OneStep

WHITE PAPER · DIGITAL BIOMARKERS

Your Walk Is Your Vital Sign

Deriving biological age from smartphone-based gait analysis

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Your walk is a vital sign — and it has an age

For decades, health has been tracked with a familiar set of numbers: blood pressure, cholesterol, heart rate. One of the most powerful indicators of long-term health has been overlooked: the way you walk.

Gait reflects how well the brain, nervous system, muscles and joints work together. Its links to mobility and fall risk are well established, but the story goes deeper. Subtle changes in walking — slower speed, more variability, more time spent stabilizing — can appear years before major health events, and are associated with hospitalization, loss of independence and cognitive decline.

The lab in your pocket

Gait used to require a gait lab. OneStep captures dozens of clinically meaningful parameters from an ordinary smartphone walk. No labs, no wearables — real walking, in the real world.

No single "normal"

Walking does not age the same way for everyone. The same speed can mean very different function at 40 and at 80, and the trends differ between women and men.

Compared with peers

Age- and sex-specific percentiles answer the question that matters: *how am I walking compared with others like me?*

Gait Age: one number everyone understands

Combining percentiles across all key gait parameters — speed, stability, symmetry and efficiency — yields a single, intuitive measure. Gait Age is the age group whose walking pattern most closely resembles yours. Walk like the average 70-year-old at 60, and your Gait Age is older; walk like the average 50-year-old at 65, and it is younger. It is a longevity-style metric based not on how you feel, but on how you function.

FROM INSIGHT TO ACTION

Spot risk sooner, before small changes become big limitations. **Personalize care** against true peers rather than generic cutoffs. **Quantify progress** in rehabilitation, training and recovery as percentiles rise and Gait Age moves younger.

Your walk holds the story of your health. The paper that follows sets out the scientific basis for reading it.

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Your Walk Is Your Vital Sign:

Deriving Biological Age from Smartphone-Based Gait Analysis

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ABSTRACT

Background. Gait integrates input from the nervous, muscular and skeletal systems, and subtle alterations often precede clinical symptoms of decline. Gait speed, double support time and gait variability have been associated with hospitalization risk, cognitive decline and loss of independence.

Objective. To introduce *Gait Age*, a composite biomarker derived from real-world smartphone gait data, and to propose its use as a proxy for biological age.

Methods. Gait parameters were captured during everyday walking with a validated smartphone application. Large-scale normative data were used to construct age- and sex-specific percentile curves (10th–90th) for twelve spatiotemporal gait parameters and the composite Walk Score. Gait Age was defined as the age group whose aggregated gait profile most closely resembles that of the individual.

Results. Gait speed, step and stride length, and single-limb support declined with age, whereas double support, gait speed variability, cadence variability and step length asymmetry increased. Trajectories differed between females and males, such that an identical raw value can correspond to different percentiles depending on age and sex.

Conclusions. Gait captured passively and continuously by smartphone can serve as an accessible, predictive and clinically meaningful metric for proactive health monitoring. Expressed as Gait Age, it offers an intuitive measure of functional aging.

KEY POINTS

Question	Can smartphone-captured gait parameters be expressed as an age-referenced biomarker of functional aging?
Findings	Age- and sex-specific normative curves for twelve gait parameters and the Walk Score show that gait speed, step and stride length decline with age while double support, variability and asymmetry increase, with distinct trajectories in females and males.
Meaning	Aggregating gait percentiles into a single Gait Age may offer an intuitive, passively measurable indicator of functional aging for earlier detection and monitoring.

KEYWORDS gait analysis · biological age · digital biomarker · smartphone · normative percentiles · gait speed · double support · healthy aging

1 Introduction

Traditional vital signs such as blood pressure, heart rate and cholesterol are fundamental indicators of physical health. Recent research suggests that gait, the pattern of how one walks, provides a real-time window into aging and overall function.[1] Because gait integrates input from the nervous, muscular and skeletal systems, subtle alterations often precede clinical symptoms of decline. Gait speed, double support time and variability in particular have been linked to hospitalization risk, cognitive decline and loss of independence.[2,3]

Conventional gait analysis has relied on laboratory systems such as instrumented walkways and optical motion capture. These require complex instrumentation and controlled environments that do not reflect everyday walking, which has limited clinical accessibility. OneStep has developed a smartphone-based system that captures gait parameters during real-world walking without wearables or calibration.[4]

A further limitation of conventional interpretation is its reliance on single, generic cutoffs. Walking does not age uniformly: the same gait speed or stability value

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can represent very different levels of function at different ages and in each sex. This paper (i) describes the relationship between gait parameters and age, (ii) presents the rationale for age- and sex-specific percentiles, and (iii) introduces *Gait Age*, a composite measure indicating the age group whose walking pattern most closely resembles an individual's.

2 Methods

2.1 Gait data acquisition

Gait was recorded with the OneStep smartphone application during walking in everyday settings. The application derives dozens of spatiotemporal gait parameters from the phone's inertial sensors; its validity and reliability against reference systems have been reported previously.[4]

2.2 Parameters

Twelve parameters were analyzed: gait speed, cadence, double support, single support (left and right), step length (left and right), stride length, step length asymmetry, gait speed variability, cadence variability and base width. The composite Walk Score was analyzed alongside them (Table 1).

Table 1. Gait parameters with normative percentiles, and the direction regarded as favorable.

