



Gait, iTUG and SPPB, measured from one smartphone video

Step Doctor turns any smartphone camera into a markerless motion lab. From a short video of one of three standard tests (a walk, an instrumented Timed Up & Go, or the Short Physical Performance Battery), it rebuilds a 3D skeleton on every frame, finds each footfall, phase, hold and rise, and reports clinical measures graded against published norms. Results arrive in about five seconds, and every number can be checked against the recording and its skeleton overlay.

At a glance

SEE THE MEASUREMENT

Every number can be checked on video

The 3D skeleton is drawn over the recording, so a clinician can check any step, phase or outlier instead of trusting a black box.

WHOLE-BODY 3D

30 body points, every frame

Trunk, hips, knees, ankles and arms are tracked directly, not inferred from a single sensor's motion.

STANDARD TESTS

Gait, iTUG and SPPB

Footfalls, all six iTUG phases and the three SPPB tests are detected automatically, with no stopwatch, mat or wearable.

CLINICALLY ANCHORED

Results in fall-risk context

Every result reads as typical or not against published norms: gait speed, TUG time, iTUG phases and the 0–12 SPPB.

30

3D BODY POINTS
PER FRAME

30 fps

FRAME-BY-FRAME
ANALYSIS

~4.5 s

MEDIAN ANALYSIS
TIME

3

STANDARD TESTS
GAIT · iTUG · SPPB

0

WEARABLES
OR MARKERS

QUALITY & SECURITY

ISO 13485:2016 certified QMS

Encrypted in transit & at rest

Offline build option

Offline hospital deployment

Two-factor admin access & audit trail

Quality management system certified by Kiwa Korea (KAB-accredited), certificate KM 26146, valid to September 2029. Scope: design, development and production of gait analysis devices and software.



From phone video to clinical gait parameter

A camera sees the whole body. Step Doctor estimates a 3D skeleton from each video frame, so measures come from where the joints actually are, not from where one sensor in a pocket suggests they might be.

01 · RECORD

Any phone camera

A short video of a walk toward the phone, a 3 m iTUG, or the three SPPB tests.

02 · DETECT

Find the person

The person is located and tracked on every frame, even with other people in view.

03 · RECONSTRUCT

3D skeleton

30 body points per frame, in metric 3D.

04 · SEGMENT

Events & phases

Heel strikes; the six iTUG phases; SPPB holds, the timed walk and each chair rise.

05 · REPORT

Measures in context

Each measure graded typical or not against published norms, with the video overlay.

● Left leg ● Right leg

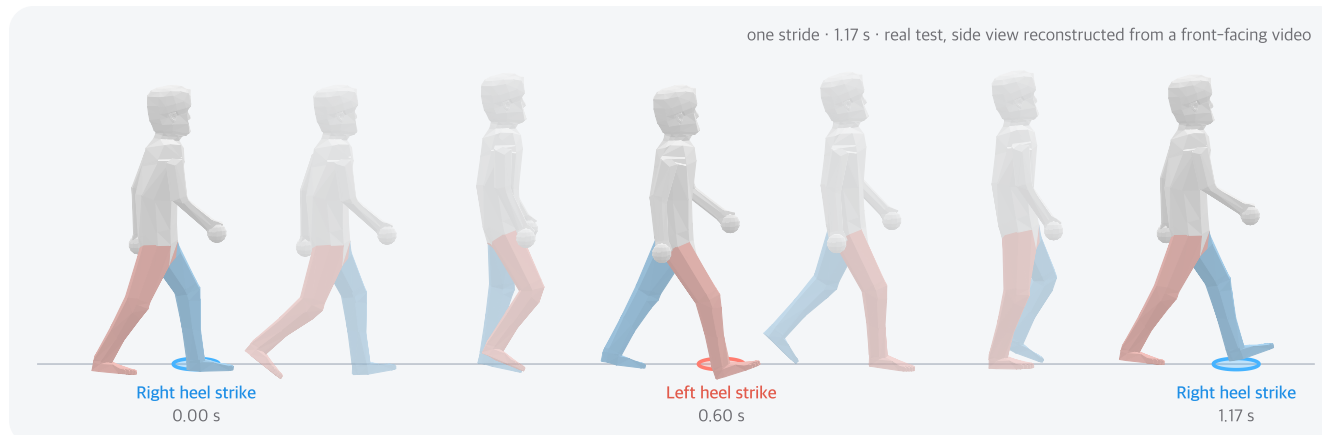


Figure 1. One stride from a real Step Doctor test, shown on the same avatar as the app. The patient walked toward a front-facing phone; the side view is reconstructed from the 3D skeleton. Solid poses are the heel strikes the system detected.

