical development to one on outcome-based achievement and personal superiority[2] Although infrequent, this changing approach has high potential to instil adverse behavioural traits in children, the consequences of which may present themselves in various aspects of life, both inside and outside sport[3]. An over-exaggerated sense of ambition is of increasing concern among professionals involved in youth health, junior sporting pathways and other related professions[4].

Changes in attitude can be accompanied by actions. The rewards and riches perceived to be synonymous with superiority and winning in sport come from countless hours of physical preparation, in some reported cases greater than 40 hours a week[5]. A minority of coaches and parents also place excessive demands on their young athletes in training, with consequences of social pressures potentially bringing long-term detriments to health[6].

In recognition of the potential health dangers associated with children's sport and physical activity, this article aims to identify and explain some psychological and physiological consequences and markers from excessive expectations and pressures on children and adolescent athletes: including nutritional deficiencies[1, 7-11], growth abnormalities[5, 12-13] and psychological challenges[3, 14-15].Through demonstrating the somewhat limited evidence available for the severe short- and long-term effects of the identified undesirable behaviours present among some children in elite sport, this article aims to provide a basis for developing a healthier direction for those involved.

## Justification of study

The demands and expectations placed on our children today are continually on the increase[2]. This trend is visible not only on the sporting field but also in many aspects of life in general, as the competitive nature of our culture provokes us to strive for superiority. In striving for this achievement in sport, the physical demands and expectations on youngsters is overwhelming at the elite level.

As gymnastics is a sport in which superior athletes emerge at a relatively young age, this article will often refer to gymnastics in discussing high training volumes in young athletes and identifying the potential consequences. In developing an understanding of the psychosocial environment of children's sport and the hardships placed on those taking part, factors to be considered include parental pressure, intensive practices, demanding competitions and social isolation[4]. In addition, there may be a lack of opportunities for social development, dauntingly public display of skills with an ensuing harsh evaluation by others and also in some cases there may be challenges to young athletes living and training away from home and family[5, 16]. Apart from these pressures placed on junior athletes and their potential detrimental effects, other possible consequences are injury[17] and atypical sexual and skeletal maturation[5, 7]. Although aspiring elite child athletes appear to have a remarkable ability to cope, this environment may be overwhelming for some. At the highly elite level there is come evidence that psychosocial stress may contribute to injury in young athletes[3].

Although the evidence is far from perfect, young athletes training seriously may be at risk of developing serious long-term health problems as a result of their intensive workload. The seriousness of these problems and their prevalence dictate a need to create greater awareness and concern to the guardian figures of these children. Some experts suggest the prevalence of children involved in excessive training continues to rise[5] and the incidence of correlated injuries among this population show a similar pattern. The issue of serious sports training in childhood therefore demands immediate and longitudinal attention.

Undoubtedly, parents, coaches and athletes would agree that over-training is potentially detrimental to the athlete. Therefore the potential seriousness and multifaceted nature of possible consequences require responsible and ethical decision-making in the practice and promotion of children's sport. Maintaining the attitudes and focus of children's sports on participation, enjoyment and self-efficacy advances the case for focussing on fundamental principles of sport, recreational and leisure activities in children who may be too challenged by intensive training and expectations in their expectations of sports[2].

## Physiological Effects

### Nutrient Deficiencies

The issue of nutrient deficiency is sometimes overlooked by coaches, parents and the athletes themselves,

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Figure 1 – *Growth Progression* from Damsgaard[3]



Figure 2 – *Height Velocity Curve* from Damsgaard[3]

## Review of Literature

### Growth, maturation and development of normal children

Growth, maturation and development occur simultaneously and interact with each other. They are, however, characterised by individual variations with regard to genetics and environmental factors such as physical activity[4].

Growth in children and adolescents is an important marker of their general health and is a highly regulated process. During infancy a high growth rate is observed immediately after birth. During the first two to three years it is regarded as a continuation of foetal growth and is primarily nutritionally determined. From the age of three, children undergo a lower and slower decelerating growth velocity until they reach puberty[5]. Childhood growth is principally determined by growth hormones until adolescence, at which point a combination of growth hormones and sex steroids dominates the regulation of the pubertal growth spurt. Puberty is associated with an increase in growth rate to the point of peak velocity, which is the maximum growth velocity that an individual attains during puberty. After puberty there is a deceleration of escalation that continues until growth ceases.

The distance curve in Figure 1 illustrates size attained at a given age. The broken lines represent different standard deviations (SD) and indicate the variability of normal growth. The median broken line (0 SD) represents the average height of the reference data at a certain age. The solid line represents the distance curve of a female gymnast[3].

Figure 2 shows a height velocity curve, where annual increments of height are plotted against chronological age. From the curve one can see the aforementioned three main growth phases. First is the rapid decelerating growth in the first three years of life. This is known as the infancy component. Second is the slowly decelerating growth in mid-childhood, known as the childhood component. The final peak in height velocity curve occurs during adolescence. It characterises the pubertal growth spurt and is known as the pubertal component. Again the bold line represents a female gymnast with delayed pubertal development.

The normal age of peak height velocity (PHV) varies between genders. PHV is 12.0 cm.yr-1 for girls with a SD of 0.5 and 14.1 cm.yr-1 for boys with a SD of 0.7[4]. Early maturing girls may reach their PHV at 10.9 years (±0.9), whereas late-maturing girls such as those participating in gymnastics may not reach PHV until 12.7 years (±0.7). Conversely, boys reach PHV at 13.1 years (±0.7) and 15.1 years (±0.9) respectively for early and late maturation.

All individuals have the same aspects of growth. The same stages of growth occur in identical order. The timing and magnitude of growth, however, are completely individualised. Before children reach puberty growth is very similar in both boys and girls (~5-6 cm.year-1 and ~2.5 kg.year-1). Key differences between sexes are most evident during puberty. Typically, girls commence puberty earlier than boys at ~10 years and ~12 years respectively[7]. The major changes that occur during puberty include size, shape and body composition.

The development of secondary sex characteristics starts on average one year earlier in girls than in boys, at age 11.2 years and 12.0 years, respectively. The first budding of the breast and a sudden increase in growth velocity marks the onset of puberty in girls. Growth of the testes (testicular volume > 3 mL) marks the onset in boys[3]. Puberty is broken down into five stages referred to as the Tanner Stages 1 to 5. The pubertal stage of an individual is based on pubic hair growth, male genital development and female breast development.

Age of first menarche is a pubertal milestone in girls and can occur between the ages of nine and 16. Menarche begins when there is sufficient fat mass. Therefore, an individual with a reduced fat mass combined with a low energy intake and/or intense physical activity may experience delayed menarche[3].

Boys are naturally taller than girls because they have an additional two years of pre-pubertal growth and attain greater height gains during puberty. On average, adult males are ~13 cm taller than females[7].

An astounding 50% of adult weight is gained during puberty. Girls' peak weight velocity is 9 kg.year-1 and occurs at the same time as their PHV at ~12 years of age.

Growth and maturation are characterised by individual variation and, although under genetic control, environmental factors including sports participation may have an influence[6].

## Exercise and children's health

Regular exercise is important for all children because it facilitates weight control, helps strengthen growing muscles and can improve cardiovascular risk factors. It assists in general health improvements; so much so, that even psychological health may benefit. An active childhood may also lay the foundation for a lifetime of fitness and well-being[8].

## Reduced growth and delayed maturation?

Baxter-Jones et al found that growth and maturation differences among gymnasts are most evident during the transition from childhood to adolescence, in particular during the adolescent growth spurt[5]. It has also been revealed that most female gymnasts exhibit the growth and maturation characteristics of late-maturing girls with parents of short stature. Female gymnasts' growth patterns are no different from those of non-training, normal and healthy late-maturing girls. This suggests that intense training does not inhibit the growth pattern of gymnasts, because the smaller size of elite gymnasts is evident long before any systematic training begins[9].

