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WHITE PAPER · PAIN AND GAIT

Oswestry Disability Index Correlates with Smartphone-Measured Gait

Gait speed, stride length, double support and the Walk Score track self-reported low back pain disability

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ABSTRACT

Background. Low back pain affects roughly 619 million people and is a leading cause of disability worldwide. The Oswestry Disability Index (ODI) is the standard self-report measure of back-pain-related disability, but as a questionnaire it depends on active patient participation and may miss small but clinically meaningful change. Systematic reviews show that quantitative gait parameters correlate with pain, with patients in greater pain walking differently.

Objective. To examine the relationship between gait parameters captured passively by a smartphone and self-reported function on the ODI, and so assess OneStep's measurements as an objective correlate of ODI scores.

Methods. Retrospective analysis of 28 patients who completed 31 ODI questionnaires in the OneStep app while recording in-app walks. Each questionnaire was paired with the mean of gait measurements within ±7 days. Pearson correlations were computed between ODI and gait speed, step rate, double support, hip range of motion, stride length, stance asymmetry and the composite Walk Score.

Results. Stride length ($r = -0.76$), Walk Score ($r = -0.75$) and gait speed ($r = -0.72$) showed strong negative correlations with ODI (all $p < 0.0001$); double support correlated positively ($r = 0.63$, $p = 0.0001$). Step rate ($r = -0.45$) and hip range of motion ($r = -0.38$) correlated moderately; stance asymmetry weakly ($r = -0.34$, $p = 0.063$).

Conclusions. Objective gait parameters measured by smartphone sensors align with an established disability measure. Passive capture during daily activity may provide leading indicators of functional change that precede shifts in self-report, enabling continuous monitoring of low back pain outside the clinic.

KEY POINTS

Question	Do gait parameters measured with a smartphone reflect self-reported low back pain disability on the Oswestry Disability Index?
Findings	Across 31 questionnaires from 28 patients, higher ODI scores went with shorter stride length ($r = -0.76$), lower Walk Score ($r = -0.75$), slower gait ($r = -0.72$) and longer double support ($r = 0.63$).
Meaning	Smartphone gait analysis is a clinically relevant, objective complement to the ODI for monitoring function and recovery in low back pain.

KEYWORDS low back pain · Oswestry Disability Index · gait speed · stride length · double support · Walk Score · patient-reported outcomes · smartphone

1 Introduction

Low back pain (LBP) affects approximately 619 million people globally and remains a leading cause of disability worldwide.[1] The Oswestry Disability Index (ODI) is widely used to assess LBP-related functional disability.[2] It is a validated 10-item patient-reported questionnaire covering pain intensity, personal care, lifting, working, sitting, standing, sleeping, sex life, social life and travelling. Each item is scored 0–5 for a maximum of 50, expressed as a percentage and stratified into minimal (0–20%), moderate (21–40%), severe (41–60%), crippling (61–80%) and bed-bound or exaggerated (81–100%) disability.[3]

While the ODI provides valuable insight into self-reported status, its clinical utility could be enhanced by integration with quantitative biomechanical assessment that verifies and measures functional performance objectively. The ODI may also miss smaller but clinically meaningful changes, particularly during decline and recovery, where the burden of active participation can lead to inconsistent reporting, which suggests value in more passive assessment.

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OneStep enables real-world gait analysis without specialized equipment using a standard smartphone's inertial measurement unit.[4] Over one million gait cycles are analysed daily, yielding 30+ spatiotemporal gait parameters, functional tests and a composite Walk Score that combines these measures into a single 0–100 value. Systematic reviews have shown significant correlations between quantitative gait parameters and pain, with patients in greater pain exhibiting altered walking patterns.[5,6] We hypothesized that higher ODI scores would correlate with impaired gait parameters and a lower Walk Score.

2 Methods

2.1 Cohort

Twenty-eight patients (6 male, 11 female, 11 unspecified) completed the ODI questionnaire during gait analysis via the smartphone application. Mean age was 57.8 years (SD 23.8; range 30–99; 30–50 n = 9, 50–70 n = 3, over 70 n = 5, unspecified n = 11). Twenty-five patients completed the questionnaire once and three twice, for 31 questionnaires. ODI scores averaged 26.2 (SD 18.5) with a median of 24.0, indicating moderate functional limitation (Table 1, Figure 1).