Domain	Parameter (unit)	Favorable direction	Figure
Pace	Gait speed (m/s) · Cadence (steps/min) · Stride length, step length L/R (cm)	Higher	1, S1, S6–S8
Stability	Double support (% gait cycle)	Lower	2
	Single support L/R (% gait cycle)	Higher	S4, S5
Rhythm	Gait speed variability (%) · Cadence variability (%)	Lower	S2, S3
Symmetry	Step length asymmetry (% of stride length)	Lower	S9
Base of support	Base width (cm)	Normative range 10–20	S10
Composite	Walk Score (0–100)	Higher	3

2.3 Normative percentiles

Using large-scale population data, percentile curves (10th, 25th, 50th, 75th and 90th) were estimated as a function of age, separately for females and males, across adulthood (approximately 25 to 88 years). For parameters where higher values are favorable, percentiles correspond directly to the raw data. For parameters where lower values are favorable (double support, variability and asymmetry), percentiles are inverted, so that a higher curve always denotes better performance for that demographic. Base width, for which a normative range rather than a direction applies, is reported on the raw scale.

2.4 Gait Age

Rather than interpreting any single metric in isolation, normative percentiles are computed across all key parameters, capturing not only how fast a person walks but how stable, symmetric and efficient the walking pattern is. These percentiles are combined into a single measure. Gait Age is defined as the age group whose walking pattern most closely resembles the individual's: a 60-year-old who walks like the average 70-year-old has an older Gait Age, and a 65-year-old who walks like the average 50-year-old has a younger one.

3 Results

3.1 Age-related trajectories

Clear age-related patterns emerged across the population. Gait speed declined gradually with age at every percentile (Figure 1), accompanied by shorter step and stride lengths (Figures S6–S8) and reduced single-limb support (Figures S4–S5). Double support, the proportion of the gait cycle with both feet on the ground, increased with age (Figure 2), consistent with a greater need for stability. Gait speed variability, cadence variability and step length asymmetry also increased with age (Figures S2, S3 and S9).

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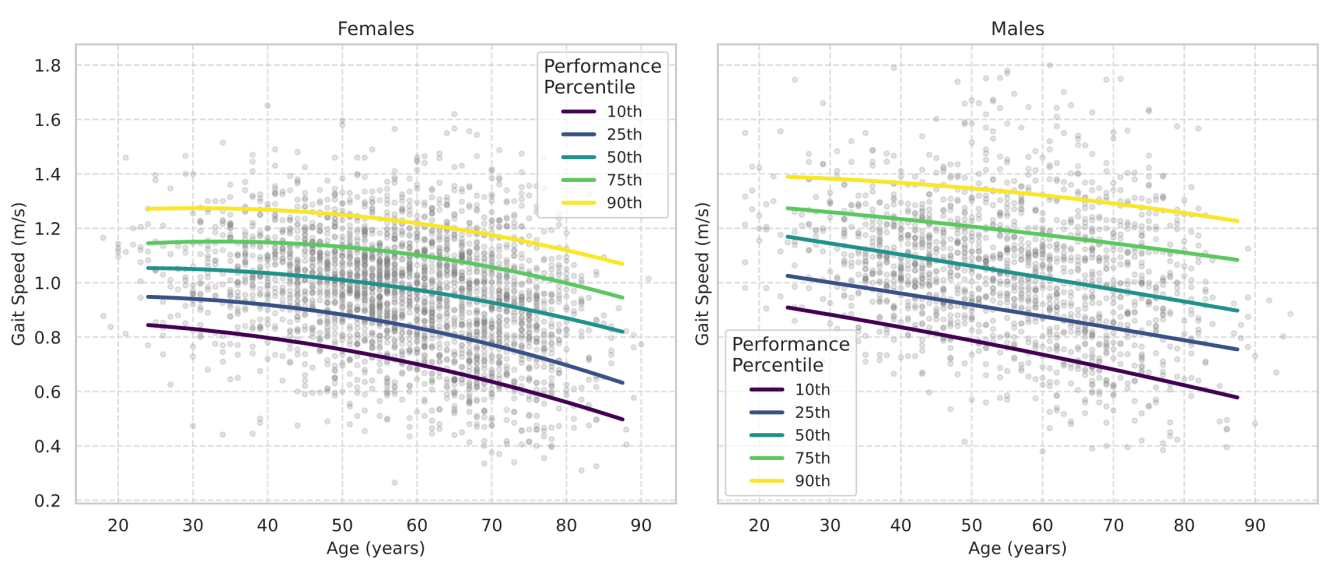


Figure 1. Gait speed percentiles by age and sex. Curves show the 10th, 25th, 50th, 75th and 90th percentiles for females (left) and males (right); grey points are individual observations. Higher values are favorable; percentiles correspond directly to raw data.