THE SENSOR

The camera every phone already has. There is nothing to wear: the camera is checked once when the app is first used, and after that the only rule is to keep the patient in frame.

WHY VISION MATTERS

Inertial methods infer gait from the motion of one point on the body. A camera measures the joints directly: step length, stance and swing, trunk and arm posture, and the stand-up and turn of a TUG.

SETUP

Any corridor or clinic room. The phone rests on a stand or is held by a clinician or carer, so patients without a smartphone, or who can't handle one, can still be tested.

WHERE IT RUNS

iOS and Android, in English and Korean. Analysis runs in the cloud. A device-bound offline build serves hospitals without cloud access.



A camera, compared with a phone in a pocket

Smartphone gait tools mostly use either the phone's inertial sensor (IMU) or its camera. Both have strengths. Step Doctor is built for supervised, standardized assessment, where seeing the movement matters most.

QUESTION	STEP DOCTOR (CAMERA, 3D POSE)	PHONE-IN-POCKET INERTIAL SENSING
What is measured	Joint positions directly in 3D: feet, knees, hips, trunk, arms	Acceleration and rotation of one point near the hip; gait events are inferred
Can a clinician see it?	Yes. The video and skeleton overlay show exactly what was measured	No. The signal isn't human-readable; results must be taken on trust
Placement	None on the body. Keep the patient in frame	Front or back pocket, or a strap; patients without pockets need a strap
Whose phone?	Any phone, any user. A clinician or carer can film the patient	Usually the patient's own phone, carried on the body
Whole-body posture	Yes. Trunk lean, arm swing, knee flexion and standing height are all captured	Limited to what one body point reveals
iTUG & SPPB	From posture. Hip height, heading and distance show every phase, balance hold and chair rise	Inferred from changes in acceleration
Passive all-day monitoring	Not the goal. AICU measures standardized tests on demand	A strength of pocket-worn sensing

Why this matters clinically

AUDITABLE

Disagreements can be resolved

If a value looks wrong, open the video and look. Every footfall and phase boundary is visible on the recording.

EXPLAINABLE

Patients see their own movement

Showing a patient their skeleton next to a typical walk makes the case for therapy better than a number alone.

INCLUSIVE

No phone or pocket required

Older adults who don't carry a phone, wear clothes without pockets, or use a walking aid can be tested by staff.



What the gait test measures

Thirty measures per walk, reported for each foot where it matters. Each one is read the way the app shows it: typical, borderline or outside range.

Speed & rhythm	Walking speed (m/s), cadence (steps/min), step and gait-cycle time L/R (s), step count
Spatial	Step length L/R, stride length L/R (cm)
Gait cycle	Stance, swing and double support % L/R
Variability & symmetry	Variation of step and stride length and time L/R; left/right imbalance (%)
Composite	Gait score 0–100 with propulsion, balance and rhythm sub-scores

● Typical walk ● Degraded walk ○ Left footfall ○ Right footfall

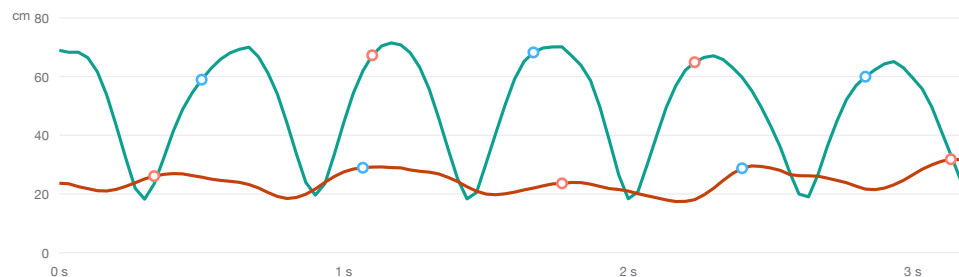


Figure 2. Distance between the feet over time, measured from the 3D skeleton. Each peak is one step. The degraded walk takes shorter, slower and less regular steps.

