Overall Performance Index (OPI)

Clinical Interpretation Guide

Composite Scoring for Movement Quality Assessment

Purpose

The Overall Performance Index (OPI) combines 16 individual biomechanical metrics into a single score (0–100) that reflects overall movement quality. It provides clinicians with a comprehensive, interpretable summary of a patient's functional status across four domains: Symmetry, Power, Control, and Stability.

The OPI is designed to track progress over time, compare between sessions, identify specific areas of deficit, and support clinical decision-making for rehabilitation progression and return-to-activity clearance.

How the Score Is Calculated

Step 1: Individual Metric Normalization

Each metric is converted to a 0–100 scale based on published clinical thresholds:

- **100 points:** At or better than the "good" threshold
- **0 points:** At or worse than the "poor" threshold
- **Linear interpolation:** Values between thresholds receive proportional scores

Example: If good RSI = 2.0 and poor RSI = 1.0, then RSI of 1.5 scores 50 points.

Step 2: Reliability-Adjusted Weighting

Each metric's contribution is weighted by its measurement reliability (ICC × base weight). Metrics with higher test-retest reliability have greater influence on the final score. This approach is based on the Combined Gait Asymmetry Metric (CGAM) methodology.

Base weights range from 1.0 to 1.5, with key metrics like RSI and real asymmetry receiving higher weights.

Step 3: Domain Aggregation

Metrics are grouped into four domains, each contributing equally to the final score. This ensures balanced assessment even when fewer metrics are available in certain domains.

Step 4: Confidence Metrics

- **Standard Error of Measurement (SEM):** Accounts for measurement precision
- **95% Confidence Interval:** OPI ± 1.96 × SEM
- **Minimal Detectable Change (MDC$_{95}$):** SEM × 2.77 — changes smaller than this may be measurement noise

Score Interpretation

OPI Score	Clinical Interpretation
90–100	**Excellent.** Movement quality consistent with healthy, athletic performance. No significant deficits identified. Suitable for unrestricted activity.
75–89	**Good.** Minor deficits present but within acceptable range. May proceed with activity with awareness of specific areas for improvement.
60–74	**Fair.** Moderate deficits identified. Review domain breakdown to target intervention. May need activity modification.
40–59	**Below Average.** Significant movement quality issues. Targeted rehabilitation recommended before progression.
< 40	**Poor.** Major deficits requiring comprehensive assessment. Activity restriction advised until underlying issues addressed.

Domain Breakdown

Each domain represents a distinct aspect of movement quality. Domain scores help localize deficits for targeted intervention.

Domain	Metrics Included	What It Tells You
Symmetry	ROM asymmetry, Velocity asymmetry, Cross-correlation, Temporal lag, Real asymmetry	Are both limbs moving similarly? Low scores indicate compensation patterns or unresolved deficits.
Power	RSI, Jump height, Peak angular velocity, Explosiveness, RMD	Can the patient produce force quickly? Low scores indicate strength or rate-of-force-development deficits.
Control	SPARC, LDLJ, Velocity peaks, RMS jerk	Is the movement smooth and coordinated? Low scores indicate motor control issues or neuromuscular dysfunction.
Stability	ROM variability (CoV), Ground contact time	Is movement consistent and stable? Low scores indicate variability, fatigue, or uncertainty in motor execution.

Clinical Flags

The system automatically flags specific patterns that warrant clinical attention:

Flag	Clinical Implication
HIGH_ASYMMETRY	Real asymmetry > 15%. Significant bilateral difference that may indicate incomplete recovery, compensation, or structural issue. Review limb-specific data.
LOW_RSI	RSI < 1.0. Poor reactive strength indicating inability to efficiently utilize stretch-shortening cycle. Plyometric readiness is limited.
POOR_CONTROL	SPARC < −3.0. Movement smoothness significantly impaired. May indicate neuromuscular control deficit, pain inhibition, or motor learning issue.
PROLONGED_CONTACT	Ground contact > 350 ms. Protective landing strategy or power deficit. Patient may not be ready for reactive activities.
HIGH_VARIABILITY	ROM CoV > 15%. Inconsistent movement execution. May indicate fatigue, uncertainty, or incomplete motor learning.

Tracking Progress Over Time

Minimal Detectable Change (MDC$_{95}$)

Changes in OPI smaller than the MDC$_{95}$ may represent measurement variability rather than true change. For typical assessments, the MDC$_{95}$ is approximately 8–12 points. Only interpret changes exceeding this threshold as clinically meaningful.

Trend Analysis

The system classifies trends across multiple sessions:

- **Improving:** Current score > previous score + MDC$_{95}$
- **Stable:** Change within ± MDC$_{95}$
- **Declining:** Current score < previous score − MDC$_{95}$

Session Report Elements

Each assessment generates: Overall OPI score with confidence interval, domain scores, top 3 strengths (highest-scoring metrics), top 3 areas for improvement (lowest-scoring metrics), and active clinical flags.

Metric Threshold Reference

The following thresholds are derived from peer-reviewed literature and used to normalize each metric to the 0–100 scale.

Metric	Good	Poor	Source
SYMMETRY			
ROM Asymmetry	< 5%	> 15%	Sadeghi 2000; Forczek 2012
Velocity Asymmetry	< 8%	> 20%	Derived from ROM principles
Cross-Correlation	> 0.95	< 0.75	Signal processing standard
Temporal Lag	< 30 ms	> 100 ms	Plotnik 2007 (PCI)
Real Asymmetry	< 5%	> 20%	Novel (convolution-based)
POWER			
RSI	> 2.0	< 1.0	Flanagan & Comyns 2008
Jump Height	> 35 cm	< 20 cm	Sole et al. 2018
Peak Angular Velocity	> 400°/s	< 200°/s	Biomechanics literature
Explosiveness	> 500°/s²	< 200°/s²	Concentric acceleration
RMD	> 15 g/s	< 5 g/s	Novel (RFD analog)
CONTROL			
SPARC	> −1.5	< −3.0	Balasubramanian 2015
LDLJ	> −6	< −10	Balasubramanian 2015
Velocity Peaks	1	> 5	Motor control literature
RMS Jerk	< 500°/s³	> 2000°/s³	Movement-specific
STABILITY			
ROM CoV	< 5%	> 15%	Motor control literature
Ground Contact Time	< 200 ms	> 350 ms	Flanagan 2008

Limitations

- OPI is derived from knee IMU data only; it does not capture hip, ankle, or trunk mechanics.
- Force-based metrics (ground reaction forces, joint moments) are not directly measured.
- Thresholds are population-level estimates; individual baselines should be established when possible.
- OPI is one component of clinical decision-making and should be interpreted alongside clinical examination and patient-reported outcomes.