Applying world's best practice athletic strength and conditioning to the RAAF's fighter pilots

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FIGHTER FIT

Elite athletes have long paid particular attention to strength and conditioning to ensure peak physical performance.

The Australian Institute of Sport defines strength and conditioning as "the provision of medical and physical services to develop and maintain speed, agility, endurance, strength, stability, flexibility, injury prevention, and management and rehabilitation for the purposes of enhanced athletic performance during competition."

The rapid adoption of science-based strength and conditioning for elite athletes since the 1960s with the development of individual programs to cater to specific strengths and weaknesses has improved athlete movement and technique, and has improved physical conditioning.

As a result, for non-contact sports in particular, the incidence of career-ending injuries has dropped in recent decades. And even without the insidious use of illegal performance-enhancing doping and improvements in equipment technology, records in almost every sport have continued to fall. Athletes continue to run faster and further for longer, balls are being thrown or hit harder and further, and heavier weights are being lifted.

Not surprisingly then, militaries around the world have started to study and adapt strength and conditioning principles, in particular for special forces soldiers and sailors, air force combat controllers and fast jet aircrew.

The Royal Australian Air Force is an early-adopter in implementing a strength and conditioning regime across its fast jet aircrews, starting in 2016 with a trial at Williamtown-based 76 Squadron where the RAAF's future fighter aircrew undergo the Introductory Fighter Course (IFC). The results have been so encouraging that a strength and conditioning program is now being rolled out across Air Combat Group (ACG).

Culture

Dubbed Fighter Fit, the program has a three-pronged focus – a conditioning phase, a maintenance phase, and if necessary, rehabilitation.

It is not uncommon for RAAF fast-jet aircrew to sustain neck injuries, particularly performing basic fighter manoeuvres (BFM), which can lead to issues with medical approvals, which can see aircrew re-assigned to other aircraft types or retiring from flying altogether.

"It's been a perennial problem for fighter aircrew," noted Wing Commander Carlos Almenara, executive officer of 78 Wing (which oversees 76 and 79SQNs, which operate the Hawk lead-in fighter trainer).

"We've known about it for a long time, and due to the extra weight and displaced centre of gravity of JHMCs and NVGs, it continues."

The JHMCS, or the Joint Helmet Mounted Cueing System, is a miniature projector system mounted

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on the forehead of the RAAF Hornet, Super Hornet and Growler aircrews' Gentex HGU-55B helmet. JHMCS (pronounced 'ja-him-cus') entered service with the RAAF in 2007, and projects flight and sensor data onto the inside of the helmet's visor, which adds additional weight on the front of the helmet.

At 1G the additional forward weight of JHMCS can cause fatigue, when manoeuvring at 7G plus for prolonged periods it places considerable additional strain on a pilot's neck and upper back, particularly in lateral flight regimes. And the additional weight of night vision goggles (NVG) exacerbates the problem further.

However, aircrew neck problems were prevalent well before the current generation of helmets entered service.

"It's been a problem as long as we've had high-G aircraft, and it's just been one of those problems that's been accepted culturally as a part of flying fast jets," said James Wallace, a human performance specialist and head physiotherapist for Fighter Fit with the RAAF's Institute of Aviation Medicine (IAM).

"A pilot sits in a cockpit sustaining 5 or 6G for a lot of the time when they're doing BFM. This peaks out at 7.5G in the Hornet. That means your head and helmet is going to weigh maybe 70 or 80 kilos while you're moving and twisting it around, and trying to keep your eyes on all the other aircraft. It's very demanding.

"And it's not just the neck, because you're also using your torso as well while you're strapped into the ejection seat," Wallace continued.

"Physios will tell you the body is not designed to hold that much weight on your head. It has been a problem and air forces around the world have been investigating what to do about it."

Even without performing BFM, long-endurance missions can cause problems.

"The Operation Okra missions were long, often 10-plus hour missions with NVGs, and that illuminated the incidence of fatigue for longer missions as well," officer commanding 78WG Group Captain Chris Hake said of the recent RAAF Hornet and Super Hornet operational missions over Iraq and Syria.

Even for aircrew who don't experience ongoing neck and back issues, all require some rehabilitation and a few weeks out of the cockpit every year.

"It's like any physical profession," said WGCDR Almenara. "Using professional sport as an example, there is risk of injury and you expect there are times in the season when you're going to be down. Culturally aircrew accept neck and back pain. Aircrew tend to live with it."