● Typical ● Borderline ● Outside range T = typical walk · D = degraded walk

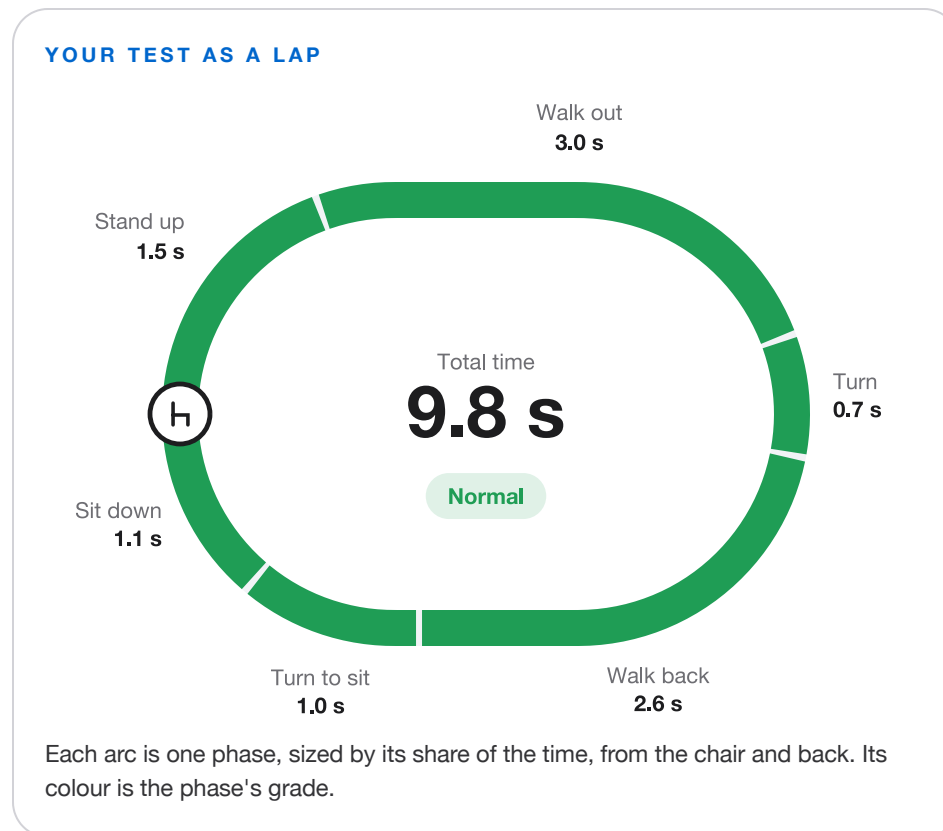
	Typical walk		Degraded walk	
Walking speed cm/s		96 Typical	28	Outside range
Cadence steps/min		102 Typical	86	Borderline
Stride length cm		121 Typical	40	Outside range
Step time s		0.59 Typical	0.70	Borderline
Double support %		25 Typical	36	Borderline
Stance %		63 Typical	69	Outside range

Figure 3. The same two walks on the app's range tracks. Each marker takes the colour of its zone, so a reader sees at a glance which measures are usual and which are not.



iTUG: six phases, each against published norms

The patient stands up, walks 3 m, turns, walks back, turns to sit and sits down. Step Doctor times the whole test and every phase from the 3D pose, then grades each phase against older adults timed the same way.