Late maturation is a selection criterion for artistic gymnastics because it provides performance advantages[5]. Gymnasts' profiles are of short stature with mean values below the norm mean. There is a current trend towards a decreased stature in gymnasts, today's elite female champions being shorter than the gymnasts of 20 years ago[6].

Daly et al established that both intermediate- and advanced-level gymnasts are late-maturing and tend to demonstrate a blunting of their growth spurt compared with norm values[1]. They also found that not all gymnasts are at an increased risk for faltering in growth, only 35% of gymnasts experiencing growth faltering[1]. The PHV was 6.2 cm.year-1 for advanced level gymnasts and 6.4 cm.year-1 for intermediate level gymnasts. This is slightly higher than a previous longitudinal study which recorded 5.6 cm.year-1[10]. Both studies do, however, demonstrate that gymnasts' PHV is within the normal range, therefore suggesting that the gymnasts' had a growth spurt that is similar in timing and tempo to that of slowly-maturing girls.

Gymnasts have a lighter body mass when compared to the general population. However, unlike ballet dancers, they have an appropriate mass for their height[6].

Caine et al concluded that intense gymnastics training alone cannot be said to affect growth and maturation because environmental factors cannot be isolated from an individual's genetically-determined growth and maturation patterns[2].

## Skeletal maturation

Skeletal age is the best indicator for determining biologic age. It is far more accurate than chronological age because its development spans the entire growth period[11]. During childhood, gymnasts' skeletal ages are on par with those of other children. They are on time for chronological age[3]. However, as gymnasts enter into adolescence, most are classified as late-maturing and fall below the age specific mean maturation status. Baxter-Jones et al established that gymnasts were consistent with late-maturing females in relation to trunk and leg growth patterns[5]. Trunk growth was found to accelerate later than the normal population, but there was no difference in leg length growth. This is consistent with the normal growth of late-maturing females.

The change from average or on time skeletal ages at childhood and the late maturation status during puberty reflect the selection criteria of the sport and suggest that there is a performance advantage for later maturation among gymnasts. All youth, whether they participate in sport or not, will reach skeletal maturity. It is the timing of maturity that fluctuates between individuals.

One study found that gymnasts were on average 1.7 years behind the normal population in regard to skeletal maturation[4]. Another reported that skeletal maturation was delayed up to 3.2 years in some gymnasts but was not delayed at all in others following the same training schedule[11]. Figure 3 (page 13) illustrates the delay in skeletal maturation.

It can therefore be concluded that skeletal maturation will vary among gymnasts and that skeletal maturation may decrease as training age increases. However, not all gymnasts will be affected by delayed skeletal maturation because the role of genetics is a fundamental component of maturation.

## Is adult stature affected?

Most recent studies have found no evidence to suggest that training causes changes in adult stature, though this was not always the case. For example,

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**Figure 3 – Delay in skeletal maturation among gymnasts from Daly et al[11]**

a study by Theintz discovered that gymnasts were failing to reach their full familial height[10]. Current literature now concludes that decreased adult height is a characteristic of late maturation, such as that present in female gymnasts[5].

Size differences have also been reported in those gymnasts who continue with the sport and those who do not[11]. This indicates the likelihood of self-selection processes towards a smaller stature. It should be emphasised that the short stature of gymnasts is evident long before any intense training is conducted and that both male and female gymnasts commonly have shorter parents.

Lags in overall gymnasts' growth followed by accelerated growth to attain adult stature have also been reported[12]. For example, Baxter-Jones and Helms found that gymnasts are regularly shorter until they are 16 but by 17 they seem to be similar to average height[12]. It is believed that the so-called "catch up growth" is simply the gymnasts' normal growth pattern, but occurring later as they display delayed characteristics of physical maturation. It is important to remember that growth cessation is going to occur much later among those who begin maturation after the mean age. Therefore, early maturers will finish maturation and reach their adult stature long before late maturers. In contrast, Caine et al argue that the catch-up growth observed following retirement from gymnastics provides evidence that the tempo of growth is affected through intense gymnastics training[2].

It should also be noted that short adult stature is associated with inadequate growth during infancy - a time when intense gymnastics training does not occur[6].

## Sexual maturation

Sexual maturation is essentially determining where, in the five stages of puberty, an individual is situated. It is the period when a child experiences physical, hormonal and sexual changes and becomes capable of reproduction. Sexual maturation is associated with rapid growth and the appearance of secondary sexual characteristics. Sexual maturation aspects tend to focus on the age of menarche and the potential influence of training[6]. However, late breast and pubic hair development are also sexual maturation characteristics evident in female gymnasts.

Caine et al reported that gymnasts, when compared with their genetically-identical siblings, displayed delayed sexual maturation[2]. The gymnasts' menarche occurred between one and 4.5 years after their siblings' in three studies of monozygotic twins, one of whom participated in intense gymnastics training. The mean difference for menarche in monozygotic twins is four months. Baxter-Jones et al believe that gymnasts are likely to acquire later menarche when compared to the normal population and other girls participating in other sports because of their delayed maturation. It was also found that the period between ages at PHV and menarche for girls who take part in active sport differs from that of girls who do not[5].

Many interrelating factors contribute to the time when menarche occurs. Timing of menarche is the result of genetics, hormones and environmental factors. Other influences include intense physical training, low per cent body fat and weight, diet and energy intake, nutritional deprivation and stress. It is therefore difficult to determine the relationship between timing and delayed menarche in relation to training because so many factors play a significant role[11].

Assessing sexual maturation is much harder for males because there is no standardised marker such as menarche[11]. Male gymnasts are also believed to have delayed sexual maturation, demonstrated by a smaller testicular volume[12]. Gurd and Klentrou, however, stated that no significant differences existed between the resting salivary testosterone levels of gymnasts and their age equivalent controls[13]. This leads one to conclude that there is no cause-effect relationship between intense training and delayed maturation among boys.

## Physical demands of training

Gymnastics training is high in intensity and volume. Female artistic gymnastics often consists of a warm-up including stretching, both static and dynamic, individual apparatus rehearsal on vault, bars, beam and floor, whole body strength and conditioning, a ballet or dance lesson once or twice a week, specific flexibility sessions and a cool-down. Training is often twice a day for up to five hours in a single session.

It has previously been proposed that there is a training threshold at which individuals may be at risk of attenuated growth[10, 12]. It was hypothesised that gymnasts training fewer than 15 to 18 hours per week did not appear to have their growth patterns altered or affected

by their training schedule. There is no evidence, however, that supports the assumption that extended intensive gymnastics training influences the growth and maturation of young female gymnasts[2]. The reason for this is that the gymnasts involved in the studies are of a high elite standard, are often maintaining low energy diets and are under increased psychological pressures and stress to perform. These factors alone, without the intense training, may exert physiological distress on the body.

Intensive gymnastics training results in lower relative body fat and increased energy expenditure. Because of the extreme training schedule that gymnasts follow, 12 months of the year, it is vital that physical and psychological signs for overtraining are assessed in each gymnast[14].

## Hormones

According to Daly et al, inadequate energy and nutrient intake, particularly when combined with intense training or stress, may alter the secretion of growth-related hormones, therefore contributing to reduced growth and delayed maturation[11]. Daly et al believe that it is difficult to assess the influence of exercise on many growth and reproductive hormones because of their pulsatile and circadian pattern of release.

Female gymnasts often exhibit low levels of insulin-like growth factor (IGF-1), oestrogen, testosterone, luteinising hormone (LH), follicle-stimulating hormone (FSH) and progesterone. These decreased hormones levels have been linked to gymnasts' negative energy balance, poor dietary practices and delayed maturation[11]. Male gymnasts also display low levels of growth hormone, sex hormone-binding globin or testosterone and IGF-1[13].

It is still unclear as to whether reduced levels of growth and delayed maturation in young male and female gymnasts are the response of hormonal adaptations relating to training or whether they are caused by a combination of stress and poor dietary practices[11].

