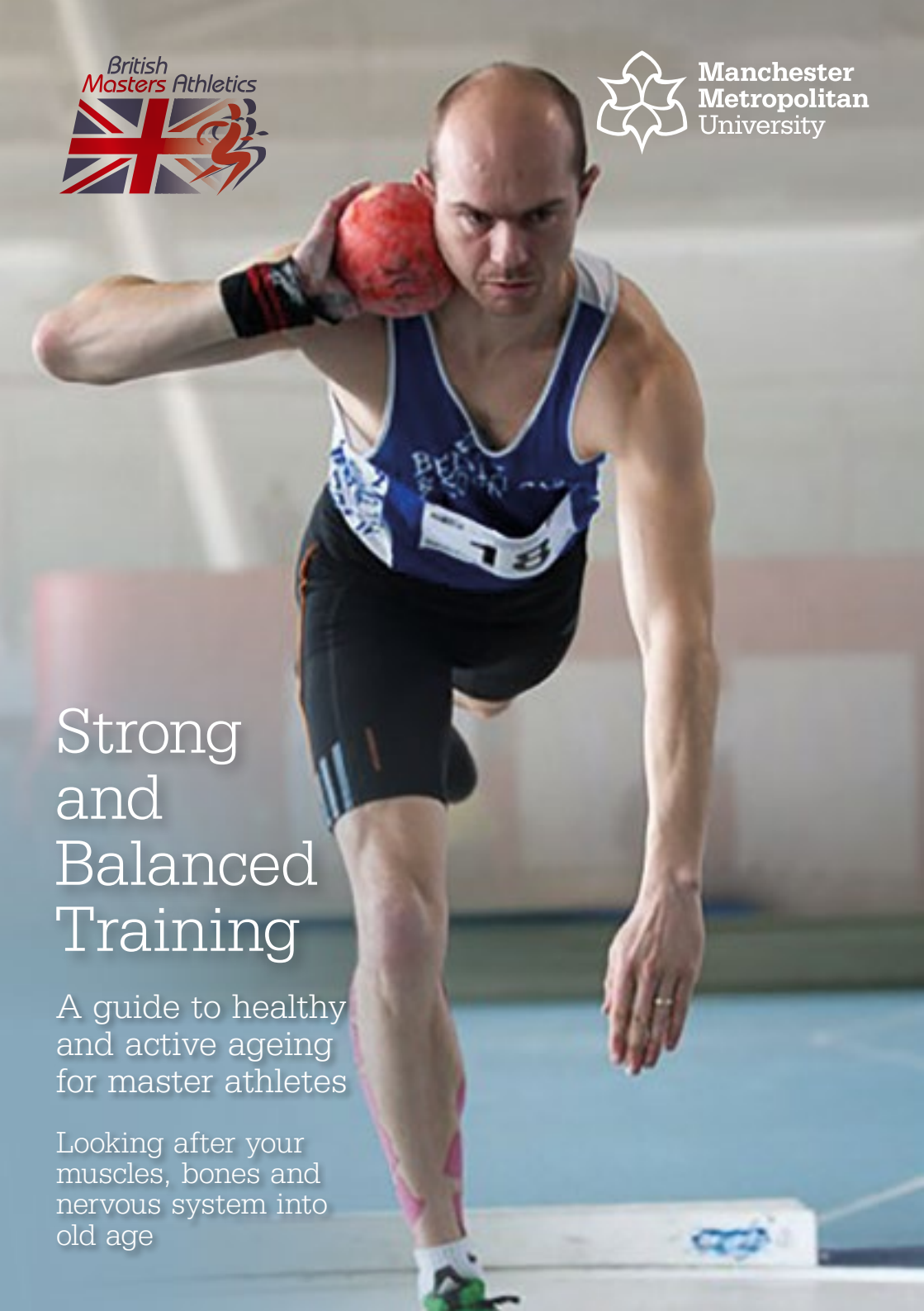
British Masters Athletics

Manchester Metropolitan University



Strong and Balanced Training

A guide to healthy and active ageing for master athletes

Looking after your muscles, bones and nervous system into old age

Welcome to Strong and Balanced Training for Master Athletes

When people become older they usually reduce their activity levels, which has a detrimental impact on health and wellbeing. We all know that regular exercise helps people. But, just how active and athletic can people be in older age?

