

## Criterion Validity of Observational Methods for Biomechanical Exposure Assessment Using Direct Measurements

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### Abstract:

Observational methods are widely used to assess biomechanical exposure in occupational settings due to their feasibility, low cost, and applicability across different work contexts. Despite their extensive use, the literature consistently highlights a lack of robust evidence regarding the criterion validity of these methods when compared with instrumented direct measurements considered as reference standards. This study aimed to evaluate the criterion validity of four widely used observational methods—Quick Exposure Check (QEC), Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and Strain Index—by comparing their outputs with direct biomechanical measurements. This analytical study of measurement properties was conducted during a simulated manual packaging task. Biomechanical exposure was assessed simultaneously using observational methods and instrumented direct measurements, including electrogoniometry, surface electromyography, and dynamometry, allowing an integrated analysis of posture, repetitiveness, and muscle activity. Criterion validity was assessed using Spearman's correlation coefficient in accordance with COSMIN guidelines, with particular emphasis on convergence in ergonomic risk classification. The results demonstrated positive correlations of moderate to high magnitude, all statistically significant ( $p < 0.001$ ). Higher correlations were observed for trunk flexion ( $r \approx 0.83$ ), with greater convergence in risk classification for RULA and REBA. For wrist flexion/extension and repetitiveness, correlations were also positive and ranged from moderate to high magnitude ( $r \approx 0.63$ – $0.73$ ;  $p < 0.001$ ); however, greater discrepancies in risk classification were identified for QEC and the Strain Index. These findings demonstrate that observational methods show acceptable criterion

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validity when direct measurements are used as reference standards, particularly for trunk posture assessment. At the same time, they indicate that the performance of observational methods varies according to the biomechanical variable and body segment assessed, reinforcing the need for informed and task-oriented selection of methods in biomechanical exposure assessment.

**Keywords:**

Biomechanical exposure, Observational methods, Criterion validity, Direct measurement, Ergonomics.