## Nutrition and energy expenditure

It has been reported that female gymnasts have insufficient nutrition and energy intake to support their normal growth and development when participating in intensive training[11]. Baxter-Jones et al have also revealed that gymnasts have a deficiency of essential micronutrients such as zinc, iron and calcium that may also play a role in delaying normal growth and skeletal maturation[4].

Nutritional problems occur during puberty as gymnasts aim to maintain the pre-pubertal physique, which is associated with the aesthetics of the sport. As mentioned above, adolescence is a time of rapid growth and maturation. It is a period in which nutritional factors are particularly sensitive to normal growth and maturation. If gymnasts are not receiving an adequate nutritional intake during this period, growth and development may be compromised.

If gymnasts are not receiving adequate energy and a negative energy balance is occurring, a reduced level of IGF-1 will result. Caine et al reported that those who have reduced levels of IGF-1 were associated with negative energy balances and reduced growth rates[2]. They also discovered that the reduced levels of IGF-1 were reported in female gymnasts but not male gymnasts. If gymnasts are not meeting their daily energy requirements for the level of physical activity at which they are engaged, the energy demands of training may compete with the cellular processes underlying normal growth, development and maturation. Sufficient energy requirements are therefore necessary to meet activity demands and to ensure good short- and long-term health[15]. Optimal nutrient intake is also compulsory for optimal bone growth, which will reduce the likelihood of stress fractures and other overuse injuries16).

It has been reported that a gymnast who trains four hours per day needs an additional 400 to 700 Kcal of energy daily(2, 15). A lack of required energy and vital nutrients may be catastrophic during the adolescent growth spurt, because approximately 15% of final adult stature is attained during puberty and nutritional requirements further increase[2].

Studies by Baxter-Jones et al and Daly et al have revealed that gymnasts consume 250 to 1200 Kcal below national recommendations[1, 6]. This alone is alarming, but gymnasts' energy expenditure also exceeds daily energy intake. Gymnasts' high energy expenditure, which is often 44% greater per week than their age equivalent controls, cannot be explained by a raised basal metabolic rate (BMR). Davies et al found evidence that the raised energy expenditure evident among female artistic gymnasts was the result of the high level of physical activity in which gymnasts participate[15].

In a study of elite female gymnasts, energy intake was associated with a reduced growth velocity and delayed skeletal maturation[17]. Despite these findings it is difficult to distinguish any single factor such as intense training that may inhibit growth and maturation. It is more likely a collaboration of many interrelating determinants such as genetics, nutrition and psychological stressors that act together to effect growth, development and maturation.

## Psychological and emotional stress

Psychological stresses on gymnasts may come from coaches and their coaching style, parental pressures, social isolation and lack of opportunities for social development, maintaining body weight, intensive practice sessions, demanding and frequent competitions, year-long training and often the pressures of living away from home, family and close friends. Some other factors that may cause stress on young gymnasts include overtraining, inadequate recovery, inadequate caloric intake, injury and selection for national and international competitions[2].

Evidence of extreme psychological stress has been shown to influence growth[11]. Gymnasts may have immense psychological stress in relation to their body image and physique. Growth may be affected through the onset of disordered eating behaviour, which may lead to permanent growth deficits in the long term and irreversible decrements in bone density.

Psychological factors also influence an athlete's performance. Anxiety and fear can have a detrimental influence on performance, whereas self-confidence, self-efficacy and positive thinking can improve performance[18]. Kolt and Kirkby believe that anxiety is the most common psychological factor linked to sporting-related injuries. They reported

that heightened anxiety is both a cause and consequence of sustaining an injury and concluded that a significant link was evident between anxiety and injury.

For some gymnasts, fear may become a major psychological barrier to learning and acquiring new skills and delay the improvement of known skills. It has also been shown to reduce gymnasts' motivation levels and evoke withdrawal from the sport at an early age[19].

## Injury and growth

Gymnastics appears to be associated with high injury incidence when compared with many other sports. Unlike other sports such as swimming, soccer and tennis, injuries in gymnastics have been associated with pubertal status with more injuries occurring in the later stages of puberty[12]. The heightened injury rate can be attributed to the frequent high-impact loading on the body, resulting in extreme levels of mechanical stress on the musculoskeletal system. Gymnasts will place between 8.8 and 14.4 times body weight through their limbs during any given training session[20]. This ground reaction force is not simply confined to the lower extremities but also, though to a lesser extent, to the upper extremities. Dixon and Fricker reported an injury rate of 200%, or two injuries per gymnast per year, in elite male and female artistic gymnasts at the Australian Institute of Sport[21]. Similar results were found by Kolt and Kirkby as they reported an injury rate of 1.98 injuries per gymnast per year[22].

Several studies have reported the most common injury location to be the ankle and foot, followed by the lower back, knee, wrist and hand[20, 23]. The lower limbs (ankle, foot, lower leg, knee and hip) account for 57.3% of all injuries. This is followed by 22.7% in the upper limbs (shoulder, elbow, forearm, wrist and hand) and 17.8% in the spine and trunk[20].

Growth plate injuries are another concern that have gained minimal attention through research studies because they are put in non-specific categories such as 'other'[22]. Researchers have alleged that repetitive mechanical loading from year-round training and landing forcefully from heights may result in growth plate injuries. The potential for acute lower limb growth plate injury is of particular concern given the high frequency of knee and ankle injuries among gymnasts.

Female gymnasts must turn 15 during the year of a national competition to be eligible to compete in that competition. This allows cartilage to be more structured and mature. Anderson has proposed that, if gymnasts are at the elite level and are not physically mature, the likelihood of injury increases[24].

Linear growth deficits may arise from stress injuries of the lower extremity physes in young athletes, in particular gymnasts. Lower extremity injuries should heal without complications to growth[11]; however there is some evidence that premature, partial or complete closure of the growth plate may occur[25]. Reports on acute physeal injuries to gymnasts are limited, however, and it is unlikely that traumatic lower extremity physeal injuries would result in a shortened adult stature[11].

Caine et al believe that there is evidence of premature partial and complete epiphyseal closure of the distal radius in skeletally-immature female gymnasts[2]. Maffulli and Burns support this finding, claiming that the cartilaginous cells of the epiphysis may be damaged, producing premature closure of the epiphyseal plate and bone growth disturbance, with subsequent deformity[26].

Gymnastics is associated with spondylolisthesis, the slippage of the superior vertebra on the inferior and spondylolysis, an osseous defect of the pars interarticularis between the superior and inferior facets of the vertebral body[26]. Other common injuries include knee meniscal injuries, ankle inversion injuries, Achilles tendonitis, patellor tendonitis, Osgood Schlatter disease, Sever's disease, wrist impingement syndrome and tibial stress syndrome. Spondylolysis occurs in 32% of gymnasts and is commonly caused by the excessive hyperextension of the spine required in skills such as backward walkovers, backs flips and handsprings[16].

Strength, flexibility, coordination and power are needed to perform without injury[27]. Duration, volume and intensity, along with variation throughout training sessions and the rate of skill progression, are mandatory considerations for a successful training program and for individuals to achieve the highest skill level without risking burnout or injury.

## Conclusion

For years, concerns have centred on the proposition that intensive gymnastics training causes growth retardation and delays in maturation. From an extensive analysis of available literature it can be concluded that training does not appear to affect timing and tempo of growth and maturation adversely. It is more likely that either gymnasts themselves, or their parents, choose a sport with performance requirements to which they are physiologically and anthropometrically most suited. Small stature and delayed maturation are likely to be the results of biological selective factors rather than the effects of training as there is no definitive correlation between training volume and physical characteristics.

Extensive previous research on the effects of intensive gymnastics training has failed to be longitudinal, tending rather to be cross-sectional. The growth and development of the participants are in constant state of change, so it becomes impossible to repeat a measurement or assessment and obtain the same result. Longitudinal studies are therefore necessary to allow the effects of training to be distinguished from those associated with normal growth and development. Past research has been further limited in that most control subjects display a normal rate of maturation and not the gymnasts' delayed state of maturation, and therefore are not a reliable comparison.