Total	Male	Female	N.D.	Mean age (SD)	30–50	50–70	70+	N.D.
28	6	11	11	57.8 (23.8)	9	3	5	11

Table 1. Cohort demographics.

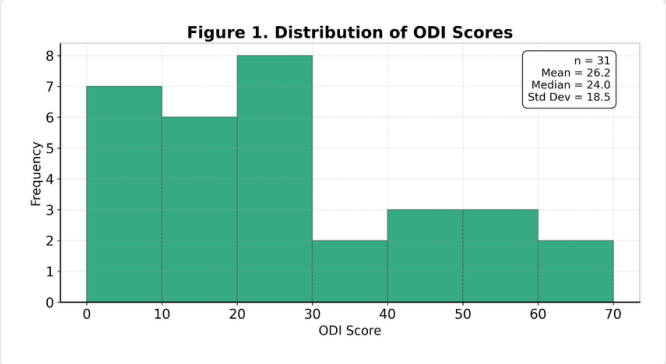


Figure 1. Distribution of ODI scores (n = 31; mean 26.2, median 24.0, SD 18.5).

2.2 Gait analysis

The OneStep application records gait via the smartphone IMU at 100 Hz; patients initiate recordings in the app. Parameters analysed were gait speed (m/s), step rate (steps/min), double support (% of time with both feet on the ground), hip range of motion (sagittal plane), stride length, stance asymmetry (difference in stance time between legs) and the Walk Score (composite mobility assessment).

2.3 Matching and statistics

Each ODI questionnaire was paired with gait measurements recorded within ±7 days of completion, and mean values of all parameters from eligible in-app walks in that window were calculated per patient and questionnaire. Pearson correlation coefficients were computed between ODI scores (0–100, higher indicating greater disability) and each gait parameter, and visualized as scatter plots with regression lines.

3 Results

Pearson correlations and p-values were: stride length $r = -0.76$ ($p < 0.0001$), Walk Score $r = -0.75$ ($p < 0.0001$), gait speed $r = -0.72$ ($p < 0.0001$), double support $r = 0.63$ ($p = 0.0001$), step rate $r = -0.45$ ($p = 0.0113$), hip range of motion $r = -0.38$ ($p = 0.0326$) and stance asymmetry $r = -0.34$ ($p = 0.0630$) (Figure 2).

Patients with higher disability scores therefore walked more slowly, with shorter strides and lower overall mobility function, and spent more time with both feet on the ground. Step rate and hip range of motion showed moderate negative correlations and stance asymmetry a weak one.

