Understanding sex-specific differences in functional decline

Dr Jennifer Jakobi heads a team investigating the way in which sex contributes to differential functional decline in men and women as they age. She highlights the problems being addressed by this research and the widespread benefits her findings will afford the population

What inspired you to focus your research on functional decline?

It stemmed from a fascination of observing variability in older people. I was captivated by the difference between fit, older adults undertaking sport and those that find crossing the road to be challenging. The inconsistency in movement outcome created an interest in exercise neuroscience and understanding how physiology changes with age. However, the desire to study and reduce functional decline in older adults came from listening and talking with participants in my lab-based studies; I couldn't ignore the questions and concerns they had with regard to becoming dependent on others. My laboratory research was informing the scientific community about underlying sex-specific changes in physiology and the older adult participants identified the need and desire to take this information into the community to better their lives.

Thus, it's not so much that my research focuses on functional decline; rather it uncovers the physiological changes that precede functional decline in order to design prehabilitation programmes that prevent the loss of independence. I concentrate on how the neuromuscular system of men and women undergo unique, sex-specific rates of age-related decline, and apply these physiological determinations to interventions that enhance functional movement.

To what extent is the inability to live independently a problem in Canada?

The best way to answer this is with statistics. I don't collect these data, but the information is shocking and demonstrates the need to change the ability of older adults to age well. By 2036, 25 per cent of the Canadian population will be aged 65 years and over. Of Canada's growing older adult population of 65+ years, 46 per cent are already experiencing functional decline and – according to the Canadian Institute of Health Information – 24 per cent have already become physically dependent and frail.

In 2014, approximately 20,000 people were on the waiting list for a nursing home in Ontario and the 'baby boom' climax hasn't yet hit. While this needs to be addressed, for me, the greater question is not how to create more space, but is rather how to change the need for those spaces. In Canada, remaining at home conferred a saving of 40-75 per cent, relative to a residential care facility. We therefore need to keep older adults independent to reduce the personal, family and economic challenges associated with functional decline.

Can you explain what is meant when you describe someone as frail?

Defining frailty is not a simple task. It has recently become operationalised as a risk index by counting the number of deficits over time that are predictive of adverse health outcomes. This can range from increased medication use to falls and fractures. This geriatric syndrome progresses along a continuum of decline and, in its early stages, is difficult to measure, whereas in its later stages it is easily recognised. Older adults who can be considered frail have an increased risk of falls, disability and hospitalisation. Irrespective of whether you are male or female, one of the key aspects to understand about frailty and functional decline is that it is not an inevitable consequence of ageing.

How does tendon stiffness affect force control in older people?

Successfully executing functional tasks requires appropriate force development from the muscle, as well as transmission of this force through the tendon to the skeleton. Thus, the muscle provides strength and power to the movement, while the tendon contributes to control and stability.

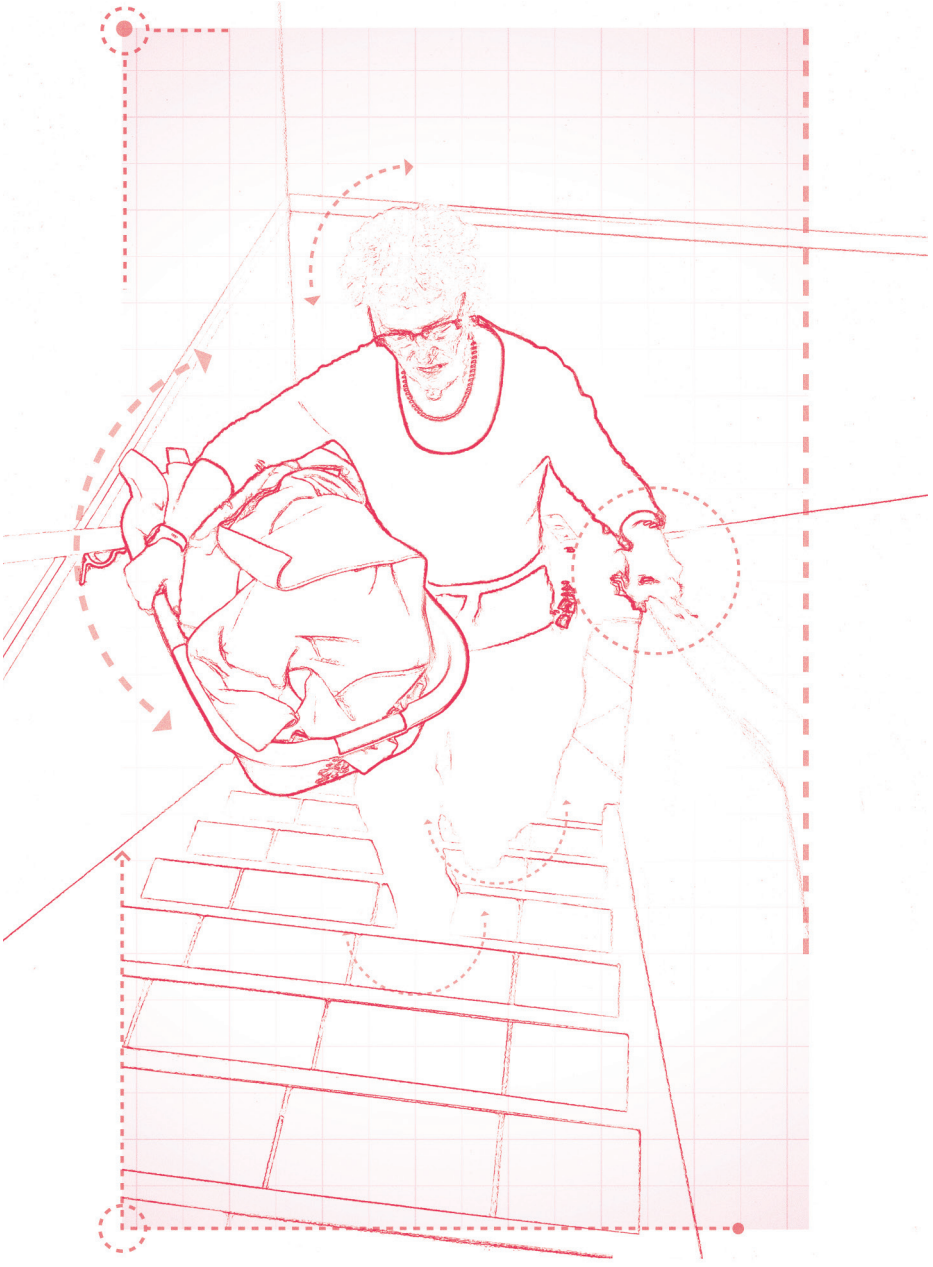
Current work indicates that the decreased ability of older adults to sustain a precise effort is, in part, due to changes in the mechanical properties of the tendon. A stiffer tendon, such as in young adults, is better able to transmit force and produce steadier contractions than the more compliant tendon of an older adult.