What can we do to maintain our athletic performance through our later years?

This is the main thrust of our research and master athletes are prime examples of people who stay active. We are delighted to share the results of our research which was funded by the European Union and the UK Medical Research Council in partnership with the British Masters Athletics Federation. For us, the journey of discovery has been fascinating and made us more conscious of our own fitness and health. We have prepared this publication to pass on information and tips to encourage you to continue in master athletics, no matter your standing in track and field athletics, and inspire you to make positive, informed choices about your lifestyle.

We would also love to hear from you with any comments or feedback you have. You can find our contact details at the back of this brochure.

Professor Jamie McPhee

Professor Hans Degens

Faculty of Science and Engineering, Manchester Metropolitan University

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In brief

Executive Summary:

21st century athletes: age is no barrier to success!

By 2025 almost a quarter of the UK's population will be older than 60 years. The media paints a gloomy picture of ageing, where people live longer but with serious health conditions that strain our health and social care services. We are convinced that regular physical activity can avert many of these problems. In fact, master athletes dedicate much of their time to regular exercise and their efforts are rewarded with exceptionally good health and physical fitness.

Given these health and fitness benefits in master athletes, there is no doubt that everybody should exercise regularly to improve muscle strength, balance and overall physical fitness. The good news is that one is never too old to begin, even if you have never run, jumped or played a sport before. It does, of course, require commitment to incorporate

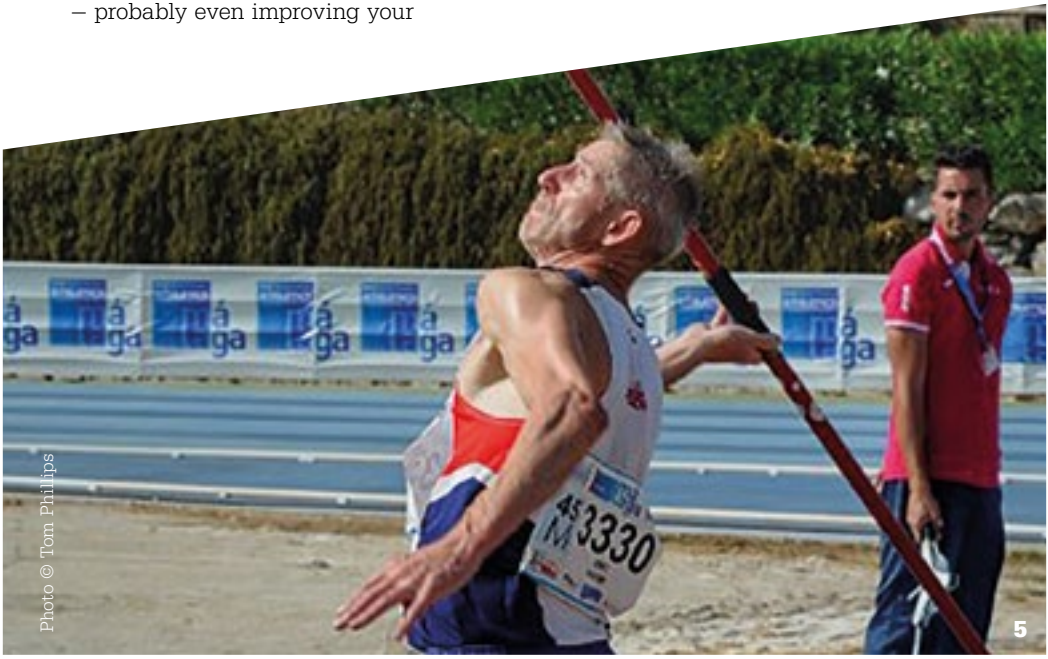
exercise and adequate nutrition in your life. BMAF offers support and clubs for older athletes, while local leisure facilities offer a wide range of activities specifically designed for people with health issues, so there is something on offer for everyone! This may help you encourage your friends to also pick up exercise; it is never too late!