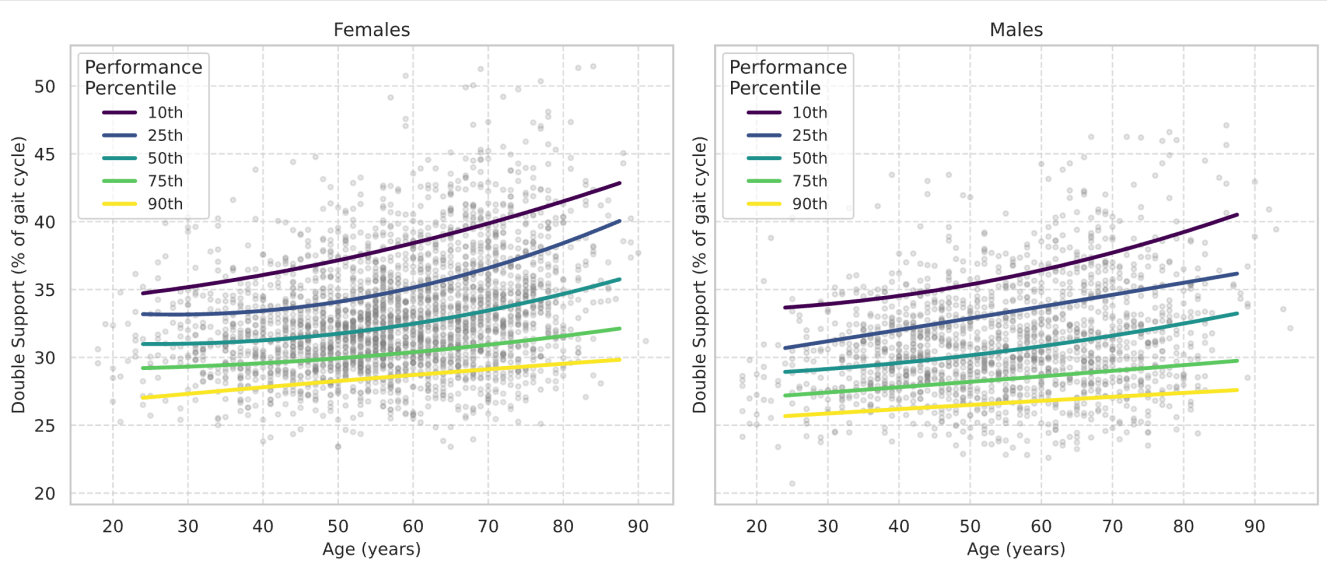


Figure 2. Double support percentiles by age and sex. Double support is expressed as a percentage of the gait cycle. Lower values are favorable; percentiles are inverted so that a higher-performing curve always denotes better function.

3.2 Sex differences

Trajectories differed between females and males. At comparable ages, males showed higher gait speed and longer step and stride lengths, and the shape of the age-related curves differed between sexes for several parameters, including cadence (Figure S1) and double support (Figure 2). An identical raw value can therefore correspond to markedly different percentiles depending on an individual's age and sex.

3.3 Composite Walk Score

The composite Walk Score declined with age in both sexes, with the decline steepening in later decades at the lower percentiles (Figure 3). The spread between the 10th and 90th percentiles widened with age, reflecting increasing heterogeneity of function in older adults.

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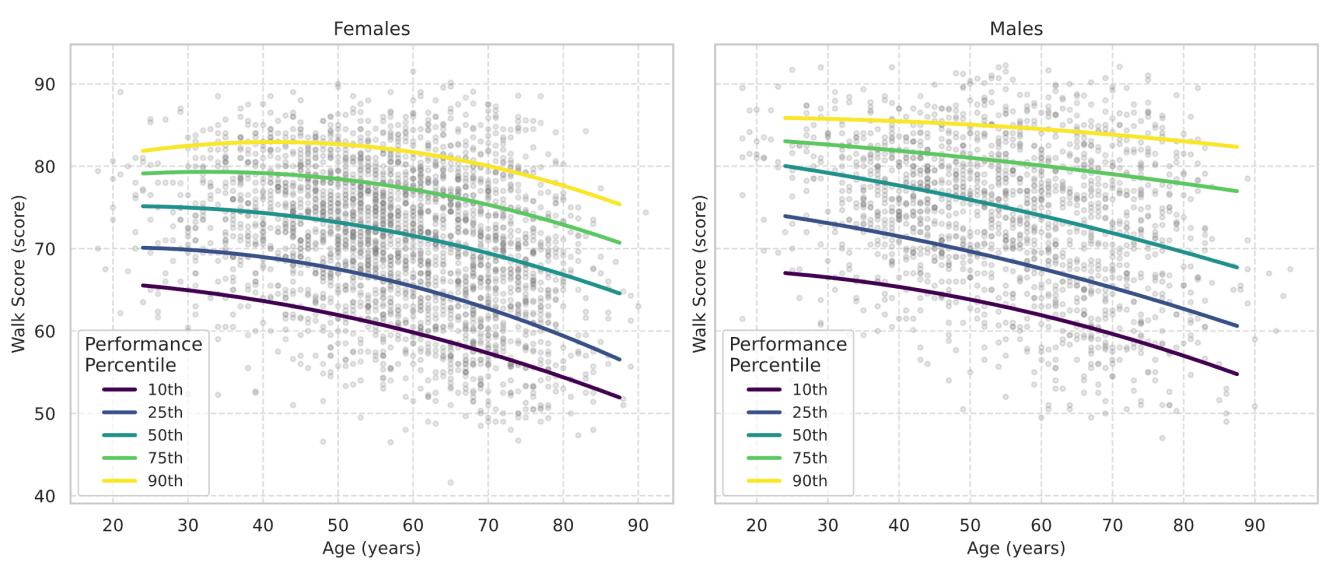


Figure 3. Walk Score percentiles by age and sex. The Walk Score (0–100) is OneStep's composite gait score. Higher values are favorable; percentiles correspond directly to raw data.

4 Discussion

Gait is increasingly recognized as a fundamental indicator of overall health. Its associations with functional mobility and fall risk are well established, and changes in walking patterns such as slower speed, greater variability and longer stabilization time can appear years before major health events, including hospitalization, loss of independence and cognitive decline.[1–3] In this sense, gait functions as a vital sign that reflects the integrated performance of the brain, nervous system, muscles and joints.

The normative curves presented here show why a single "normal" threshold is inadequate. Because walking changes with age and differs by sex, the same measurement can denote excellent function in one person and impairment in another; what is "excellent" at 80 is not the same as what is "excellent" at 40. Age- and sex-specific percentiles reframe interpretation around the clinically relevant question: *how is this person walking compared with others like them?*

Gait Age extends this logic by aggregating percentiles across parameters into one intuitive number. Like other biological-age constructs, it expresses function relative to the population, but it is grounded in directly observed performance rather than self-report. Because it can be captured passively during everyday walking with a smartphone, it lends itself to repeated measurement over time.