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even though thorough research has shown that hypocaloric energy intake is associated with disordered eating, menstrual dysfunction and low bone density, all pathologies which have been commonly recorded to carry through well into adult life for some elite female athletes, particularly those engaged in aesthetic based sports[10].

As the body becomes more active and harder working, it requires a greater and well balanced energy intake to meet the increased energy expenditure demands. Because of the nature of their training, it is possible that many young athletes incur nutritional deficiencies. They need to meet not only the increased demands of their training regimen but also the additional demands of a growing and developing body. During periods of intensive training, nutritional deficiencies have the potential to influence many aspects of a child's life, including decreased physical performance, compromised growth and development, decreased cognitive function and an increased risk of developing illness or disease.

Nutritional studies conducted on female gymnasts consistently report mean energy intakes that are 275 Kcal to 1200 Kcal lower than national recommendations and subsequently place them at risk of nutritional deficiencies[1]. Among the concerns for dietary behaviours in young athletes are iron deficiencies which have the potential to compromise health and athletic performance. Studies of male and female gymnasts revealed significantly higher rates of iron deficiencies in these groups, even when compared to groups of elite athletes involved in other sports[9]. Constantini et al reported haemoglobin levels of less than 14g/dL in 45% of the male gymnast subjects, which compared poorly with 28% prevalence in non-gymnast athletes. Haemoglobin levels of less than 13g/dL were recorded in 25% of pre-menarchal female gymnasts, against 15% in female non-gymnasts[9]. In understanding that haemoglobin is responsible for the transportation of oxygen to the body, it can be calculated how performance of these athletes will be sub-optimal. Constantini et al specifically reported a high prevalence of deficiencies in transferrin saturation and ferritin levels in both male and female gymnasts[9]. Many responsible coaches of junior athletes in high demanding sports required regular blood checks for adequate iron in the blood.

Another nutrient of particular focus during childhood is calcium, the element responsible for bone growth and development[7]. Adequate recommended daily intakes for calcium may be compromised in sports with an emphasis on minimal weight gains. The literature states that physical activity plays a vital role in promoting good bone density in children[18], but it should be noted on the contrary that sweating which is achieved through exercise is correlated to calcium losses. Although the quantities of calcium required for sweating are relatively small by nature, the combination of under-nourishment and excessive training among some of our child sport stars suggests that diligence is needed concerning micronutrient intakes of calcium[11]. Barr and Mackay support the idea that children exposed to over-training are at greater risk of calcium deficiencies, which in turn may escalate the chance of injury and compromise development of the child[7].

In response to the sub-optimal nutritional consumption often reported in child athletes in sports emphasising minimal weight gains, a deviation from the regular functioning of the metabolic and digestive systems may occur. Alterations to these systems arise as a result of the high-energy demands of the training lifestyle not being met by the daily dietary consumption of the athlete. This may lead to compensation strategies in the body to prevent starvation. It is believed that disturbances or imbalances in the metabolic and digestive systems may cause serious pathogenic implications during maturation[8]. An experiment by Burkhard-Jagodzinska et al on 12 elite junior rowers aged 11 to 15 years supports the hypothesis that excessive training has the potential to create dysfunction in these systems, showing that heavy training in children promoted a lowering of the resting metabolic rate as well as plasma insulin concentrations. The results also noted an altered thermogenic effect during glucose metabolism[8]. This demonstrates the need for elite child athletes - - perhaps even more so the primary carers involved with their growth and development, both inside and outside the sporting context -- to seek and use nutritional knowledge for practical purposes and long-term benefits.

## Growth and maturation abnormalities

Although resistance training can promote many benefits to the young athlete, such as greater bone mineral density and the subsequent decrease in risk of injury, strategic precautions need to be taken to ensure that the quality of resistance training is non-injurious to the athlete.

Over-training or unsuitable methods of training have the potential to cause permanent skeletal abnormalities among children. There is limited but salient evidence for a connection between inappropriate resistance training of children and adverse skeletal development. Investigations into resistance training and children has concluded that, if excessive pressure is applied to the body via resistance training, under extreme conditions alterations can occur in the growth or epiphyseal plates of long bones. The consequential deformation of these growth plates can lead to decreased ability of bones to develop fully and hence to impair growth. It should be noted that these consequences can be avoided; existing evidence is sparse and only relates to incidences of unsupervised and poorly-designed training programs for children. Guidelines for resistance training of children and adolescents should be understood before they undertake any form of strength training[13]. Scaling down adults programs is not appropriate. Many health researchers and professionals suggest that pre-pubertal athletes should not engage in any free-weight training, recommending instead body-weight resistance exercise and water-based resistance exercise. ASCM advocate the safety and strength benefits for young people from well-supervised and well-designed programs[19].

Research shows that, in addition to the serious side effects associated with it, the benefits of heavy resistance training are inferior to those that can be achieved by high-repetition, light-load

resistance-based training. A study of 43 children aged 8 to 12.3 years conducted by Faigenbaum et al revealed that completing sets of 15 to 20 repetitions with a lighter weight proved more beneficial to training gains than a resistance program promoting larger loads at six to 10 repetitions[12]. The results also showed that the *muscular endurance-based program* was beneficial in obtaining training gains in absolute strength (23%), muscular endurance (42%) and flexibility (15%), compared to the muscular strength-based program which only obtained gains in absolute strength (21%)[12].

The most frequent explanation for the lack of hypertrophy despite gains in strength and muscular endurance in pre-pubertal children is low concentrations of circulating testosterone. Rather, the training benefits from resistance training in children are the result of neuromuscular adaptations from increased opportunities to practice skills. As further repetitions and repeated practices promote further training and activation of the neuromuscular system, a high-repetition, light-resistance program can be more beneficial to strength gains in children than a low-repetition, high-low regime. Neuromuscular adaptations in children are accredited to a greater motor unit recruitment, more efficient motor unit activation and greater central nervous system functioning. Because many children's coaches and even parents are unaware that the child athlete is physiologically different to the adult athlete, many juveniles are put at risk of the consequences linked to heavy resistance training on the growing skeleton.

Some bone and growth abnormalities in elite youth athletes can occur not only as the result of resistance training, but also excessive training of any nature. Theintz et al in a study of young female gymnasts show delayed skeletal ageing and development, with skeletal maturation delays recorded at 1.8 years in young gymnasts[20]. Caine et al support this finding, indicating that skeletal maturation is further delayed by 0.5 (+-0.1) years in athletes who sustain an excessive workload for longer than two years[5]. Quantifying excessive load remains illusive, however. Caine et al report that young female gymnasts are "short" because of the overwhelming demands placed on them, showing that 14% of high-level pre-, peri- and post-pubertal female gymnasts (training 20 to 27 hours per week) had short stature below two standard deviations of the calculated normative data. In contrast, only 4.5% of non-elite competitive gymnasts training 7.5 to 22.5 hours per week had "short" stature[5]. Not all authors agree, however, that adult height is compromised as a result of elite gymnastics training[21]. The consensus is that compromised skeletal health from intensive training alone is unlikely. Many other factors such as inadequate nutrition and psychometric stresses are likely to contribute to the small number of young athletes in whom compromised growth is suspected.

Delayed sexual maturation with intensive training is somewhat difficult to pinpoint because there is a plethora of reasons for alterations in sexual maturation and development. It is possible that excessive training of junior athletes can contribute to late or delayed maturation but there may be other causes. Health professionals have always used female gymnasts as a prime example for this problem. Case studies comparing the onset of menarche in monozygotic twins, one of whom competed in elite gymnastics, showed an average of four months delay in maturation of the elite gymnast, with one study showing one set of twins to have a difference of four and a half years[5]. Longitudinal studies have also shown that "catch up" maturation quickly occurs when a female gymnast ceases or reduces training because of injury or quits the sport[5]. The complexity of interactive causes of delayed maturation include strong familial influences and training should therefore be not isolated as causal.

