P eople today are living longer than previous generations, and—not for lack of trying—there is still no cure for old age. Fall risk, a major health concern among seniors, has huge implications for quality of life and independent living through the golden years. Falls in seniors also represent a massive burden on our health care system, with an estimated $20 billion per year spent on fall-related medical costs in the United States.

Statistically, older adults who fall are at higher risk for falling again. And a fall that requires medical intervention can initiate a marked decline in health. Fall risk assessment and successful early interventions are an important health care priority for the aging population.

A growing body of research into fall risk in older adults recognizes that it’s an enormously complex and multivariate problem. Scientists come at it from a multitude of disciplines—neurology, psychology, pharmacology, disease, biomechanics, and kinesiology—using all the tools of modern scientific research.

To improve screening and prediction of fall risk, studies consider an almost limitless number of highly specific correlating factors—mental acuity and cognitive impairment; living situation and activity level; and specific health considerations like osteoporosis, neurological gait disorders, pacemaker, sinus node disease, Parkinson’s, and back pain.

Of course, not all potential variables are causally related to falls. Some, like age or race, may correlate to higher fall risk but may not directly cause falls. What’s more, studying any one causal variable in isolation may not fully measure how, in interaction with other variables, it contributes to maintaining stability or whether it predicts fall risk.

Enormous strides have been made over the last decades in identifying physical factors useful in fall risk assessment and in the development of intervention strategies. Jonathan Dingwell, a associate professor in the AKA-member department of kinesiology and health education at the University of Texas at Austin, is an expert in the biomechanics of walking. He approaches the study of fall risk and stability from multiple angles, most recently using dynamic 3-D modeling to assess fall risk factors that cannot easily be isolated or emulated in real test subjects. He also uses 3-D video...
A Balancing Act: Fall Risk Assessment and Intervention

of subjects walking on treadmills to study several factors, including gait variability, the effect of both mechanical and visual perturbations on stability during walking, and how varying step widths and lengths contribute to stability while walking.

When we stand or walk, the interplay of various mechanical degrees of freedom means there is more than one possible strategy that would maintain upright position. “There’s an infinite number of ways that you can walk successfully, so it’s hard to pin down a single thing that could lead to being more stable or more unstable,” observes Dingwell.

Dingwell explains that everyone’s gait is variable. The brain doesn’t send the same signal to the limbs with each step. Even healthy young people with little fall risk have some degree of gait variability. And while greater gait variability is in fact associated with greater fall risk, it’s not a linear correlation, making gait variability challenging to use in assessing fall risk.

“Our perspective is that it’s actually in the differences between strides and how that difference is negotiated that you actually see the interesting things that are happening in terms of stability and balance,” notes Dingwell. “How does the brain correct for differences? If you have a very small perturbation in a stride, how rapidly does that perturbation either grow or decay on the next stride?”

Dingwell has experimentally tested a common clinical recommendation that slowing walking speed can reduce fall risk, which has been debated by fall risk scholars. Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell has experimentally tested a common clinical recommendation that slowing walking speed can reduce fall risk, which has been debated by fall risk scholars. Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell has experimentally tested a common clinical recommendation that slowing walking speed can reduce fall risk, which has been debated by fall risk scholars. Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell has experimentally tested a common clinical recommendation that slowing walking speed can reduce fall risk, which has been debated by fall risk scholars. Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell has experimentally tested a common clinical recommendation that slowing walking speed can reduce fall risk, which has been debated by fall risk scholars. Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell said the recommendation is probably sound; but from a biomechanical point of view, this would also depend on the kind of fall one is trying to avoid. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.

Dingwell’s stability studies show that slower walking increases gait variability, which in turn decreases stability, but that doesn’t match up with data reported in other studies.

“Slower walking speed correlates to higher fall risk, but this is confounded by the fact that older adults tend to walk slower. The correlation doesn’t mean slower speed is causing the falls. It could be that the same thing that’s causing them to fall is what’s causing them to slow down,” explains Dingwell.
A Balancing Act: Fall Risk Assessment and Intervention

Continued from page 25

adjust balance,” explains Cullen.

“During motion, your brain is normally able to make an estimate, or what we call an internal model, of the sensory inflow that it should get from your sensory systems—vision, touch somatosensory, proprioception, vestibular. Your cerebellum then computes the mismatch (or error) between what your brain expects and the actual sensory input.

“Athletes can compute this mismatch for very complex motions, as in a gymnast doing a back flip on a balance beam. This explains why cerebellar patients cannot do this, even for a simple movement like placing a foot on a step.”

The team’s results also show for the first time that two separate processing streams in the cerebellum encode unexpected movements, one for unexpected head movement (through the vestibular system of the inner ear) and one for body position and velocity (through comparison of vestibular and neck-muscle sensory inputs from muscles and Golgi tendon organs).

As people age, they begin to lose that sense of balance because they lose some of the sensory input, including vestibular sensation, that was present in younger years. This makes balance more challenging because there is less reliable information to estimate movements. Older adults rely more on vision, which is a slow sense compared with vestibular and proprioceptive systems. “In rehabilitation programs, patients can retrain their sensory organization to use faster sensory inputs such as vestibular and proprioception to better maintain balance,” notes Cullen.

Other new research is looking into how we can better predict risk of outdoor falls in older adults, since the risk factors are distinct from those of indoor falls. Hyun Gu Kang of California State Polytechnic University’s kinesiology and health program looked at the correlation between postural sway while standing and indoor and outdoor fall risk—both with and without dual tasking.

Kang’s data came from the MOBILIZE Boston study and included 717 healthy community-dwelling adults over the age of 75 who did not have any diagnosis of visual or cognitive impairment. Based on falls data collected over a three-year period through self-reporting, Kang and his colleagues determined that individuals with more control over postural sway (i.e., better reflexes and stronger muscle tone) were at higher risk for outdoor falls, whereas individuals with more postural sway were at greater risk for indoor falls.

Kang explains, “Indoor falls tend to occur in older adults with various frailties, such as depression and poor balance. Outdoor falls seem to occur in otherwise healthy adults, so lower postural stiffness and damping may indicate subtle problems that may progress to poor balance later. Also, the causes of falls indoors and outdoors may be different, requiring different motor responses.”

The study also found that postural sway measurements taken with dual tasking had no effect on predictive accuracy for fall risk. More and more, scholars of fall risk are assessing the ultimate goal of their research and how best to define its success:

“Even if we can get individuals at high risk of falling into the right interventions to increase their strength, motor coordination, responsiveness, and reaction time, we may still not see a reduced number of falls,” comments Dingwell. “Stronger, more fit individuals might increase their activity level until they put themselves at higher risk of falling. Still, that could be a good outcome, if we are successful in improving lifestyles and health and offer a better quality of life.”