4.1 Clinical applications

- **Earlier detection.** Declining percentiles or an advancing Gait Age can flag risk before small changes become functional limitations.
- **Personalized interpretation.** Patients are compared with their true peers rather than with generic cutoffs.
- **Monitoring progress.** Rehabilitation, training and recovery can be quantified as percentiles rise and Gait Age moves younger.

4.2 Limitations

The normative curves were derived from a population with varying levels of pain interference; accuracy for the general population may therefore differ. Future revisions of this report will include updated data and additional cohorts.

5 Conclusion

Gait holds a rich record of an individual's health. Smartphone-based gait analysis makes it possible to read that record outside the laboratory and to translate it into a measure that patients and clinicians readily understand. Gait Age supports tracking function over time, earlier intervention and the protection of independence.

References

1. Nonnekes J, Post E, Imbalzano G, Bloem BR. Gait changes with aging: an early warning sign for underlying pathology. *J Neurol.* 2025;272(4):257. PMID: 40053183.
2. Collyer TA, Murray AM, Woods RL, et al. Association of dual decline in cognition and gait speed with risk of dementia in older adults. *JAMA Netw Open.* 2022;5(5):e2214647. PMID: 35639376.

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3. Mukli P, Detwiler S, Owens CD, et al. Gait variability predicts cognitive impairment in older adults with subclinical cerebral small vessel disease. *Front Aging Neurosci.* 2022;14:1052451. PMID: 36466602.
4. Christensen JC, Stanley EC, Oro EG, et al. The validity and reliability of the OneStep smartphone application under various gait conditions in healthy adults with feasibility in clinical practice. *J Orthop Surg Res.* 2022;17(1):417. PMID: 36104792.

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Supplementary figures

Age- and sex-specific percentile curves (10th–90th) for the remaining parameters. Females left, males right; grey points are individual observations.

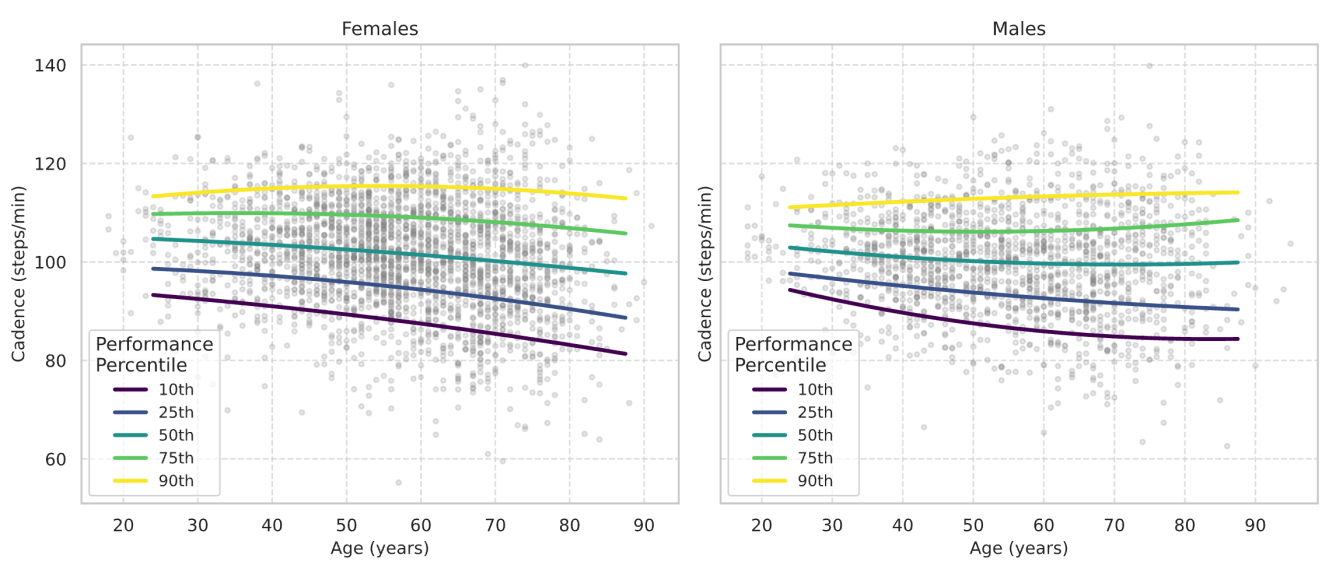


Figure S1. Cadence (steps/min). Higher values are favorable; percentiles correspond directly to raw data.