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## Psychological Effects

### Depression

Because children are emotionally immature, they can be susceptible to increased risk of depression[6]. On the positive side, one study has shown depression rates are approximately 3.5 times lower in children involved in organised sport than in those who are not[4]. However, there also seems to be a correlation between mental disorder and excessive training. A connection between the sum of heightened internal and external pressures and excessive training may also be seen as a significant factor for depression among elite child athletes. Issues such as sporting success, meeting the perceived demands of influential figures and body image[15], individually or collectively have the potential to alter mood states in young athletes striving for success.

Frequent depression or stress associated with the individual may lead to extreme behaviours of various kinds, with some athletes succumbing to "burnout", a condition in which they cease participating in sport. Others may opt to continue and may even increase their training workload to further unsafe and risky levels. Depression in childhood and adolescents is also correlated to increased rates of suicide[16]. Furthermore, the strong correlation between child and adult depression[14] shows the potential of the disorder to plague a person throughout life and highlights the overwhelming need for preventative and early risk detection strategies.

### Aggression

Provoking aggressive and over-competitive behaviour by coaches, parents and other influential figures is detrimental not only to the young athlete but also to the sporting environment[2]. Perhaps of greater concern is the transition of this behaviour into everyday life[3].

A major concern about aggressive behaviour in sport is the insidious cycling that aggression may create and the negative profile it gives structured physical activity. Individuals taught aggression as a child athlete may teach it in turn as adults, and as parents and coaches. This cycle of aggression in sport needs to be broken if the value of physical activity to the general community is to be promoted. The sporting world should be a starting point for creating awareness of this issue.

## Solutions

### Changing attitudes

Changing the attitudes and roles of those involved in junior sport is the initial and perhaps most important strategy for bringing about a more desirable environment. This environment would allow for improving sporting performance, while still promoting normal physical, psychological and social growth and development in the younger generation. Holistic development should be the main priority and the main benefit to children involved in physical activity[2]. Successful transition of behaviour from achievement to development of sound attitudes will promote safety and enjoyment in physical activity for children.

Performance evaluation should give way to a more developmentally appropriate "participation and effort"-based evaluation[2]. In encouraging this change in outlook, coaches, parents and other involved groups should be made aware of the consequences surrounding the undesirable creation of a highly pressured physical and psychological environment for children. Carers need to be aware of and pursue safe practices when involving children. Coaches and parents should be educated to encourage effort in performance rather than the result.

### Finding optimal training techniques for children

More is not always better. In regard to the individual needs of children and the characteristics of an effective training program, training workloads which are excessive in nature may be detrimental to performance and health, though some children continue to participate in more than 40 physical training hours every week[5].

As this article has emphasised, the consequences of excessive training in children can be multiple, irreversible and often severe in nature. The health risks can range from structural and physiological, to psychological and social. In arguing for reduced workloads for children exposed to excessive training, the factors involved in a more efficient training program need to be provided and promoted to coaches. In identifying these factors, the major issue to be addressed may turn to "under recovery" including being critical of the large absence of recovery sessions allocated to children[5].

Over-training has been described as the result of an imbalance between stress and recovery[22]. Educating coaches about effective recovery in training is imperative. Recovery has been identified as a vital component of any training schedule and critical in allowing for optimal performance[23] and functioning 24. Because over-training is often linked to inadequate recovery, some aspiring young athletes may be performing consistently below their physical[24] and mental potential[25]. The value of recovery training to performance and development has been a focus of much research. Rest and recovery play a role in maximising training benefits, allowing the body to be revitalised[26] and mental capacity to be sustained[24]. It has also been shown that recovery training is significant in permitting normal immunity and minimising the risk of injury[26].

The physical and mental pressures commonly attached to over-training are highly correlated to the cessation of elite sporting competition and training[27]. Coaches and parents should therefore be encouraged to enforce adequate recovery for their young athletes. Children should be monitored for the symptoms of over-training. Symptoms can vary widely but, in general they include decreased performance, lack of concentration and irregular behaviour[24]. Failure to include recovery training may contribute to children dropping out of all sport or physical activity.

## Conclusions

This article has shown substantial support for the notion that high volumes of training have the potential to lead to enduring psychological, cognitive-behavioural and physiological problems in children and adolescents. Coaches, parents and other guiding individuals need to take control of the potentially dangerous situation, through leadership and enforcement of safe sporting practices.

Future study should be directed towards advancing understanding of the capacities and limitations of our young sports participants and providing guidelines and education for those involved in developing them. Developmentally appropriate strategies will encourage sport to be more positive, enjoyable and safe for children, at the same time maximising the opportunities for empowerment and improvement in sporting performance.

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# Best on floor: controversies and the evidence in women's artistic gymnastics

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Gymnastics is in the spotlight a bit more than usual after the World Championships and with the Commonwealth Games in Melbourne. All of the usual questions arise about youth, growth, excessive training, injuries and eating disorders. The sport is controversial on many fronts — some legitimate and some unfounded — and of course, the evidence is sparse.

Gymnastics is widely recommended in early age groups. It is fun and a great way to encourage normal development of coordination, balance, discipline and concentration. Gymnastics is recommended as an excellent way to prepare young athletes for other sports. It is elite gymnastics that is frequently questioned for its relevance as a sport on offer to young Australians.

Elite artistic gymnastics is suitable for a very small percentage of young girls. The demands are very high — around 36 hours of training a week at the highest level — and it is important to start at a young age. The sport favours a very particular body type as the skills require high power to weight ratio, requiring gymnasts to maintain formidable strength along with low mass. The athlete needs to be psychologically suited to the training, resilient to major injury and motivated to continue training for the years that it takes to reach senior competition. It is not surprising that very few gymnasts make it to the top of their field.

Of concern is that much of the gymnastics-specific research is limited by the small sample numbers of elite gymnasts. Much of the research achieves power by including recreational level subjects which biases results away from those that are doing the high training loads. Many of the most successful countries do not support a lot of mainstream research. In all, many of the real questions remain unanswered although several recent studies have followed gymnasts past retirement to investigate the ongoing effects of injury and growth-related issues.

Short stature is clearly advantageous to the gymnast by optimising balance, speed of rotation and power output. There are exceptions to this rule but it is a matter of physics that the sport is biased towards a small, light, strong and flexible athlete. Being both light and strong is where the challenge lies and where many health professionals clash with coaches who dislike the use of some conventional resistance training methods. Excessive muscle mass or body fat can pose considerable problems for take-off effort, landing forces, and therefore load-related injury. Maintaining ideal body type is important for the aesthetic qualities needed in gymnastics but also essential for injury prevention.

It is difficult to know whether shorter athletes are more likely to be successful and therefore stay in the sport longer or whether the sport itself contributes to short stature. It is possible that vertical impact, training intensity, low body fat and delayed menarche contribute to lack of vertical growth. Many researchers have looked into this relationship with no evidence available to demonstrate inadequate growth. Caine et al (2001) reviewed 55 articles relating to growth in elite female gymnasts. Their summary of the available evidence shows that growth is delayed, usually until after retirement, but that terminal height is usually within normal limits.

It is also apparent from the literature that gymnasts grow during periods of rest such as holiday or injury (Lindholm et al 1994) and this is clinically very important for health professionals and coaches. A change in height brings a change in centre of gravity which of course has implications on gymnastics skills. Coaches are acutely aware that gymnasts change with even a few days off and this is sometimes difficult for physios to comprehend. We need to remember that timing is crucial (just consider landing a double somersault with a full twist) so even a very slight change in height, weight, coordination or concentration can have safety and performance consequences.