While exercise is good for health, specialisation in master athletics may come at the expense of underdevelopment of some organ systems. For example, master endurance runners are rewarded by a very lean physique (low body fat) and cardiovascular health, but they often have low muscle and bone strength, and balance. Throwers, meanwhile, are typically strong with good bone health, but leanness and the cardiovascular system are more of a problem.

A few simple tweaks to your training programme could help to build your strength and improve your balance – probably even improving your performance and reduce the risk of falls and fractures. A simple tip is to include hops, strengthening and balancing exercises in your warm-up and cool-down to enhance your muscle and bone strength, and balance.

We hope that the tips in this brochure are helpful and inspire you to make some changes in your training that supports your performance.

And above all, enjoy!



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SECTION TWO:

In action

Active and Healthy Ageing

Our research showed that even master athletes who exercise every day may need to adjust their training programmes to help prevent deterioration in balance, muscle mass, bone strength and/or cardiovascular function.

Benefits of regular exercise

Regular physical activity – whether a leisure activity or serious competition training – can delay the progression of over 30 common diseases and in some cases reverse symptoms where they already exist. In this respect, exercise can be viewed as a highly potent medicine. Some of the benefits that master athletes already have, depending on whether you are a thrower or an endurance runner, include:

- Reduced waist circumference by lowering body fat stores
- Reduced blood pressure
- Stronger heart
- Improved circulation of blood around the body
- Reduced circulating fats and cholesterol
- Lowered blood sugars, reducing the risk of type 2 diabetes and cardiovascular disease
- Improved muscle size and strength
- Stronger bones
- Reduced risk of falls
- Improved immune system
- Improved overall mental health and wellbeing

What are we doing to address physical inactivity in the general population?

Around two out of every three older adults do not meet the recommended physical activity levels. The sedentary lifestyle deconditions the body. The consequence is that inactive people of 65 years and older can expect to live about half of their remaining years with a disability.

Our research group is part of the Greater Manchester Coalition for Active and Healthy Ageing that is supported by the European Innovation Partnership. We work alongside the NHS and local authorities in this network to develop ways to bridge the gap between the overwhelming evidence that regular physical activity is highly beneficial during ageing – and the fact that so few older people actually engage in regular exercise.

We aim to develop effective and efficient physical activity programmes that can be implemented on a large scale across communities.

Importantly, the programmes are designed around what older people actually want to do to maximise participation and enjoyment.

Is it too late for me if I didn't exercise when I was younger?

There are many examples of people taking up exercise in middle or older age and finding that they really enjoy it and have a hidden talent. In fact, if someone takes up regular intense exercise in their 50s, it would be entirely possible for them to win races against others who trained all of their lives.

We looked in more detail at the athletes and made some remarkable observations. We separated out the runners who had trained all of their adult lives – an average of 50 years of training – from those who took up training in middle age or older.

The late starters on average took up regular training at the age of 52, but some were already retired and in their 60s before deciding to train and compete in running.

Both groups had an average age of around 70 years when we tested them.

There was in fact very little difference in body fatness, bone density and muscle mass between those who had trained all of their lives and those who took up training at an older age.

So our view is this: don't worry if you have not trained or competed in sports all of your life: it is not too late to start and it is possible to gain many of the benefits enjoyed by those who trained all of their lives.

To further enhance the benefits you already have, we give some simple tips.