PHASE	TIME	GRADE	TYPICAL ≤
Stand up	1.5 s	Typical	1.8 s
Walk out	3.0 s	Typical	4.0 s
Turn	0.7 s	Typical	2.8 s
Walk back	2.6 s	Typical	4.0 s
Turn to sit	1.0 s	Typical	2.8 s
Sit down	1.1 s	Typical	1.5 s

"Typical ≤" is the study mean + 1 SD for that phase. Total 9.8 s: normal mobility (under 10 s).

How iTUG is graded

Typical

Up to the study mean + 1 SD.

Slower

Up to the study mean + 2 SD.

Much slower

Beyond the study mean + 2 SD.

Reference: 280 community-dwelling older adults without cognitive impairment (mean age 83), timed phase by phase with body-worn sensors. The study's two 8 ft walks are scaled to one 3 m walk. Mirelman A, et al. *J Am Geriatr Soc* 2014;62(4):673–678.

[doi:10.1111/jgs.12734](https://doi.org/10.1111/jgs.12734)

Colour now means how usual a time is, not which phase it is. The total is judged separately against the published fall-risk cut-offs (page 8).



The whole iTUG, in one scene

The phases come from the 3D pose itself: hip height marks standing up and sitting down; the body's heading and distance from the camera mark the walks, the turn and the turn to sit.