Jill McNitt-Gray is a much respected biomechanist who has worked with gymnastics in the United States for many years. She has shown that very slight changes to joint angles on landing make considerable changes to vertical and horizontal ground reaction forces. Along with training techniques for landing, she stresses the importance of utilising mats which are regularly replaced and uniform in compliance across the whole surface.

Bass et al (2000) investigated the 'velocity of change' to sitting height and leg length over 2 years in 21 gymnasts of all participation levels. This was compared with 110 active control subjects. They found that the gymnasts had delayed growth within a range of 0 to 3.2 years. This was most evident in trunk height which is most dependent upon oestrogen for maturation. When 13 athletes were followed through retirement their height velocity increased considerably so that they were close to the range of the controls. These retired athletes were all under 17 years by the time the study finished. This finding has been supported in other studies that were less effectively controlled.

So if gymnasts do catch up to their expected height after retirement, what happens to their epiphyses in the meantime? What if they don't retire until their 20s? Some researchers have proposed that the workload involved in gymnastics may predispose to early closure of the growth plates (Caine et al 1989). In contrast, considering that there

is good evidence to show that gymnasts grow after retirement, it seems more` likely that this process is either delayed or close to normal. Menarche is usually delayed and there is evidence that skeletal maturation follows this trend (Laron and Klinger). In my experience with Australian elite gymnastics there have been several injuries to active epiphyses (at the wrist, distal tibia and calcaneus) in athletes aged 17, 18 and 19. We need to be aware that gymnasts show individual variation in the behaviour of their skeletal growth and be ready to consider this for every injury presentation.

Does it matter that growth is delayed in gymnasts? Yes, if it is related to pathology or poor nutrition. Gymnasts with pathological growth delay or attenuation may be missed among a population of short athletes. This highlights the need for medical screening of gymnasts for iron and calcium levels especially. In an otherwise healthy athlete, delayed growth brings an increased risk of growth-related injury. Gymnasts need close attention from medical staff and coaches to minimise this risk where possible through optimal conditioning, effective equipment and ideal training loads.

Growth plate injury is of major concern for long-term development particularly when injury causes early epiphyseal closure. This is rare but concerning especially at the distal radius, resulting in positive ulna variance, and at the tibia or femur which could bring about a leg length discrepancy.

Coaches want their athletes to learn all of the major skills before the adolescent growth spurt because it is normal to lose the ability to perform skills well for some time after puberty. Currently, some of the best gymnasts in the world are in their 20s so it is clear that an adult body-type (and with that goes adult psychological maturity) can perform at the highest level. All gymnasts try to maintain very low skinfolds and this is largely responsible for reduction in puberty-related hormone levels and delayed menarche. Low body fat is related to diet and high training loads. Eating disorders are evident in artistic gymnastics but relatively rare. To handle the load of training, demands of competition and to avoid injury, gymnasts need adequate nutritional and sleep recovery. Bass et al (2000) reported lower energy intake as reported by gymnasts via food diary compared with active controls. This finding is not surprising given that gymnasts try to control their diet and self-reporting is not ideally reliable. There is no evidence that the gymnastics culture in Australia encourages insufficient nutrition.

There is evidence that the rate of loading in gymnastics facilitates bone density. This supports the hypotheses that the female athlete triad of eating disorder, amenorrhoea and osteoporosis is uncommon in gymnastics. Ward et al (2005) studied bone mineral densities (BMD) across a range of sites in 44 gymnasts and 42 controls aged between five and 11. They found site-specific differences in these pre-pubertal gymnasts with total BMD greater in gymnasts by 3.5 per cent. Other researchers (Nanyan et al 2005 and Laing et al 2005) support this finding of increased BMD in pre-pubertal gymnasts, but what happens after puberty and retirement?

Limited by small subject numbers but interesting nonetheless is a study by Rudlac et al (2004) which compared 10 gymnasts with nine controls and followed these for four years after retirement. Findings were again site-specific but gymnasts appeared to maintain increased total BMD, especially volumetric BMD at the femoral neck. Earlier study by Lindholm et al (1995) showed that BMD of 19 former gymnasts was normal after retirement despite delayed menarche compared with active controls.

The 'code of points' in gymnastics is the assignment of competition scores to individual and combined skills. This changes every four years following an Olympic cycle which affects the skills for which gymnasts train every day. Of course, this has strong influence upon the type of injuries sustained: if the emphasis is on lumbar extension skills then we would expect to see more injury to the posterior spinal elements. This makes epidemiology studies quickly outdated. Ideas for injury prevention and conditioning need to take the code of points into consideration. Communication with astute coaches is the best way to anticipate the effect the code will have on gymnasts.

Comparisons with other sports is difficult and relies upon the definition of injury used and the method of injury reporting (ie, percentage of athletes vs injuries per hour of exposure). It is interesting to note that Caine et al (1989) found that 38 of 44 gymnasts in full, unrestricted training reported some pain or discomfort in the previous week. Daly et al found that female gymnasts spend around 63% of total training time resting between efforts. This makes description of injury per hour of exposure difficult.

McLain and Reynolds (1989) found that, in American high school sports, girls' gymnastics was second highest to football when percentages of athletes with injuries was considered. If this was expressed as a percentage of training time then gymnastics injuries would appear much lower. Considering all of the available epidemiology literature, it seems that gymnasts are injured more frequently and with more serious consequences than athletes of other sports.

Is all of this relevant to physiotherapists? Yes, in my experience an appreciation of these broader issues has been important in working with the wide range of injuries presenting in elite women's artistic gymnastics. Rather than make judgments about the benefits of the sport, physios need to work hard on injury prevention and encourage ongoing research to address the evidence instead of the myths.

## Suggested reading


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# Hospitalised sports injury: A snapshot of the Australian scene

Though injuries in sport are common, only a minority cause the victim to end up being admitted to hospital. On the other hand, this minority of injuries are usually more severe and most costly. In 2002-03, of the 6.6 million hospital admissions throughout Australia, 45,452 were the result of injuries in sport and recreation.

Of these the greatest number – 14,218 – occurred in the 0-14 year age group.

Though there were more females aged 15 and over engaged in sport and recreation than males, 73.9% of sport and recreation related hospitalisations happened to males.

The sport causing the highest number of hospitalisations (12,600) was football

These are some of the major findings in *Hospitalised sports injury, Australia 2002-03*, a report by Louise Flood and James Harrison of the Research Centre for Injury Studies at Flinders University for the Australian Institute of Health and Welfare, using data from the National Morbidity Database compiled by the AIHW for inpatient care throughout Australia in the 2002-03 financial year.

The sports it examines are football, water sports, cycling, roller sports, wheeled motor sports, equestrian pursuits, basketball and netball, ice and snow sports, cricket, racquet sports, walking and running, combative sports, gymnastics and trampolining and field hockey.

Sport Health's report of a significant advance in what we know about injury in sport concentrates on football – the major cause of sports-related hospitalisations — and gymnastics, which is a focus of this issue.

The report says that there were 3,944 admissions from Australian football. Water sports caused 2,799 water sport related hospitalisations, sport- and recreation-related cycling 2,725, roller sports 2,265, wheeled motor sports 2,093 and equestrian activities 1,816.

Australian football (39.7) and football (29.8) were responsible for the highest rates of hospitalisation per 100,000 population for males in 2002-03. For females, equestrian activities (11.7) and netball (10.0) caused the highest rates.

The most common principal diagnosis in those hospitalised for sports and recreation was fractures, with 22,655 (or 52.8%) admissions.

The report found that 20.7% of hospitalisations involved the knee and lower leg as principal body region injured, 19.1% the elbow and forearm and 18.5% the head. The most commonly injured principal body region depended on the sport played. Elbow and forearm injury requiring hospitalisation was more common in the 0–14 year age group. Knee and lower leg injury requiring hospitalisation was more common in the middle age groups (as a percentage of all injury in the age group.

Falls were the most common mechanism of injury and accounted for 36.0% (n=16,384) of cases. There were 65 deaths in those hospitalised for sports and recreation related reasons.