Finally, how do you envision your research will improve quality of life in older people?

Controlling force output is as important as enhancing strength in old age for preventing and delaying the loss of functional independence. Up to now, interventions – notably in frail older women – are not succeeding. I hope that this will change through my work, where we attempt to avoid 'bombarding' the neuromuscular system with a broad intervention and instead develop targeted goals for prehabilitation programmes. These are designed to counter unique, physiological adaptations that occur between men and women with age. Ultimately, we hope that these interventions will succeed in improving functional independence, slowing the regression toward frailty and thereby enhancing quality of life.

Maintaining independence in older people

Researchers at the **University of British Columbia Okanagan** are working on understanding how neuromuscular changes differ between men and women as they age. Their findings will inform the development of prehabilitation interventions that enhance functional movement and mobility – improving quality of life



OUR ABILITY TO physically move is something that we often take for granted. Indeed, for many older adults movement constitutes functional independence as it allows older adults to function under their own volition rather than relying on others. There is an old adage that states we never fully realise what we have until it is gone, but the ability to remain mobile for as long as possible is – whether we know it or not – something that provides us with a means of preserving independence, which in turn contributes to quality of life.

Being able to perform household chores, such as cleaning, preparing meals or even a quick trip to the shops, requires a level of functional independence. Without this requisite level of function, an individual becomes reliant on assistive devices or other persons to help perform these tasks on their behalf. When these types of daily activities cannot be performed successfully by an individual, an identification of functional dependence occurs.

This is a problem in itself – being able to do things for oneself provides an individual with countless benefits, both perceptible and imperceptible – but the burden of demands it places on other elements of society is also worthy of consideration. Family members may be required to provide assistance; care professionals might need to offer their services regularly; and, ultimately, the healthcare system will likely be needed in some way.

AGEING DOESN'T MEAN DECLINING

Perhaps unsurprisingly, a leading cause of loss in functional dependence is ageing. However, it is important to understand that frailty and functional decline are not inevitable consequences of ageing, and steps can be taken to ensure the maintenance of functional independence. With this in mind, a team based at the University of British Columbia Okanagan, Canada, is conducting research into how physiology can enable better function.

Led by Dr Jennifer Jakobi, the group has focused on the coordinated interaction of the nervous and muscular (neuromuscular) systems. More specifically, the researchers have set about finding a means of preventing the loss of functional independence in older adults through improved understanding and identification of sex-specific changes in neuromuscular physiology. Importantly, Jakobi's endeavours seek to redress the fact that sex-related physiology influences are one of the most understudied factors in the loss of functional independence.

One of the team's studies recorded muscle activity using portable electromyography (EMG) devices. Both men and women were told to go about their daily lives while measurements

Jakobi determined that, remarkably, the rapid onset of strength loss occurs approximately 20 years earlier in women than men

were taken. The study found that over the course of an eight-hour day, the muscles of women work harder and more frequently than those of men. "These recordings are not due to women doing more, as gross mobility was similar between sexes during the day, and to substantiate this we validated the real-life EMG data with lab-based functional tasks ranging from self-grooming to laundry," explains Jakobi. "Overall, muscle activity is higher in women than men and this is only partly related to absolute muscle strength."