While the JHMCS added to the RAAF's Gentex HGU-55B helmets has provided excellent situational awareness, it has also come with a displaced centre of gravity on the helmet which is necessary to counteract with ballast weights. DEFENCE

But rather than just accepting the problems, Air Combat Group decided to start recording injuries and to investigate the cultural aspects of aircrew not reporting problems. This saw ACG in conjunction with the Institute of Aviation Medicine conduct a series of aircrew surveys in 2016, which led to the startling discovery that the RAAF was losing the equivalent of seven man-years of productivity each year across its fast-jet force, primarily due to neck problems. That's a significant number for a small air force.

"On top of that, the majority of us occasionally have some problems that, while we might still be flying, we're performing at sub-optimal levels," said WGCDR Almenara.

"Then there is a small percentage of people who get injured to the point that they may never be able to fly a fast jet again due to neck problems. ACG and Air Force decided this was an unacceptable level of attrition."

While ACG was aware of the problem and had introduced mitigation strategies based on education, self-management and guidance which included limiting the number of sorties a pilot could fly in a week, more needed to be done.

"In my view, the problem with those strategies in the past was that they relied a lot on the individual," WGCDR Almenara said.

"It was a case of, 'here are some tools to use and now go and manage yourself and advise us if you have further problems'. But culturally, aircrew just do not come forward when there's a problem. We just push through it and keep going."

GPCAPT Hake observed that the problem was more than about just economics.

"We don't have to hurt people, and there is a moral dimension to this that we're very aware of," he said. "It's more than the pure economics, however economics is a good driver to get investment. So, ACG has finally seen this as an investment in our people, not a cost, and that's a big move forward."

ACG established a muscular-skeletal injury steering group.

"We looked at the whole range of mitigation options," WGCDR Almenara said. "Initially, we started looking at engineering solutions such as what can we do to modify the cockpit, the helmets, life support equipment and lumbar supports for different postures.

"Some of those were extremely expensive options, including trying

to find lighter weight JHMCS and helmets or modify the cockpit environment. But to be honest, it's questionable how much value we would end up with out of that process.

"A new helmet might be a little bit lighter and have a better centre of gravity, but it wasn't fixing the core of the problem. We've been hurting fighter pilot necks since WW2, so whilst it was important if we've made the problem worse through design, it probably doesn't target the root of the issue and provide best 'bang-for-buck'."

Conditioning

So the steering group decided to focus most of its attention on aircrew strength and conditioning, where conditioning, intervention and injury management strategies could be applied from when aircrew first entered the fast-jet world.

"We have a highly motivated workforce that works long hours and is very focused on their tactical excellence," WGCDR Almenara said.

"Trying to squeeze anything new into their working week is a challenge, so we needed a program that was attractive to them and they could see they were going to get very quick benefits from, but that was also going to be convenient enough to be worked into the battle rhythm without having to impact the operational side of their flying."

The program needed to be credible and convenient to the squadrons, be flexible enough to their workflow, and be tailorable to an individual's needs. To that end, the working relationship between the Fighter Fit managers and squadron executives was vital, and similar to the professional sports model where clinical staff liaise with coaches, a model of risk management was put in place.

"Around that time I contacted one of our lead physios on base," said WGCDR Almenara. "He and some personal training instructors studied other programs and we started to implement conditioning and risk management strategies within 76SQN."

In late 2015, 76SQN put its trainee aircrew onto a conditioning program in the lead-up to the high-G part of the IFC, and from that it was able to determine the metrics to start measuring aircrew physical conditions and apply risk categories to individuals.

"Depending on the risk category, we started monitoring them during the high-G part of the course and looking for any early signs of injury that we could start to manage before it became a problem," WGCDR Almenara said.

"That was successful, and since we've done that I haven't seen a trainee suspended here for any physical-related problems."

Such has been the success of the program at 76SQN, WGCDR Almenara says the RAAF has rolled it back to the 79SQN Hawk conversion and 2FTS 'Wings' courses at RAAF Pearce, and to the Central Flying School (CFS) at RAAF East Sale.

"We're going to be conditioning candidates all the way through the training system, so they learn to understand and manage themselves, and recognise any signs of potential problems."

'We're going to be conditioning candidates all the way through.'

WGCDR CARLOS ALMENARA

Maintenance

Once aircrew get to the high-G part of the IFC, the program switches from a conditioning to a maintenance phase where there is a system of monitoring the aircrew so they maintain the standards achieved in the conditioning phase.

Williamtown Fighter Fit sports physiotherapist Toby Watson said the system functions through an app on their smartphone.