REAL TEST

9.8 s total · normal mobility

Standing height estimate 161 cm
Turn point 0.66 m from the camera

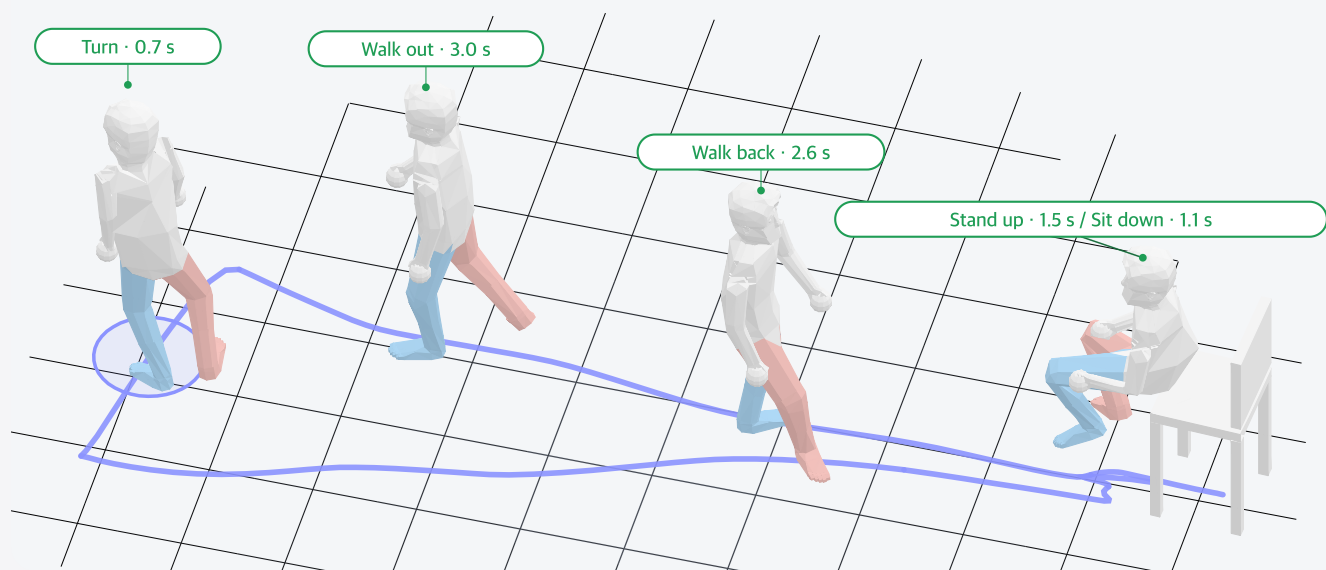


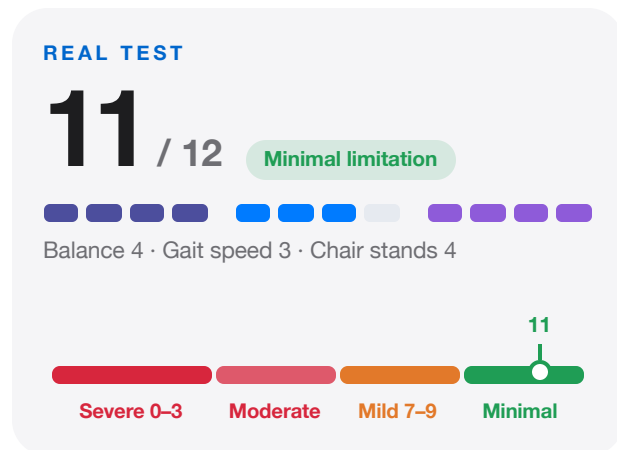
Figure 4. The test on the same avatar as the app, with the subject at each phase. Labels take the phase's grade colour. The course is drawn spread out (the return in its own lane) so every phase stays visible; poses and times are real.

ITUG OUTPUT	DEFINITION	WHAT IT REFLECTS
Total time	Start of rising to seated again (s)	Overall functional mobility; the established fall-risk screen
Stand up / sit down	Sit-to-stand and stand-to-sit (s)	Lower-limb strength; controlled lowering
Walk out / walk back	Each 3 m walk (s)	Gait speed and stability
Turn / turn to sit	The 180° turn, and turning round at the chair (s)	Dynamic balance, which is sensitive to early decline
Context	Standing height, turn distance, quality warnings	Test conduct; incomplete tests are flagged, not guessed



SPPB: three tests, one score out of 12

Balance, a timed 4 m walk and five chair rises, each scored 0–4 on the NIA protocol. The app films each test, finds the hold, the walk and every rise from the 3D pose, and scores the battery.



TEST	RESULT	POINTS
Side-by-side	10.0 s held · sway 0.4°	1
Semi-tandem	10.0 s held · sway 0.5°	1
Tandem	10.0 s held · sway 2.7°	2
4 m walk	Best of 5.91 / 5.47 s · 0.73 m/s	3
Five chair rises	9.5 s	4

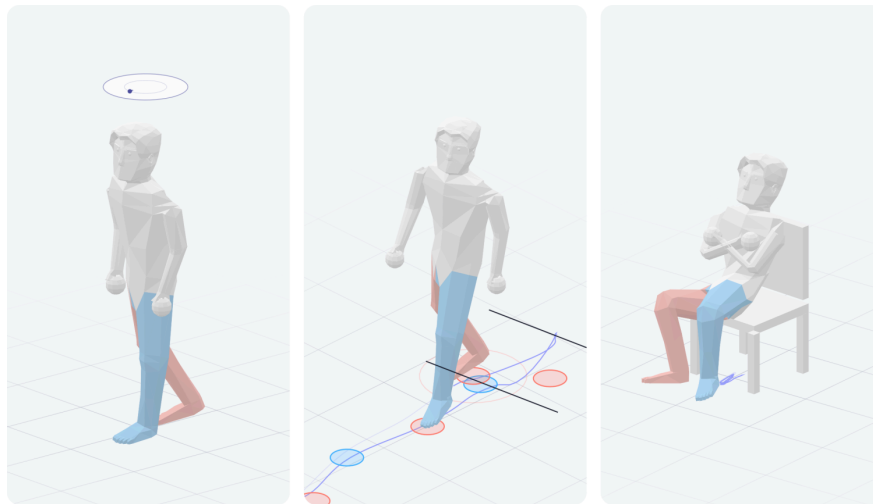


Figure 5. The three tests of a real SPPB on the app's avatar: the tandem stance (the disc above the head traces trunk sway), the timed walk (lines mark the timed stretch), and the chair rises.