TIP 1:

Be active, even outside of your training hours

Studies have shown that people who train often reduce their physical activity levels outside their training hours. This inactivity can reverse some of the benefits of training. Don't sit for prolonged periods, and stay active outside your training hours with activities such as shopping, housework, visiting parks, museums, concerts and other recreational pursuits.

TIP 2:

All types of activity are beneficial, so stick with what you enjoy, but making some small tweaks can return some large benefits

People are often confused about what activities they should do to stay fit and healthy in older age.

The simple answer is that you should do whatever you find enjoyable.

Our experience is that most people prefer to perform activities that can be continued for 30 minutes or more at a time, such as walking, gardening, cycling and dancing. They are great for controlling weight and improving metabolism, but they don't necessarily increase muscle and bone strength. Unless it specifically includes balance training it does not improve balance either. We therefore recommend that everyone should also do some muscle strengthening activities and balance training.

Defining levels of activity

- **Light activity:** light housework, a short stroll, chair-based exercise classes. These activities get the blood flowing around the limbs and when performed with friends they are great for socializing.
- **Moderate activity:** gardening, housework, dancing, table tennis, bowling, golf, walking, cycling, playing with children, walking around a museum or gallery. Moderate activity raises the heart rate and can improve metabolism and control body weight.
- **Intense activity**: heavy housework or heavy gardening, sports such as competitive tennis, athletics and gym. These activities usually increase muscular and heart strength, endurance and bone health for experienced exercisers.

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TIP 3:

Age is no barrier to success; tell your friends!

Training and performance – who would win?

The table below shows how fast the quickest 70- to 80-year-old master athletes can run.

	Time	
Distance	**Men**	**Women**
5,000m	20 minutes	24 minutes
10,000m	40 minutes	50 minutes
Marathon	3 hours	3 hours 50 minutes

To put this into perspective, most young adults are unable to run 10,000m or even 5,000m without stopping and having to walk!

TIP 4:

Small muscles: a big problem. What can I do to increase my strength?

To increase muscle size and strength, and reverse some of the effects of ageing, it is advisable to include some regular resistance exercise into your weekly routines. This could include working on weights machines in a gym, using elastic resistance bands, or any other exercise that requires strong muscle contractions.

TIP 5:

A bone of contention: how can I keep strong bones?

To maintain good bone health we need to introduce regularly high forces on the bone, or 'impacts', such as the foot striking the ground when sprinting, or the arm smashing the ball with a racquet in tennis. For example, we were astonished to find that the racquet arm had around 40% higher bone density than the non-dominant arm of the same tennis player! As good bone health reduces the risk of fractures, we recommend that master athletes, and in particular those competing in endurance events, include some regular high-impact activity, such as hopping (bouncing on one leg) for a minute or two each day, to increase bone strength of the legs, hips and spine.

TIP 6:

Diet! You are what you eat?

Muscles need proteins to grow and our research shows that older people need more proteins in their diet than young. So consuming a little more protein can help older muscles to grow and recover quickly after a tough training session. This is particularly effective when protein is consumed after an exercise session.

TOP TIP

Losing your nerve: a balancing act. What can I do to improve my balance?

Currently, we cannot do much to prevent loss of nerves in our legs during ageing, but we certainly can help to maintain nerve-muscle connections. The key is to remain physically active and it doesn't seem to matter if the activities are endurance or sprint/power or resistance based. We can also learn to better control the nerves that remain by practising new balance and coordination exercises, with excellent examples being Tai Chi and dancing. A simple challenge is to practice tying your shoelace while standing on one leg, if you can. Whatever you decide to do, we recommend to include balance training into your warm-up and cool-down programme.

SECTION THREE:

In depth

After reading the previous pages, you may have become interested to read in more detail what our research has found. In the next sections we describe what happens to physical function, muscles, bones and nerves as we age.