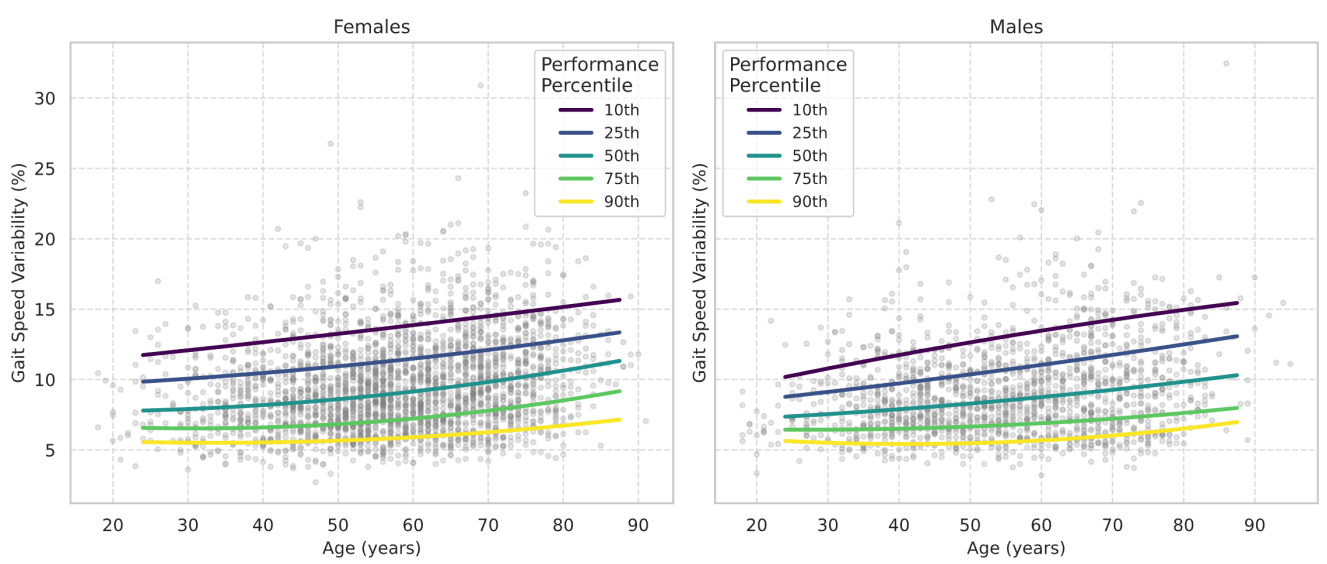


Figure S2. Gait speed variability (%). Lower values are favorable; percentiles are inverted so that a higher-performing curve denotes better function.

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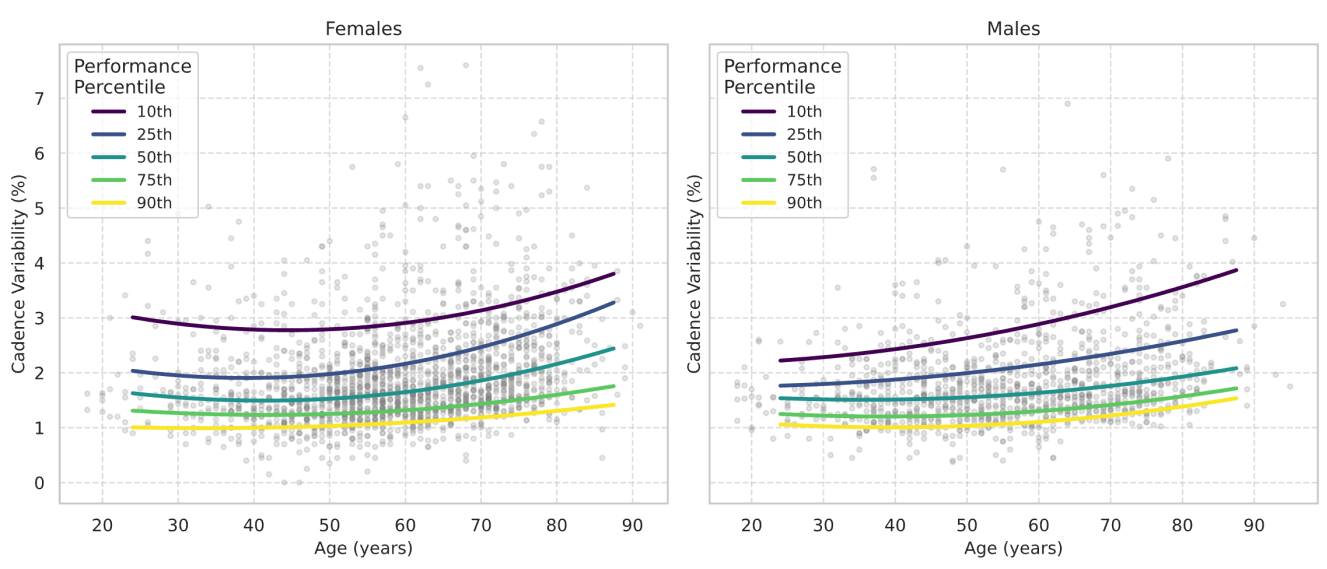


Figure S3. Cadence variability (%). Lower values are favorable; percentiles are inverted.