NIA POINTS	4	3	2	1
4 m walk (s)	< 4.82	4.82–6.20	6.21–8.70	> 8.70
Five chair rises (s)	≤ 11.19	11.20–13.69	13.70–16.69	16.70–60
Balance	Side-by-side 1 + semi-tandem 1 (10 s each) + tandem 2 (10 s) or 1 (3–9.99 s)			

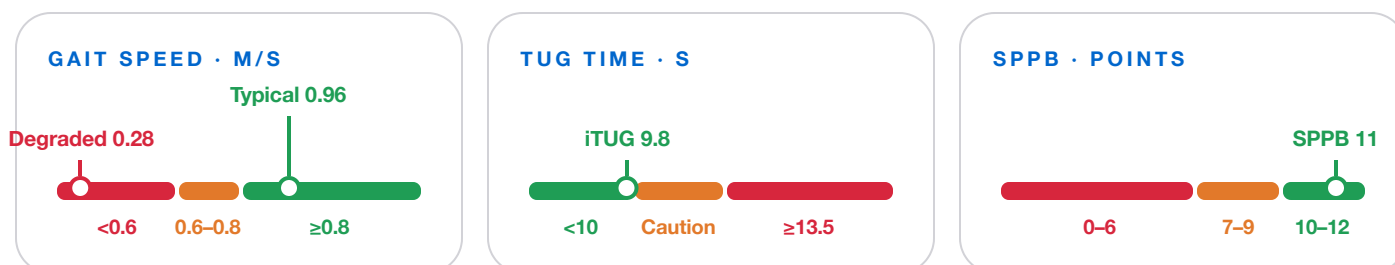
Balance quality 84/100 (Good) is AICU's trunk-sway measure, shown beside the score but never part of it.

Judged against published evidence

Gait speed, TUG time and the SPPB are among the most studied predictors of falls and decline in older adults. Step Doctor reports each one against the thresholds in that research.

MEASURE	THRESHOLD OR EFFECT	EVIDENCE
Gait speed	Each 0.1 m/s slower	About 7% higher risk of falling (Verghese et al., 2009)
Gait speed	< 0.6 · ~0.8 · ≥ 1.0 m/s	Poorer health, average life expectancy, longer survival (Studenski et al., 2011); normal adults walk about 1.2–1.4 m/s (Fritz & Lusardi, 2009)
Gait speed	Each 0.1 m/s faster	Lower mortality in 34,485 older adults (Studenski et al., 2011)
Gait variability	Higher stride-time variability	Predicted falls over one year (Hausdorff et al., 2001)
TUG time	< 10 s · ≥ 13.5 s	Typical: averages 8.1–11.3 s by age (Bohannon, 2006); identified fallers, 87% sensitivity and specificity in a small study (Shumway-Cook et al., 2000)
iTUG phases	Mean + 1 / + 2 SD (our grading)	Phase reference times for 280 older adults without cognitive impairment; turn-to-walk was slower in mild cognitive impairment (Mirelman et al., 2014)
SPPB total	0–12 · bands 10/7/4	Lower scores predicted mortality and nursing-home admission (Guralnik et al., 1994)
SPPB cut-offs	NIA points per test	Protocol figure used for the walk and chair cut-offs (Rodríguez-Mañas et al., 2014)
SPPB change	0.5 · 1 point	Small, then substantial meaningful change (Perera et al., 2006 ; Kwon et al., 2009)

Worked example: the same scales, real results



Step Doctor supports screening and monitoring. It doesn't diagnose, and results should inform, not replace, clinical judgement.



From first test to follow-up, in one app

Measurement is only the start. Step Doctor explains each result, suggests what to work on, and makes the retest easy enough to do at home.

01 · SCREEN

Record a test

Gait, iTUG or SPPB, in clinic or at home, filmed by the patient, a carer or a clinician.

02 · UNDERSTAND

Results in seconds

Measures graded against published norms, with the 3D replay.

03 · EXPLAIN

Plain-language report

A shareable PDF and an AI assistant that answers questions about the result.

04 · ACT

Targeted exercises

Curated video exercises matched to what the test found.

05 · RETEST

Track change

Reminders and repeat tests on the same phone show the trend over time.

PATIENT APP

iOS and Android

Guided recording for all three tests, results history and trends, reminders, English and Korean.

CLINICIAN LINK

Care relationships

Clinicians are linked to their patients and follow the results those patients share, with assessments and reports in one place.