General daily activities

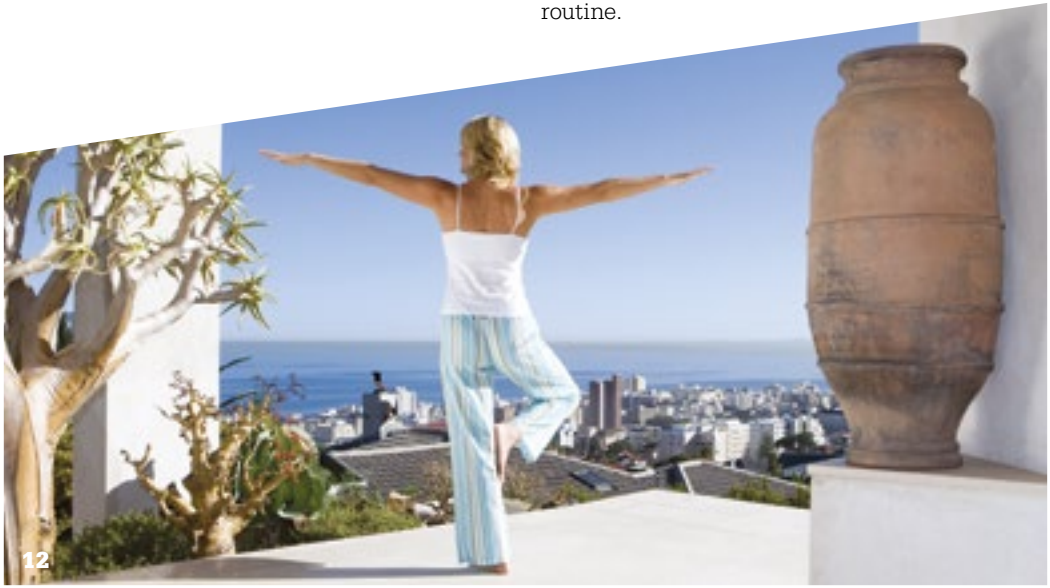
We determined the ability of people to complete physical tasks such as walking, standing up/sitting down and balancing. These activities were selected because they are important when shopping, working, visiting friends and family or taking part in leisure activities.

We found that 70-year-old people walked about 25% slower and also needed more time to rise from a chair and sit down again than 25-year-old people. Most striking, however, was the decline of balance amongst older people. For example, most young adults can stand on one leg with their eyes closed for 27 seconds, but people aged over 70 can manage this on average for only five seconds.

This is a serious problem because poor balance increases the risk of falls and fractures.

So, how do master athletes compare?

The physical performance of master athletes was similar to that of much younger people. They walked slightly faster than others of the same age and found it much easier to move from sitting to standing. Surprising to us was, however, that master athletes had difficulties to balance. With eyes closed they managed to stand on one leg for just eight seconds (compared to 27 seconds in young people). This tells us that regular running exercise does not stop the decline in balance that occurs during ageing. It is thus important to include balance training in the daily routine.



Comparison of typical movements

	Healthy Young	Healthy Old	Master Athlete	Unfit/Frail /Old
Walking speed Speed when walking at usual pace. A higher number indicates a better performance.	 1.9 m/s	 1.4 m/s	 1.5 m/s	 0.8 m/s
Timed Up and Go Time taken to stand up, walk around a cone 3m away and return to original seated position. A lower number indicates a better performance.	 4.6 sec	 6.1 sec	 5.2 sec	 Over 10 sec
Sit to stand transitions Time taken to stand up and sit down five times, as quickly as possible. A lower number indicates a better performance.	 4 sec	 9 sec	 6 sec	 Over 20 sec
Balancing Time able to balance on one leg with eyes closed. A higher number indicates a better performance.	 27 sec	 5 sec	 8 sec	 Unable
Completing heavy housework Perceived difficulties when completing housework, such as cleaning floors, taking out waste etc.	 No difficulties	 Moderate difficulties	 Few difficulties	 Severe difficulties
Feeling tired or fatigued Feeling tired, exhausted or low energy levels	 None	 Occasional	 None	 Often

KEY REFERENCES:

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Leightley et al. Journal of Aging and Physical Activity. 2017. 25:345–350

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Muscles in action

The muscles that control our voluntary movements are known as skeletal muscles. They also play a major role in metabolism by storing fat and sugars derived from the blood. Low muscle mass in old age is a recognised medical condition called sarcopenia and is associated with weakness. This weakness increases the effort to complete everyday physical tasks.