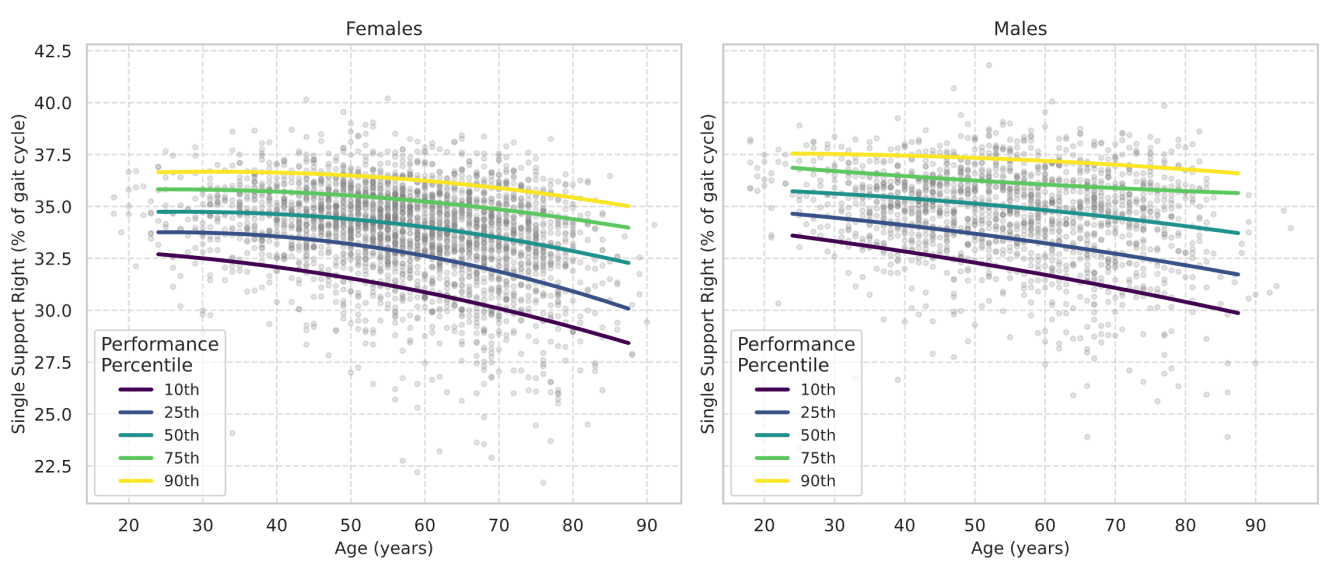


Figure S4. Single support, right (% gait cycle). Higher values are favorable; percentiles correspond directly to raw data.

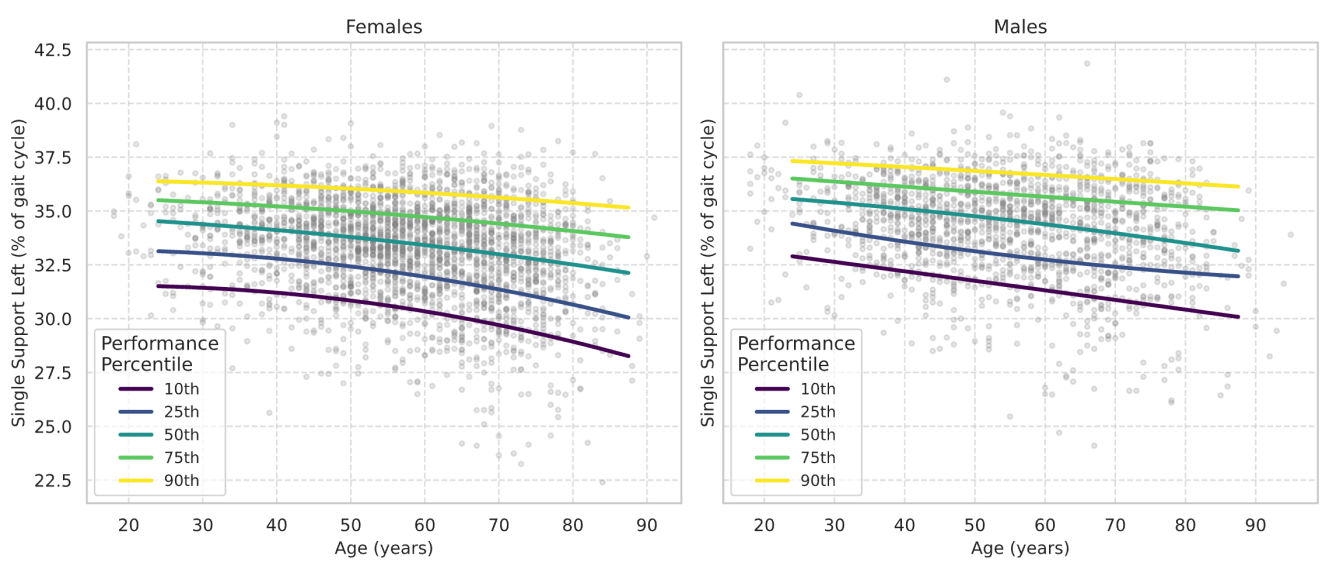


Figure S5. Single support, left (% gait cycle). Higher values are favorable; percentiles correspond directly to raw data.

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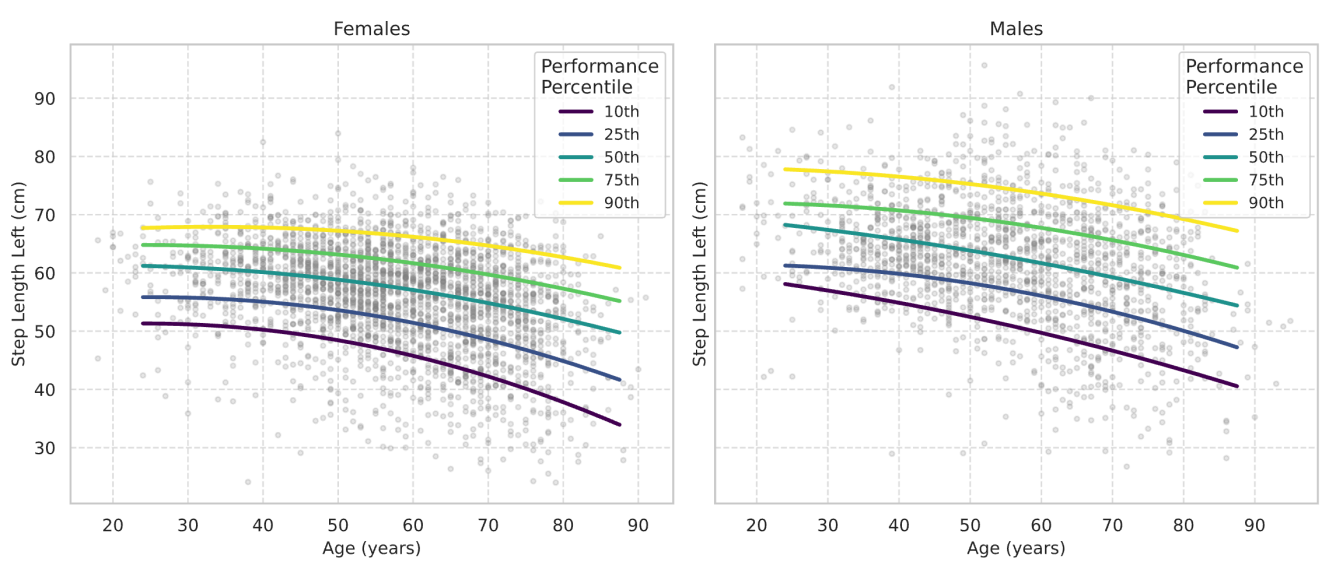


Figure S6. Step length, left (cm). Higher values are favorable; percentiles correspond directly to raw data.