DEPLOYMENT

Cloud or offline

Standard cloud analysis, or a device-bound offline build that analyses on the phone for hospitals that can't send data out.

Exercise library, matched to findings

Heel-to-toe walking

Single-leg stance

Sit-to-stand

Calf raises

Marching in place

Interval walking for pace

Wide, safe turns

Controlled sitting down

Daily walking

Each exercise comes with a demonstration video. Where a result warrants it, the app recommends a follow-up with a physical therapist.

TYPICAL USE

In clinic

Staff film a gait test, an iTUG or an SPPB during the visit, on any phone. Results and the risk context are ready before the patient leaves, with the video available to review.

Between visits

The patient or a carer repeats the tests at home on a reminder schedule. The clinician sees the trend, and the patient practises the recommended exercises.



Built to be trusted

QUALITY MANAGEMENT

ISO 13485:2016 (KS P ISO 13485:2016) certified quality management system. Certified by Kiwa Korea, accredited by KAB, certificate KM 26146, valid 23 September 2026 to 22 September 2029.

INTERNAL VALIDATION

93% clinical accuracy against a gold-standard pressure-sensor gait mat (internal study; not yet peer-reviewed).

FAIL SAFE, NOT FAIL SILENT

Recordings that can't be measured reliably are rejected rather than estimated, and the user isn't charged. Incomplete iTUG and SPPB tests are flagged.

DATA PROTECTION

Encrypted in transit and at rest. Error monitoring runs on our own servers. Admin access needs two-factor sign-in and is audit-logged.

Resources

Gait demo video (30 s)	A typical and a degraded walk on one screen, with live measures
iTUG demo video (45 s)	A typical and a slowed iTUG with the lap, phase grades and risk scale
SPPB demo video (38 s)	Balance, 4 m walk and chair rises, scored live to 12
Website	gait.aicu.life
iOS app	apps.apple.com/app/id6747734817
Android app	play.google.com · life.aicu.gait

References

- Bohannon RW. Reference values for the Timed Up and Go test: a descriptive meta-analysis. *J Geriatr Phys Ther.* 2006;29(2):64–68. [doi](#)
- Fritz S, Lusardi M. White paper: “Walking speed: the sixth vital sign.” *J Geriatr Phys Ther.* 2009;32(2):2–5. [doi](#)
- Guralnik JM, et al. A short physical performance battery assessing lower extremity function. *J Gerontol.* 1994;49(2):M85–M94. [doi](#)
- Hausdorff JM, Rios DA, Edelberg HK. Gait variability and fall risk in community-living older adults. *Arch Phys Med Rehabil.* 2001;82(8):1050–1056. [doi](#)
- Kwon S, et al. What is a meaningful change in physical performance? *J Nutr Health Aging.* 2009;13(6):538–544. [doi](#)
- Mirelman A, Weiss A, Buchman AS, Bennett DA, Giladi N, Hausdorff JM. Association between performance on Timed Up and Go subtasks and mild cognitive impairment. *J Am Geriatr Soc.* 2014;62(4):673–678. [doi](#)
- Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common physical performance measures in older adults. *J Am Geriatr Soc.* 2006;54(5):743–749. [doi](#)
- Podsiadlo D, Richardson S. The timed “Up & Go”. *J Am Geriatr Soc.* 1991;39(2):142–148. [doi](#)
- Rodríguez-Mañas L, et al. An evaluation of the effectiveness of a multi-modal intervention in frail and pre-frail older people with type 2 diabetes – the MID-Frail study: study protocol for a randomised controlled trial. *Trials.* 2014;15:34. [doi](#)
- Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls using the Timed Up & Go Test. *Phys Ther.* 2000;80(9):896–903. [doi](#)
- Studenski S, et al. Gait speed and survival in older adults. *JAMA.* 2011;305(1):50–58. [doi](#)
- Vergheze J, Holtzer R, Lipton RB, Wang C. Quantitative gait markers and incident fall risk in older adults. *J Gerontol A Biol Sci Med Sci.* 2009;64(8):896–901. [doi](#)

Figures and example values are real Step Doctor analyses from an internal test account. Processing time is the production median.