Our research shows that the decrease in leg muscle mass starts at the age of 40 years and progresses so that an average 80 year old has about 40% smaller muscles.

So, how do master athletes compare?

Endurance athletes usually have a similar muscle size and strength as non-athletic people of the same age, but muscle health in terms of metabolism is better. On the other hand, muscle size and strength of master sprinters and older people involved in regular strength training are very good for their age and can be similar to those in much younger non-athletic people. This illustrates that the type of exercise affects the way the body adapts, even in older age.

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Maden-Wilkinson et al. Age. 2014. 36:383–393

Piasecki et al. Biogerontology. 2016. 17:485–496

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Bones

As we get older the bone density gradually declines, leading to a medical condition called osteoporosis (commonly known as thin or brittle bones). Our research shows that it affects about 30% of older women and 10% of older men. This is alarming, because osteoporotic bones are about five times more likely to fracture. Indeed, osteoporosis underlies around three million fractures every year in Europe with associated healthcare and social costs of about €30 billion per year.

Photo © Alex Rotas

So, how do master athletes compare?

The lower limb bones are exposed to forces up to four times body mass during walking, and even more during jumping, as they absorb impacts and effects of gravity. These forces squeeze, bend and twist our bones. The tibia (shin bone), for example, becomes about a millimetre shorter when the heel strikes the ground during running. These stresses and strains on the bone stimulate bone growth and regular exercise is for these reasons an excellent means to delay, or even reverse, osteoporosis. Perhaps most important is the magnitude of the stresses and strains on the bone, and not so much the frequency, as bone strength of master endurance runners is similar to non-athletic people of the same age, while that of master sprinters or power athletes is much greater than those of the endurance runners.

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Hannam et al. Osteoporosis International. 2017. 28:1001–1011

Ireland et al. Journal of Musculoskeletal and Neuronal Interactions. 2011. 11:298–305

Ireland et al. Medicine & Science in Sports & Exercise. 2013. 45:1749–1758

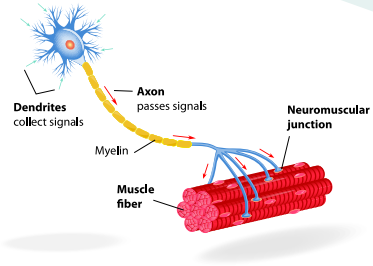
Piasecki et al. Archives of Osteoporosis. 2018. 13:72