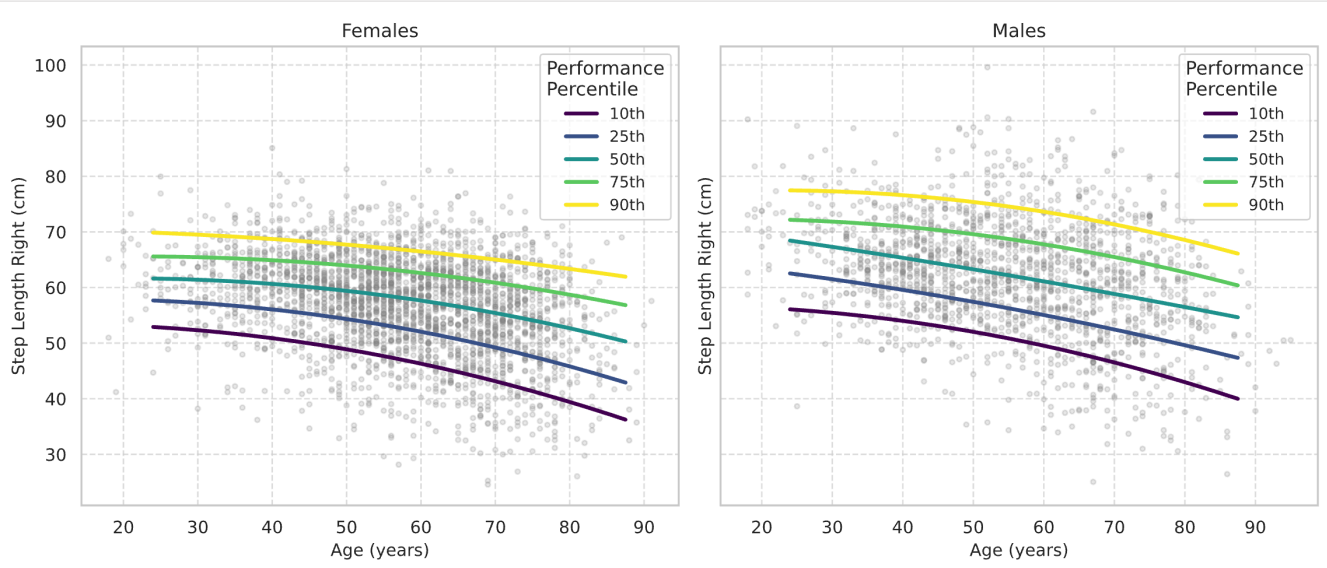


Figure S7. Step length, right (cm). Higher values are favorable; percentiles correspond directly to raw data.

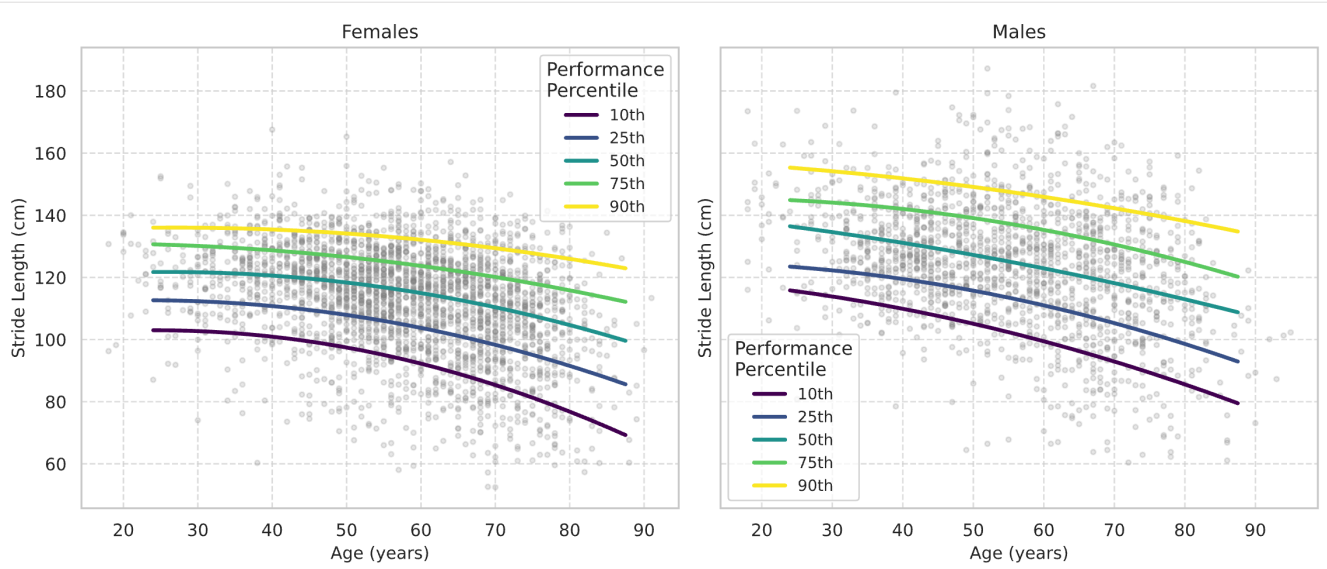


Figure S8. Stride length (cm). Higher values are favorable; percentiles correspond directly to raw data.