"The app was developed for us," he said. "It looks at specifics such as pain and well-being, but it's not designed to ground aircrew. It's designed to identify potential problem areas early, so we'll say, 'Come and see us and do something about it', rather than letting it turn into something bigger.

"The goal is to identify problems early rather than waiting for aircrew to get to a point where they need physio or other healthcare," Watson said.

"So, in being proactive we're looking at things like general pain, sleep, fatigue and soreness, because those things are likely indicators that their bodies might not be responding as well as they could be."

Toby Watson comes from an AFL, track and field and cycling background in physiotherapy, so he has worked with athletes who have competed in speed, strength, impact and endurance sports. As with these previous roles, his job is to identify what activities his

The rehabilitation machines installed at Williamtown allow pilots to focus on specific muscle areas for rehab and strengthening work.
ANDREW MCLAUGHLIN

patients are participating in and what injuries are they most at risk from, what they are currently strong enough to handle, and what work needs to be done to gain strength where they need it.

"So, we get a baseline screen to see where they're at, where we think they need to be, and where they're going to learn as we go," he said.

"We're on the leading edge of this so there isn't a great body of evidence for us to work with, but we're building that for ourselves. There is evidence in professional sport, however, and it's just like building someone up for game day.

"And then on 'game day' we talk about what is an appropriate warm-up, how does it fit in the rhythm of their day with their brief, life support, walk to the jet and everything else. How can we make that fit?"

Watson draws a comparison between grand tour cycling teams and an air combat squadron, where the emphasis is on the recovery over a long period. "Post flight, what's the cool-down look like where they have to go to debrief. We know they'll lose a couple of litres of fluid in an hour, so we've got to make sure that if they're going to 'double-pump' on the day that they're not going to get dehydrated, because you can't perform as well if you don't hydrate properly."

But Watson added that there are elements to consider from the other sports he's worked in as well.

"Track and field is all about being really specific in what you prepare for, cycling is all about recovery and how well can you get yourself ready to go again, and AFL is all about being belted like the guys do in high-G BFM, so there's a bit of each of them."

Wallace and Watson now work full-time on the Fighter Fit program for Air Combat Group.

"Part of the program was defining the resources that we need. We drew James from within Joint Health. He was our neck specialist here at Williamtown, and now he's under contract to oversee the program across Air Force and the ADF," said WGCDR Almenara.

"Together with RAAF Institute of Aviation Medicine, he's also conducting a research program. We're now able to collect more data than before, and we'll be able to compare that data as the program progresses and see how the results of the program are going. This will help us to continue improving our program to reduce injury and manage risks for our aircrew.

RAAF Air Mobility Group Loadmasters have to deal with lifting and twisting injuries, and so they will soon be introduced to the Fighter Fit program. DEFENCE

"Toby is one of our on-site clinical physios. We specifically looked for people with sports physio backgrounds to get this program off the ground. We also have an exercise physiologist here who does all the functional movement work, injury management, and injury prevention that exercise physiologists manage. He also runs our spinal conditioning equipment."

Rehab

If any rehabilitation is required, ACG aircrew now have better access to treatment. Staff can access rehabilitation within their units and, most importantly, they have already developed a relationship with the ACG physiotherapists through the conditioning and maintenance work already undertaken.

The rehab program includes a range of high-end equipment that allows the physios to measure the level of injury and to target specific areas for rehab and strengthening work.

"Early research led us to machines similar to weight machines, but they're fully electronic and they're networked," WGCDR Almenara explained.

"They test a pilot's range of movement, strength and endurance at very specific parts of the neck and back. They also isolate an individual's movements to specific joint areas moving on the machine. This is beneficial because the human body will recruit other muscles to help with that movement.

"We can get instant metrics, and can measure strength, range and endurance so we then tailor a conditioning program from that data."

Machine trials with lead aircrew in 2017 found promising trends of improvements in strength in the targeted muscle areas after 12 weeks – split into two six-week blocks. Those promising trends from that initial small sample size have continued as the program has been rolled out across ACG.

"What we found was, in most areas we were above average in strength from the start," WGCDR Almenara said. "However, in neck rotation we were significantly weaker than

For all RAAF fast-jet trainee aircrew, Fighter Fit is now a part of their normal daily work routine. The Fighter Fit program managers are confident that using the program in all fighter squadrons will become part of the cultural norm within three to four years. DEFENCE

the average population. This was surprising since we assumed aircrew had strong necks because we're putting them under load every day.