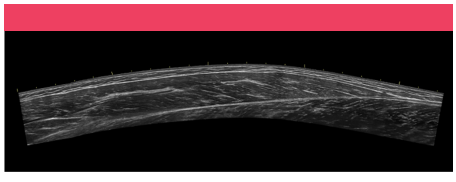
INFORMING EARLY PREHABILITATION

Every functional movement requires a threshold of absolute strength. Generally speaking, women are weaker than men, and age-related decline occurs earlier in women than men, thus women drop below these thresholds before men. Essentially, women can be thought of as having less of a reserve to rely upon as they age, and they tap into this reserve earlier than men. It is therefore important for women to build up their strength at a younger age, to ensure their reserves are greater and not depleted early in the ageing process. One particularly effective means of doing this is through prehabilitation, a form of training that aims to prevent functional decline rather than restore function after it is lost.

Jakobi and her team therefore focused aspects of their research on understanding the precise neuromuscular changes that differ between men and women as they age to inform the design of prehabilitation programmes. It is well documented that strength decreases with age and the stronger an individual, the more successful they are in producing even the lowest of efforts. However, Jakobi determined that, remarkably, the rapid onset of strength loss occurs approximately 20 years earlier in women than men, meaning that prehabilitation interventions must be put in place for women far earlier than was previously thought.

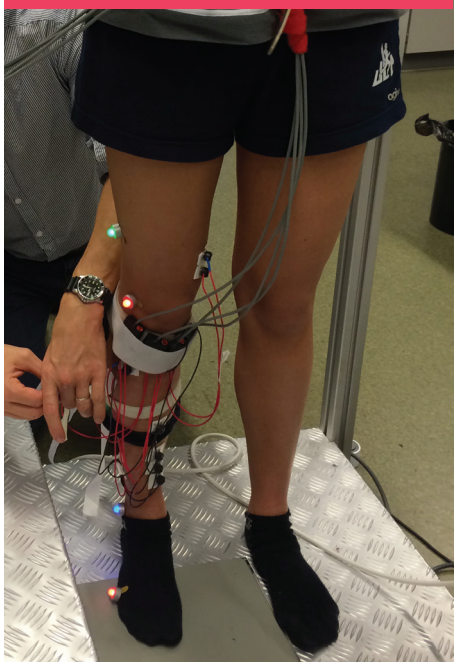
PREVENTING DECLINE

To maximise the efficacy of prehabilitation interventions, an understanding of the interrelationship between the peripheral nervous system, muscle and tendon in generating purposeful movement is necessary. Attaining this understanding will also uncover reasons for the greater incidence of functional disability in women than men.



Representative ultrasound image of the left medial gastrocnemius of a young, physically active male prior to a stretch training intervention. Image was captured via a single LOGIQView scan from the muscle tendon junction to the popliteal crease. (30 fps, 42 gain, 2.6 cm depth. ML6-15 Probe, LOGIQ E9 GE©)

Experimental setup for collaborative project in Brussels evaluating age differences in muscle and tendon architecture and activation patterns during stair climbing in men and women.



With this in mind, Jakobi and her team have conducted investigations into spinal circuitry through studies of single motor units (MUs). The MU is the interconnection of the central nervous system to the muscle; it is the last element where neural control influences mechanical output, produced through coordinated contractions of muscles.

The MUs range from slow to fast types and, as we age, there is a decrease in the number of fast types. Jakobi's team has advanced the technique for recording MUs to enable increased understanding of age- and sex-related differences in physical movement. Importantly, theirs is the first study to quantify MU activity in a functional task: "We demonstrated that when the load and trajectory of a dynamic movement is matched to a functional movement of drinking, the act of drinking reduces steadiness during the lift movement," explains Jakobi. "This difference in force control was associated with a higher discharge rate and greater variability of MU activity."

By recording such simple functional tasks, the team has elucidated the complexity in which the MU controls and adapts force, based on load and the intent of action. Ultimately, the findings will inform the development of a multi-component exercise intervention that will enhance control of functional movement. This means that rather than fixing a loss, Jakobi's research will prevent a decline. All Canadians stand to benefit through the reduction in health inequities between men and women, where the vulnerable populations, such as older adults and frail, older women, will be targeted with the prehabilitation programmes.

SEX-SPECIFIC DIFFERENCES IN FUNCTIONAL DECLINE

OBJECTIVES

- To establish how age-related decline in neuromuscular function differs between males and females
- To use the knowledge of sex-specific age-related decline to develop innovative prehabilitation interventions to assist the next generation of older adults to live longer with prolonged functional independence

KEY COLLABORATORS

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FUNDING

Natural Sciences and Engineering Research Council of Canada

Killam Faculty Research Fellowship, UBC

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JENNIFER JAKOBI gained her PhD from Western University. Following a postdoctoral fellowship in Boulder, Colorado, she took up a faculty position at the University of Windsor. In 2008 she joined UBC Okanagan. Her research programme is advancing knowledge in how sex-specific neuromuscular age-related decline contributes to greater functional loss in women compared with men.