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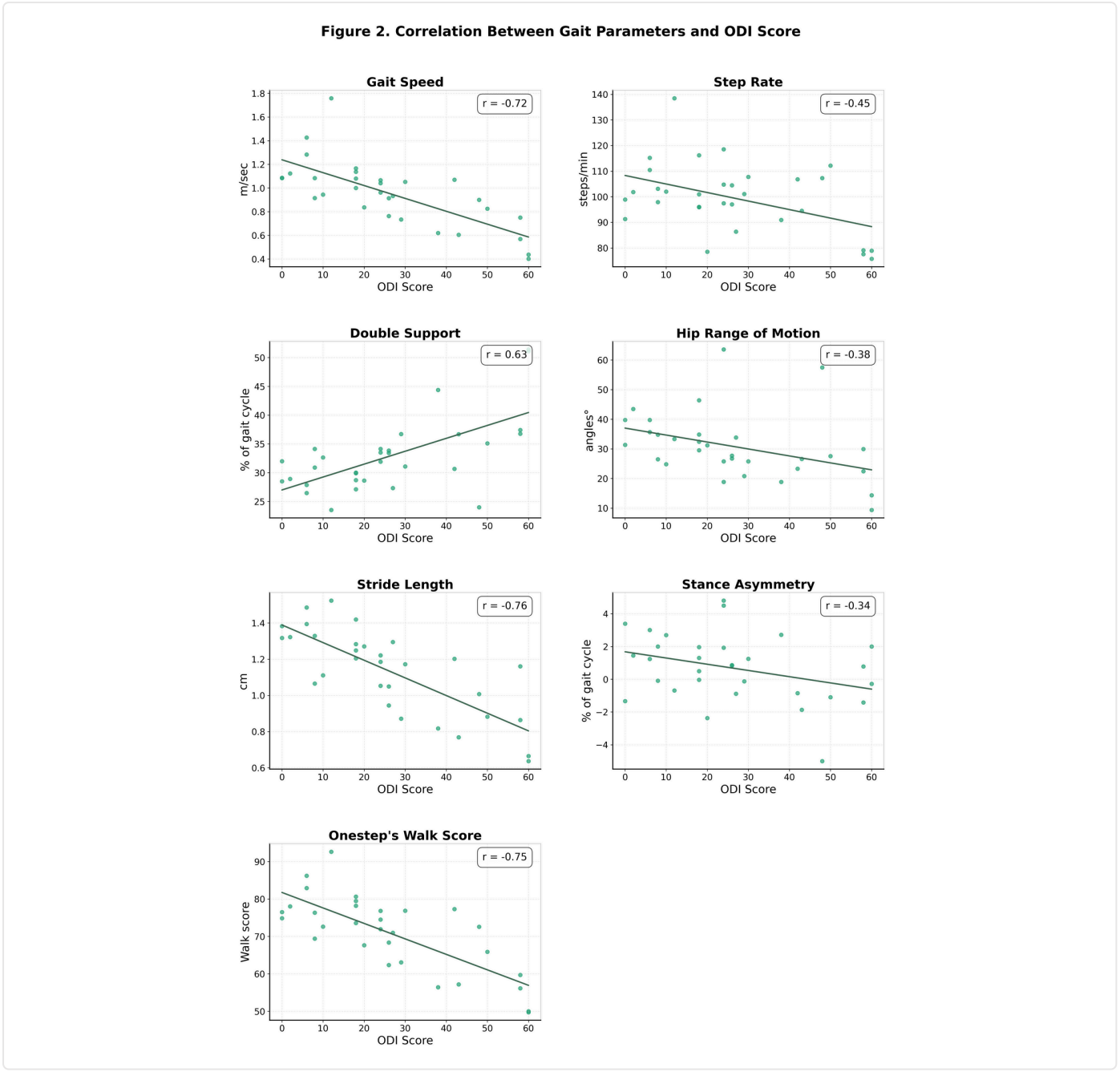


Figure 2. Correlation between gait parameters and ODI score. In-app measurements (green) with linear regression lines and Pearson r for gait speed, step rate, double support, hip range of motion, stride length, stance asymmetry and the Walk Score. n = 31 questionnaires from 28 patients.

4 Discussion

As expected, this study reveals strong correlations between ODI scores and OneStep's smartphone-based gait parameters, showing the utility of combining subjective patient reports with objective mobility measurement. The robust relationships with stride length, Walk Score and gait speed position OneStep as a clinically relevant assessment tool that aligns with an established disability measure.

Barzilay et al. observed that patients with chronic low back pain may show measurable functional improvement before they are subjectively aware of recovery, creating a temporal gap between objective recovery and patient-reported outcomes.[7] OneStep can capture initial improvements in gait that are not yet reflected in ODI scores, which can encourage patients and confirm to clinicians that outcomes are improving before the patient perceives it.

The ability to collect objective, quantifiable metrics in patients' natural environments is a significant advance over traditional assessment. By enabling remote monitoring, OneStep allows more frequent data collection without in-person visits, letting clinicians track subtle changes in functional mobility. The main limitation of this

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analysis is its size; the cohort is small and demographic data were incomplete for a large share of it.

5 Conclusion

Gait speed, stride length, double support and the Walk Score correlate strongly with ODI. Smartphone-based gait analysis offers an objective, continuous view of function in low back pain that complements self-report and may detect change ahead of it.

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