"The hypothesis here is that the soft tissue injuries we induce under G cause the body to protect and shut down those neck muscles, and then our bodies recruit other muscles in the back and shoulders to do the work. This causes other referred pain in the upper back. This has been one of the most interesting areas of the program considering how long we've known about aircrew having neck injuries."

WGCDR Almenara said this is probably the first time the RAAF has started to look more closely at these rotation aspects and what's going on with the associated muscles.

"As someone who has had neck pain for a number of years, all of this makes a lot of sense to me," he said. "So, regardless of how accurate this data is in terms of the population reference, the fact that we are seeing these trends and the referred pain, it all points to conditioning these rotation muscles is really important to protect our necks and backs. It's only a small sample size at the moment, but we have seen significant improvement in these symptoms so far with this conditioning."

But apart from the challenge of how to implement Fighter Fit, there was still the issue of overcoming the fighter pilot's natural tendency to live with pain, and the difficulty of finding the necessary time in their busy schedules.

"We do need compliance otherwise we don't mitigate anything," said WGCDR Almenara. "It is now part of our duty of care, so it's compulsory while aircrew are in training. We are conditioning their necks and backs to cope with their job requirements. It is part of ACG's duty of care to make sure we don't injure aircrew while they are doing their jobs as much as reasonably practical.

"For the rest of the aircrew, these tools are available for squadron executives to manage their risk on behalf of the Commander of ACG. We fit it into their flying program as flexibly as possible."

The program won't be compulsory for qualified aircrew, however compliance will be monitored and if squadron executives aren't meeting recommended levels of compliance and fitness results, they'll have to explain why. Indeed, rather than make it a burden, the program's architects aim to appeal to and count on the natural competitive nature of the aircrew to ensure their units are compliant.

A fighter pilot's head and helmet will weigh up to 70 or 80kg while manoeuvring. MARK JESSOP

"We are relying on our very competitive fighter pilot community," WGCDR Almenara said. "There is also an element of generational change as well. For all of the trainee aircrew, this is now a part of their normal daily work routine. Within three or four years' time they'll make up 80 per cent of the squadrons, and it will then be the cultural norm."

Rollout

While Fighter Fit is currently being funded through ACG, its early success has led to considerable interest in adopting this model not only across other elements of ACG and Air Force, but also in other branches of the ADF.

Other areas in Air Force to consider the benefits of the program include the combat controllers from 4SQN, the loadmaster community within Air Mobility Group (AMG), and the air movements community within the RAAF's Combat Support Group.

Loadmasters are tasked with lifting heavy weights, tying down loads, and moving about confined spaces in a transport aircraft cargo hold, often during turbulent low-level flight.

"Their injuries are different to fast jet aircrew, so Air Command and AMG are looking at possibly tailoring this program for loadmasters as well," GPCAPT Hake said.

"Loadmasters get a lot of 'black and blue' due to the unsteady platform and the lifting and twisting and movement. Air Force is currently developing studies to try to identify their problems and their risk, and to implement some mitigation strategies."

'We are relying on our very competitive fighter pilot community'

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The Williamtown program has now been rolled out at RAAF Amberley, and similar programs are being implemented at Tindal and Pearce. The Williamtown facility is located in the 76SQN headquarters in space formerly occupied by the old Hawk simulators. This is a central location on base, so it is planned for it to remain there due to its proximity to the new F-35 squadron headquarters buildings being constructed across the road.

"The impact of driving around the base for 10 minutes to the gym and having to get changed for the drive over there, is enough for it just to be too much of an impact on the routine," WGCDR Almenara said.

"So, with the amount that the squadrons have going on at the moment, I'm trying to make it as convenient as possible. The facilities at the other bases are being positioned with similar considerations in mind."

The early results have been so encouraging that, with word spreading though the fighter pilot network, some allied air forces have expressed an interest in conducting their own program.

"The Canadians have contacted me because they have defined their problem and they are very keen to understand our program and see what they can take away," WGCDR Almenara said. "We have also had some interest from the US Navy. And the RAF is keen to see what we were doing after we went and looked at their program last year."

It's fair to say that the implementation and running of Fighter Fit costs real money, but the capability addition by ensuring more fighter aircrew are available to fly and potential savings the program can make in terms of preventing injuries or even early retirements cannot be understated.

"At the end of the day, I don't think the expense is that great compared to what it costs to train our people to fly our aircraft," WGCDR Almenara said in closing. "It's actually a fairly moderate expense, especially compared to all of the other engineering options we could have investigated. It's a drop in the ocean by comparison and it's going to have a much greater effect."