Most hospitalised injuries due to sports and recreation happened in the 0–14 year age group, the report says, followed by the 15–24 year age group. The highest rate of hospitalisation per 100,000 participants (15 years and over) was in the 15–24 year age group with 516.5.

More females than males took part in sports but the male participation rate was slightly higher than that of females (82.6% vs. 82.4%)(1). Of people admitted to hospital because of sport injury, 73.9% were male. The rate of hospitalisation per 100,000 population was much higher in males than females (344.4 versus 120.0). So was the rate per 100,000 participants (373.4 vs. 114.6). The report said that this might be due to the differing kinds of sports participated in or the different ways in which sports were played by males and females rather than because males were more injury-prone or more likely to be hospitalised.

## Football

Football accounted for 27.7% of all sports-related hospital admissions, Australian football accounting for 31.3% and football 26%. For all codes, most hospitalisations occurred in the younger age groups and in males.

Head injuries were the most common reason for hospitalisation in Australian football (24.8%), rugby league (24.4%) and rugby union (24.0%). Knee and lower leg injury were the most common reason for hospitalisation in football (40.8%) and touch football (35.6%). In all football codes, fractures were the most common principal diagnosis in those admitted to hospital. They comprised 61.9% of admissions in football, 56.2% in rugby union, 56.0% in Australian football, 51.9% in rugby league and 48.5% in touch football.

Contact with another person was the most common mechanism of injury resulting in hospitalisation for Australian football (n=1,303, 33.0%). Hockey and Knowles found that for Australian football, 31.5% of injury was due to falls

and 49.6% due to striking or collision with another person (Hockey & Knowles 2000).

## Gymnastics

The report cited a study of injury in gymnastics which found a higher risk of injury with higher skill level. Sprains and strains were the most commonly reported injuries in most studies. The lower limb was more commonly injured than the upper limb, the ankle and knee being involved in 55% of cases. Elbow and wrist overuse injuries were common in the upper limb. The trunk and spine was injured in 15–20% of cases(2).

Another study cited in the report was of a prospective study on 64 female Australian gymnasts (aged 11–19 years) who were either elite (in contention for the national team) or sub-elite (competing at state and national competitions). It found that there were 3.64 injuries per gymnast per year. All gymnasts sustained at least one injury during the study(3).

The study found that 59.0% of injuries involved the lower limbs, 31.2% the ankle/foot and 13.5% the knee. The dominance of lower limb injuries could be because gymnasts performed multiple landings which were often from a great height after twisting and rotating.

It found that the upper limb was injured in 20.9% of cases, 9.7% of total cases being wrist/hand injuries. The spine/trunk was injured in 17.2% of cases; 29.7% of injuries were sprains; 23.2% of injuries were strains; 12.3% of injuries were growth plate injuries; 11.2% of injuries were inflammation; and 8.3% of injuries were fractures. Most (64.2%) of injuries were acute (50.3% in the elite group and 75% in the subelite group).

The report said that, for those aged from five to 14, gymnastics and trampolining was predominantly female sports, the Australian Bureau of Statistics reporting that 5.4% of females and 1.7% of males participated in organised gymnastics and trampolining in the 12 months to interview in April 2003(4).

Those injured in gymnastics and trampolining were predominately young, with 82.0% of cases being under 14 . Almost two thirds (65.5%) of those 14 and under were females. Males were more commonly hospitalised in all the other age groups except the 35–44 year age group (but only seven cases occurred in this age group). Of the 42 injured in the 15–24 year age group, 64.3% were males.

The elbow and forearm (34.8%) and shoulder and upper arm (21.3%) were the most commonly injured body parts in those admitted to hospital because of injury in gymnastics and trampolining (as principal diagnosis). Most of the injuries in those hospitalised were fractures (n=290, 74.9%).

**Hospitalised sports injury, Australia 2002-03 can be found at www.nisu.flinders.edu.au.**

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# M2006 SSMO in BAD AMF @ EXC*

Brendan de Morton

*To help readers translate the headline above, Dr de Morton says "I was lucky enough to work at the Commonwealth Games in Melbourne (M2006) as the Sports Specific Medical Officer (SSMO) in charge of the Athlete Medical Facility (AMF) in badminton (BAD) based at the Melbourne Exhibition Centre (EXC).

**Badminton does not have a high profile in Australia and, having never been involved in the sport except for playing "backyard shuttlecock" as a child, it was with some curiosity that I accepted the position as SSMO in badminton at the Commonwealth Games. Along with boxing and weight-lifting, it was based at the Melbourne Exhibition Centre.**

The medical team consisted of volunteers including doctors, physiotherapists and sports trainers as well as a TSP (Team Support Person) who organised the administrative side for the whole team, including rosters, logistics, etc. The TSPs had been full time for about two months by the start of the Games and had been involved in developing much of the administration including logistics and venue set-up.

My experience was similar to that inthe Olympics where there was a lot of "down-time" – ie, time spent not treating athletes or officials -- but this was invaluable in terms of being in a state of readiness, including doing drills, etc as well as ensuring that the members of each shift knew their roles and integrated well with each other.

The medical team's role was varied, such as having at least one person adjacent to the court at all times when games were being played, to deal with injuries on court which had to be "fixed" in a very short time; eg, bleeding which had to be stopped to continue and sprained ankles which had to be taped. It also was our role to "rule out" injured players from competition if they had an injury that was not able to be fixed or was going to affect them in a way that they could not compete the next day. Official notification to referees, etc was part of the job.

Our role also encompassed being the "medical team" to some of the teams which did not have medical cover at the venue, especially some of the smaller teams and some that did not have a significant medical component in their touring party. Quite a lot of taping, massage and physiotherapy was done, as well as providing ice for some of the better-staffed teams. Some taping was also done of shoes and racquets – it never ceases to amaze me, the versatility of medical tapes!

From a medical perspective, quite a number of officials were treated for conditions ranging from hypertension and diabetes through eye problems to URTIs and chest infections.

We also had dealings with some of the Australian physiotherapists who were involved in the TPP (Team Physiotherapy Program), a new initiative in M2006 which seemed to me to work very well and provide us with a great link with these (usually) smaller teams.

From my own perspective, it was a great experience and I enjoyed the "team experience".

The badminton Athlete Medical Facility (AMF) ran from three days before the Games started until the very last day, being open most days from 7.30 am until as late as 10.30 pm, depending on how long some of the games lasted. This did involve quite an amount of administration ensuring that rosters were adequately covered and various other sundry items that seemed to be more difficult because of the secure nature of the venue.

After ensuring that the medical side of things ran smoothly, the next most important consideration was that everyone had an enjoyable time and a very important aspect of this, especially when we were not busy a lot of the time, was to make sure that everyone made a contribution to each session if at all possible.

I was also pleased to have worked at the Polyclinic for a couple of sessions in the week before the badminton venue was operational, and it was invaluable to me to see how the Polyclinic worked and how the "outpost" such as BAD at EXC related to this for follow-up of athletes, as well as more mundane matters such as issuing prescriptions to people who were still at the venue. The array of services available in fantastic quality and availability such as physiotherapy, massage,

podiatry, optometry, etc was just amazing. The radiology services were also of extremely high quality with a "state of the art" musculoskeletal ultrasound, as well as xray and the availability of more extensive services such as CT, MRI and bone scanning at Royal Melbourne Hospital.

One of the experiences I had in the Polyclinic was with an African athlete who I saw with a foot problem. I referred him for an ultrasound and he went from seeing me to have the ultrasound done immediately to seeing the podiatrist an hour later! I was blown away by the service level – I can't imagine what the athlete thought!

The other part of the experience was getting there. Like a lot of Melburnians who live in the suburbs, I rarely ever travel by public transport. Because of the lack of parking and associated security issues, I travelled by train for every session I worked at EXC. I read half a novel on the way in and out over the 14 days of the Games.

