

What Gait Can Tell Us About Fall Risk

Understanding gait characteristics associated with an increased risk of falling

Executive Summary

Falls are complex events influenced by many interacting factors. Since walking requires coordination of balance, sensory information, muscle function, attention, and movement, changes in gait can provide measurable data about how a person walks. Research has identified several gait characteristics associated with an increased risk of falling, including slower walking speed, shorter steps and strides, longer double-support time, and greater gait variability.

However, no single gait parameter can determine whether someone will fall. Instead, gait measurements provide different pieces of information about walking performance. Considering multiple gait characteristics, documenting how they change over time, and measuring gait during standardized assessments and everyday walking provides a broader picture of how a person moves.

1. Falling Is More Than Losing Balance

Why fall risk is more complex than a single measure.

Falls rarely have a single cause. Our ability to move safely through our environment depends on many systems working together. These systems include balance, muscle strength, sensory information, coordination, attention, and the ability to respond to changes in our surroundings. Age-related changes, neurological conditions, medications, environmental factors, and previous falls may further influence a person's risk of falling.

Walking brings many of these factors together. With every step, the body must maintain balance, coordinate movement of both legs, adapt foot placement, and respond to the environment. Therefore, changes in one or more of these systems can be reflected in the way a person walks.

Research has identified measurable gait characteristics associated with fall risk. However, it is important to note that falls are multifactorial, and gait represents only one part of this complex picture. Objective gait measurement provides a means of describing different aspects of walking and how they change over time [1,2].

2. What Can We Measure During Walking?

Small changes in the way we walk can be measured.

Although walking may feel automatic, every step contains measurable information about how we move. Gait parameters describe various aspects of walking, including our speed, step length, foot positioning, and time spent in different phases of the gait cycle.

Some parameters describe the pace and pattern of walking. Gait speed measures how quickly a person walks, and step and stride length describe the distance covered with each step or stride, respectively. Step time and cadence provide information about the timing and rhythm of walking.

Other parameters provide information about support and foot placement. Double-support time describes the period during which both feet are in contact with the ground. Step width reflects the side-to-side distance between the feet. During the swing phase, toe clearance describes the distance between the foot and the ground as it moves forward.

Gait can also be described by its consistency from one step to the next. This is known as gait variability. Small variations naturally occur during walking, but greater variability in certain gait parameters has been associated with fall risk [1,2].

Together, these measurements offer different insights into walking. Rather than relying on a single parameter, examining several characteristics can provide a more complete description of a person's gait.

3. How Does Gait Change With Fall Risk?

Research has identified recurring patterns in gait that are associated with fall risk.

Everyone walks differently, and gait naturally changes with age, health, environment, and walking conditions. However, research has identified several recurring gait characteristics that are associated with an increased risk of falling. These characteristics can be grouped into four broader aspects of walking: pace, step pattern, stability and support, and gait variability [1,2].

Pace: Walking More Slowly

Gait speed is one of the most widely studied characteristics of walking. Studies have found that older adults with a history of falls tend to walk more slowly than those without [1,2]. Prospective research has also found that slower gait speed is associated with subsequent falls in older adults [3]. Walking more slowly may indicate a more cautious strategy, but gait speed can vary for many reasons and should be considered in the context of broader gait patterns.

Step Pattern: Taking Shorter Steps

Step and stride length describe how far a person progresses with each step or gait cycle. Shorter steps and strides are often observed in older adults with a history of falls and are frequently associated with slower walking speed [1,2].

Stability and Support: More Time with Both Feet on the Ground

During walking, there are brief periods when both feet are in contact with the ground, a state known as "double support." Older adults with a history of falls have been observed to have longer double-support times [1,2].

Other measures, including step width and foot clearance, may also provide information about foot placement and stability. However, the evidence linking their average values to fall history is less consistent [1].

Variability: When Steps Become Less Consistent

No two steps are exactly the same when walking. Some variation is normal. Gait variability describes how characteristics such as step length, stride length, and timing change from one step to the next.

Studies have reported greater variability in several gait parameters in people with a history of falls [1,2]. Prospective research has also associated greater variability with subsequent falls in older adults [3]. Therefore, variability provides information that an average value cannot: how consistently a walking pattern is maintained from one step to the next.

4. Gait Changes Over Time

A single measurement provides a snapshot. Repeated measurements can reveal change.

Gait is not static. Walking characteristics can change over time due to age, health, activity level, injury, or disease. A single gait assessment describes how a person walks at a given moment, but repeated measurements can show whether that walking pattern remains stable or changes over time.

This is particularly relevant when considering fall risk. In a study of community-dwelling older adults, Adam et al. found that a decline in gait speed over 12 months was associated with an increased likelihood of falls during the subsequent six months [4]. These results suggest that changes in walking performance over time may provide more information than a single measurement.

However, it is important to note that change does not necessarily mean that fall risk has increased, nor does stable gait mean that a person will not fall. Rather, repeated gait measurements provide an objective way to document changes in walking performance over time.

5. Gait Is Only Part of the Picture

No single gait parameter can determine whether someone will fall.

Although several gait characteristics are associated with fall risk, no single parameter provides a complete picture. Falls are influenced by many interacting factors, such as physical function, balance, cognition, health conditions, medications, behavior, and the environment.

The same limitation applies to commonly used mobility assessments. For instance, a systematic review and meta-analysis revealed that the Timed Up and Go (TUG) test has limited predictive value for future falls in community-dwelling older adults when used in isolation [5]. Similarly, research indicates that spatiotemporal gait parameters alone are insufficient for reliably predicting falls in older adults [2].

Therefore, objective gait measurements should be considered as individual pieces of information regarding walking performance. Considering multiple gait characteristics and how they change over time provides a more complete description of gait than relying on a single measurement.

6. Gait Beyond a Single Assessment

Walking in everyday life can provide a different perspective on gait.

Standardized gait assessments provide a controlled and repeatable way to measure walking. However, a brief evaluation may not accurately reflect how an individual moves in their daily life, as walking naturally varies based on the environment, distance, attention, fatigue, and activity level.

Wearable sensors can extend gait measurement beyond a single assessment by collecting information during everyday walking. In one study, free-living gait was measured over the course of one week in older adults and individuals with Parkinson's disease, both with and without a history of falls. The researchers found differences in broader walking patterns and individual gait characteristics, though the associations differed between populations [6]. Standardized assessments and measurements collected during everyday walking can therefore complement one another, providing information about gait across different tasks, environments, and time.

References

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