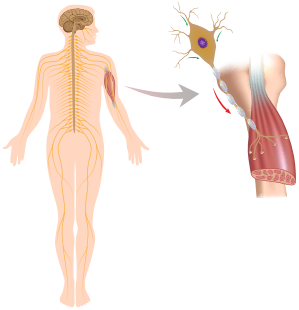
Nerves

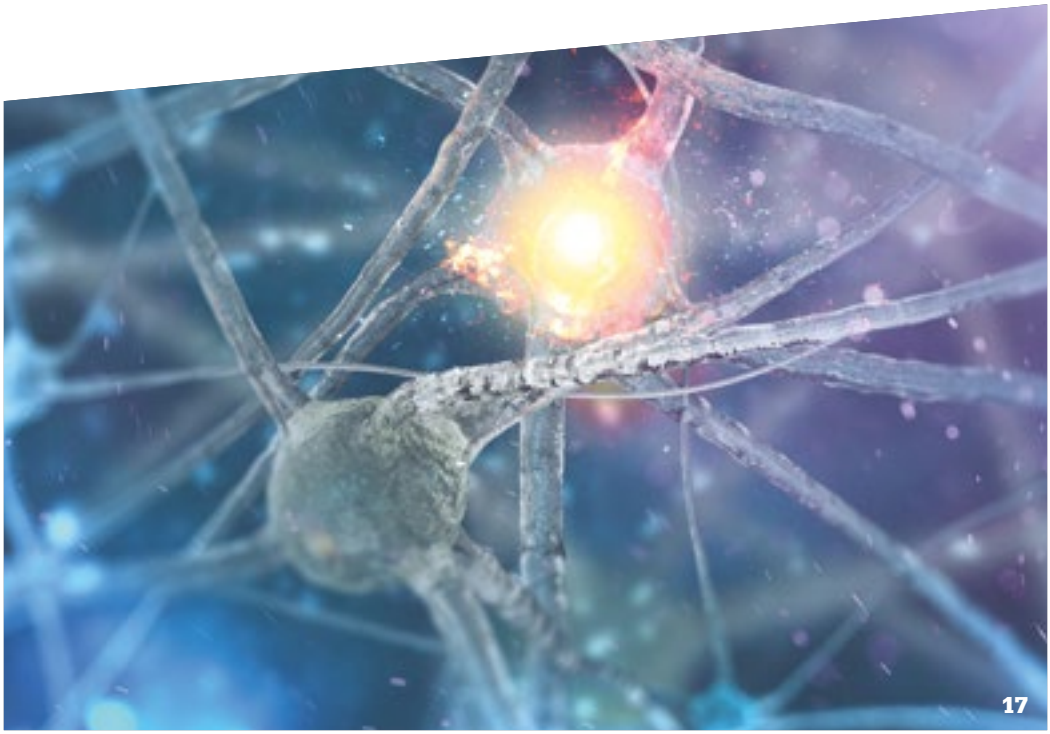
About 70,000 specialised nerve cells, known as motor neurons, in the lower parts of the spinal cord (lumbar and sacral parts) connect with leg muscles to control movement. If the connection between a muscle and its innervating nerves is broken, the muscle will waste away.

In our research, we found that about 40% of the motor neurons to leg muscles were already gone by the age of 75 years.

This is similar to the loss of muscle strength in the same time, and is associated with poorer coordination of movements. It thus appears that the loss of motor neurons is a part of ageing (like developing wrinkles or grey hair) and is the main cause of small and weak muscles in old age.







So, how do master athletes compare?

It is appealing to think that regular exercise and training might prevent the death of motor neurons during ageing. Unfortunately, we found no evidence to support this idea. All older athletes (endurance and sprinters alike) showed signs of a similar degree of motor neuron loss. On a positive note, however, the master athletes appeared better able to "rescue" muscles that had lost their nerve connection. This rescue is realised by the sprouting of nearby, healthy nerves, that can establish a new connection between the muscle and nerve. This process helps to preserve muscle mass and it is important that we learn more because the loss of motor neurons is irreversible. If we want to keep muscles strong in old age, we need to find ways to prevent the loss of nerves and/or stimulate sprouting.

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Piasecki et al. Journal of Physiology. 2016. 594:4525–4536

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Photo © Alex Rotas

SECTION FOUR:

BMAF perspective

The British Masters Athletic Federation (BMAF) has been very pleased to have worked with Manchester Metropolitan University (Manchester Met) since 2015 on their research projects. Many BMAF athletes have participated in the different stages of this work. They have enjoyed taking part and benefitted by gaining more information about themselves on various aspects of their health.

Manchester Met through their BMAF participation in its research has discovered more knowledge about different aspects of the health of older athletes, particularly by testing muscle and bone health and balancing ability, and using an accelerometer by testing athletes' overall activity levels over a 24 hour period.