Because everyone else was in the same position, the trains were relatively full of spectators, volunteers and the people who usually travel by train. The trains were amazingly punctual, and carried a large number of people who seemed to be a very happy group. There was a real "buzz" around Melbourne, on the trains as well as on the trams. I witnessed almost no anti-social behaviour.

Wearing red sleeves (designating "medical") on my official M2006 shirt did not make me immune from enquiries about trains, venues, etc. I initially felt this was not really my job but realised that I was getting so used to the trains I was actually able to answer most of the questions and authoritatively give directions. I was on a roll. Even the weather turned it on for the Games; Melbourne in March and Autumn usually has very nice weather, but this year was exceptional. It was like a sign that the weather suddenly turned very cold and miserable within a day or two of the Games finishing.

Well done to the Commonwealth Games organisation and well done to the organisers of the Commonwealth Games (M2006) Medical program.

Thanks for the memories!

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# ASADA: the new 'tough-on-drugs' approach

ASADA – the Australian Sports Anti-Doping Authority – came into operation just in time for the Commonwealth Games, replacing the previous Australian Sports Drug Agency.

In the new arrangements, all the functions in combating doping in sport in Australia – testing, investigation, research, education and prosecuting alleged doping offences – will be incorporated into the one government organisation.

Richard Ings, chair of the new body, said at the launch that ASADA "balances a tough-on-drugs approach with upholding and respecting the rights of athletes".

A spokesman for ASADA says that the full consultations with sporting organisations promised by the Government about the detail of the functions and operations of the new organisation are expected to begin shortly.

Judging by the submissions to the Senate committee examining the legislation setting up the new post-ASDA arrangements, a significant area of discussion in these consultations will be the fine detail in the National Anti-Doping Scheme, or NAD.

The NAD scheme basically will implement in Australia the two major international conventions and set out the anti-doping rules that apply to athletes and their handlers and to sporting administration bodies.

The details of the functions of the NAD scheme are prescribed by regulation.

The Department of Communications, Information Technology and the Arts (DCITA) told the Senate Committee which examined the legislation setting up the new anti-doping regime that prescribing the NAD scheme through regulations would "provide flexibility so that changes to the scheme dictated by changes to the international sports anti-doping environment will not require a full legislative amendment process on each occasion".

But this arrangement has led to some concern among sporting organisations.

The Australian Olympic Committee, for example, told the Senate committee that it believed that setting up ASADA was "definitely a step in the right direction and an improvement in Australia's anti-doping stance" but that ASADA's being able to alter the NAD scheme by legislative instrument after it had been established was "problematic".

"…ASADA will have the power and the ability to itself determine its own functions with the only limitation being a legal challenge that its interpretation of these functions is outside the parameters (of the enabling legislation)."

The committee itself regretted that the timetables set by the Government for dealing with the legislation and the regulations "meant that it could not fully consult on the details of the NAD scheme".

DCITA responded by noting that any additional functions conferred on ASADA through the NAD scheme would have to be in accordance with the international conventions.

Furthermore, it said, the legislation set out the requirements for public consultation with which ASADA would have to comply before amending the NAD scheme through regulations.

ASADA would have to publish a draft of any regulations, invite public submissions on the draft and consider these submissions within a specified period which must be at least 28 days from publication and any regulations would undergo Parliamentary scrutiny and possible disallowance by either the House of Representatives or the Senate.

Mr Ings, previously of ASDA, told the committee that ASDA was looking to put in place a new organisational structure to address management issues and to ensure that there would be separations between ASADA's deterrence function, its detention function and its enforcement/prosecution/case-answer presentation function.

"There will be an independent review process with a review board and then of course you add on top of that the automatic protections through the Administrative Appeals Tribunal and the final tribunal, who will make a decision on fault.

Other concerns by the sporting community were raised with the Senate Committee, including:

- the effect of the new regime on sporting organisations which wanted to determine their own arrangements,
- the danger of legal confusion for tribunals in sports which had their own anti-doping policy but also contractual arrangements which tied players to their own rules,
- the impact of public information by ASADA about investigations of alleged violations,
- the possible duplication of hearings into alleged violations by ASADA and individual sporting organizations,

- concerns that that ASADA would not have adequate powers to compel production of evidence in hearings before the Court of Arbitration for Sport (CAS) and other tribunals, and
- possible legal confusion over legal terminology; eg, use of the term 'athlete' (as distinct from the previous 'competitor') who are defined by reference to participation in a 'sporting activity' (as distinct from 'sport').

But arguably the major additional concern was over the combination in the new system of the previous ASDA/ASC functions (such as testing and education) and the new ones (such as investigation and prosecution of alleged doping offences).

The NRL argued, for example, that the new regime "risks some compromise if it takes a 'hands on' approach that makes (ASADA) prosecutor, court and legislator.

"It would also seem a very real risk that ASADA by trying to control all aspects of every sport will lose focus on the primary task of providing reliable information, advice and testing.

"Given the complexities involved in drugs in sports there is already a difficulty in meeting the information demands of sports and athletes and in ensuring sports are consulted in policy development."

DCITA responded to the Senate committee that there would be "an advisory committee (which) would make sure of the probity of the investigation process…and that there was an independent checking mechanism in the process".

# For your library

## The Physiology of Training

G Whyte (Ed)

ISBN 0443101175

*Imprint: Churchill Livingstone*

The Physiology of Training, part of a new Advances in Sport and Exercise series, is a one-stop resource in the physiological aspects of training, aimed not only at those involved in teaching sport and exercise science but also at people in other activities such as coaching. The series is organised under the aegis of the British Association of Sport and Exercise Sciences. Other titles forthcoming in this BASES series are Genetics and Molecular Biology of Muscle Adaptation (Spurway and Wackerhage), Paediatric Exercise Physiology (Ed: Armstrong), Exercise Physiology in Spoecial Populations (Ed: Buckley), Nutrition and Sport and The Endocrine System in Sport and Exercise (both edited by MacLaren) and Environmental Physiology for Sport and Exercise (Ed: Cable).

## Therapeutic Exercise: Treatment Planning for Progression

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## Pharmacology Application in Athletic Training

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ISBN 0803611277

*Imprint: FA Davis*

The objective is to educated certified athletic trainers (ATCs) in the many facets of pharmacology in recovery and healing: how drugs work in the body, indications and adverse effects on participation in sport and rehabilitation, the types of drugs that are typically abused, (American) legal implications, and handling emergencies.

# Notice of Annual General Meeting and Call for Nominations

Notice is hereby given that the Annual General Meeting of Sports Medicine Australia will be held at the Shangri-La Fijian Resort, Yanuka, Fiji, on Saturday 21 October 2006 at 5.00PM.

## Agenda

1 Opening
2. Roll Call, Apologies and Proxies
3 President's Welcome
4. Minutes of the Previous AGM
5. Reports
6. Consideration of financial statements & audit report
7. Board Election (if required)
8. Appointment & remuneration of auditors
9. Special Business
10. Close

## Call for Nominations – Board of Directors

Members are asked to provide nominations for positions on the Board of Directors of Sports Medicine Australia.

National Directors for:

- Queensland
- ACT
- Victoria
- WA
- Tasmania
- NT

I……..of.....

hereby nominate .....

for the position of .....

on the National Board of Directors of Sports Medicine Australia

Proposer's Signature.....Date.....

Seconder (full name).....

Seconder's signature.....Date.....

**Nominations should reach: Sports Medicine Australia, PO Box 237, Dickson ACT 2602 or fax to (02) 6230 5908**

**BY NO LATER THAN 5.00 PM (EST) ON Friday 29 SEPTEMBER 2006**

### Notes to the validity of nominations to the Board of Directors of SMA

**Appointment and Election of National Directors**

a) Each State Branch shall elect a National Director from and by the Federation membership in their state

b) Any nominee for National Director shall not be eligible unless they have served at least two of the last five years on their State Council or Board.