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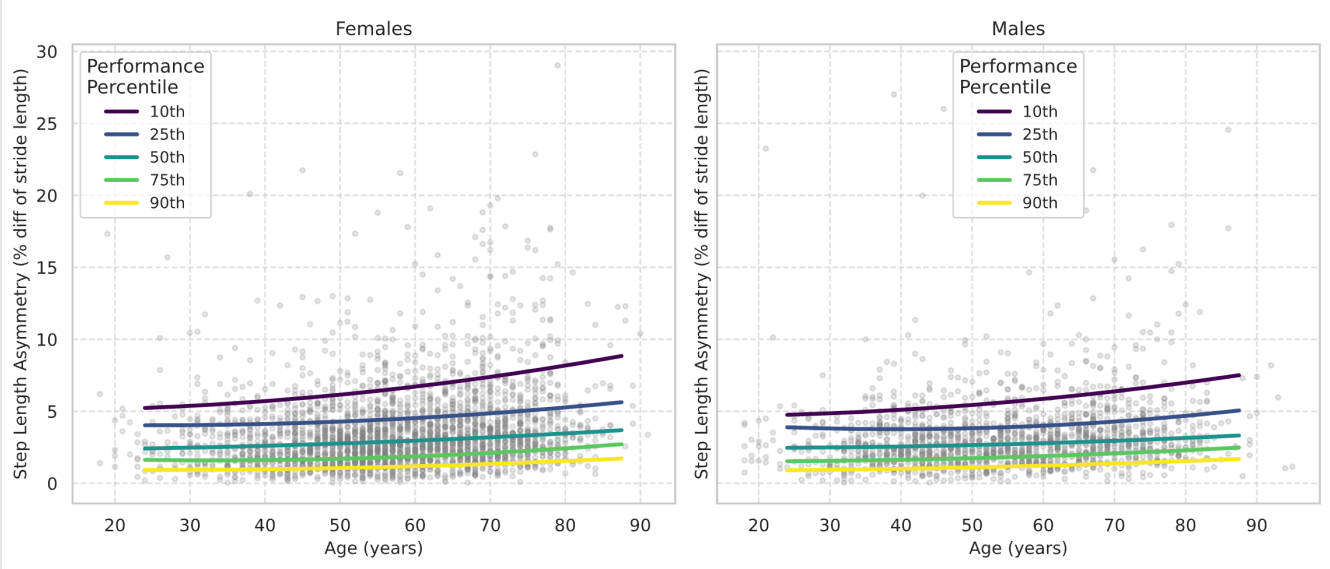


Figure S9. Step length asymmetry (% difference of stride length). Lower values are favorable; percentiles are inverted.

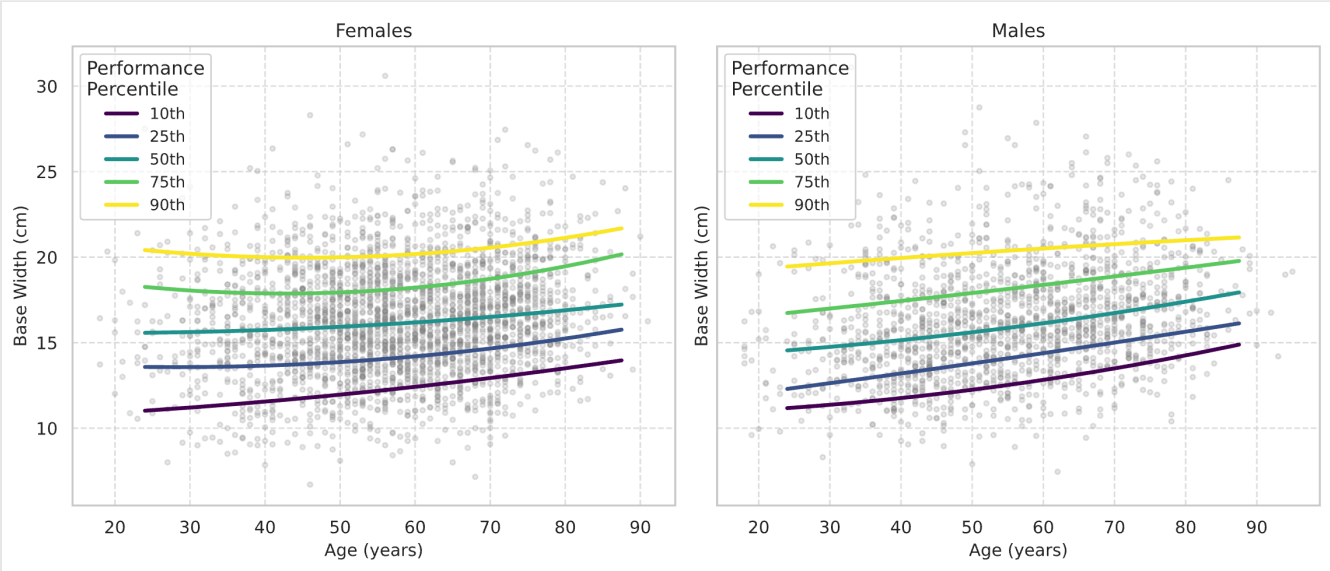


Figure S10. Base width (cm). The normative range is 10–20 cm; percentiles correspond directly to raw data.

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