The BMAF was very pleased to learn that Manchester Met is interested in promoting a closer and long term relationship between the two of us. We strongly support this initiative and look forward to many years of cooperation by being involved in future Manchester Met projects.

The research team

Professor Jamie McPhee

Jamie is Professor of Musculoskeletal Physiology at Manchester Metropolitan University. In his early career he received three prestigious Young Investigator research prizes and has since published 70 original science and medical research papers.

Jamie is Head of the Department of Sport and Exercise Sciences and Director of the University Alliance Doctoral Training for Applied Biosciences for Health, working across fourteen UK universities. He is an expert advisor to several public health groups on falls prevention, physical activity and ageing; a member of the Physiological Society and the Scientific Reviewer Panel for the European College of Sport Science.

Professor Hans Degens

Hans is Professor of Muscle Physiology at Manchester Metropolitan University. He has received awards, and a Honorary Doctorate from the Lithuanian Sports University. His work on muscle ageing spans three decades and he has worked in the USA, Sweden, Germany and Lithuania and published more than 140 peer reviewed papers on Medical and Biological Sciences.

He is visiting Professor of the Lithuanian Sports University and was local coordinator of the prestigious EU funded MOVE AGE programme that funded 39 PhD students to study mobility and ageing.

Professor Jamie McPhee

Professor Hans Degens

The research landscape

Research into musculoskeletal sciences and physical activity at Manchester Metropolitan University has a history of excellence stretching back over more than 20 years.

Much of our research into musculoskeletal science and exercise was rated as *world leading* in the most recent government evaluation of research quality in UK universities. We manage numerous large-scale collaborative projects, that are funded by UK Research Councils, medical charities, industry and the European Union. We were partners in the EU-funded Doctoral Training programme, MOVE-AGE, with universities in The Netherlands and Belgium.

Our facilities to study structure and function of the neuromuscular, skeletal and cardiovascular systems include techniques for in vivo human studies and cell and molecular investigations, and include:

- *Body imaging:* magnetic resonance imaging (MRI); dual X-ray absorptiometry (DXA); peripheral quantitative computer tomography (PQCT); ultrasound
- *Biomechanics:* state of the art motion capture system and instrumented laboratory
- *Physiological testing:* intramuscular and surface electromyography for studies of motor unit structure and function; dynamometry for strength, power, fatigue and movement control; VO2max and metabolism; and numerous other techniques
- *Cell culture, histology and biochemistry:* human muscle cell culture; muscle/nerve/immune/bone interactions; capillary and mitochondrial characteristics; single muscle fibre testing
- *Computer sciences and engineering:* Close collaborations with computer scientists and engineers enable technological developments

Our funder

The Medical Research Council

At the heart of the Medical Research Council's mission is the aim to improve human health through world-class medical research. To achieve this, the MRC supports research across the biomedical spectrum, from fundamental lab-based science to clinical trials, in all major disease areas. It works closely with the NHS and the UK Department of Health to deliver its mission, Lifelong Health and Wellbeing initiative and gives a high priority to research that is likely to make a difference to clinical practice and the health of the population.

We are very grateful to the UK Medical Research Council for funding through the Life Long Health and Wellbeing initiative (2013-2017).

Much of the information presented in this brochure was derived from the scientific research conducted within this grant (grant number MR/K025252/1) and related work from other recent projects.

Acknowledgements

We would like to say a big thank you to everyone who participated in the studies that make up this research.

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The report can be viewed online at **www.mmu.ac.uk/musclescience** and further print copies can be obtained from **sciengresearchsupport@mmu.ac.uk** or **+44 (0)161 247 2800.**

Contacts

General enquiries

Science or medical enquiries, or to register your interest in conducting new research either as a volunteer or collaborating partner, contact

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Acknowledgements:

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Dr Bergita Ganse: Aachen University Clinic, Germany

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