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ORIGINAL RESEARCH

Reliability, Construct Validity and Interpretability of the Brazilian version of the Rapid Upper Limb Assessment (RULA) and Strain Index (SI)

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Abstract
Background: There are very few observational methods for analysis of biomechanical exposure available in Brazilian-Portuguese.
Objective: This study aimed to cross-culturally adapt and test the measurement properties of the Rapid Upper Limb Assessment (RULA) and Strain Index (SI).
Methods: The cross-cultural adaptation and measurement properties test were established according to Beaton et al. and COSMIN guidelines, respectively. Several tasks that required static posture and/or repetitive motion of upper limbs were evaluated ($n > 100$).
Results: The intra-raters' reliability for the RULA ranged from poor to almost perfect (k: 0.00–0.93), and SI from poor to excellent ($ICC_{2.1}$: 0.05–0.99). The inter-raters' reliability was very poor for RULA (k: −0.12 to 0.13) and ranged from very poor to moderate for SI ($ICC_{2.1}$: 0.00–0.53). The agreement was good for RULA (75–100% intra-raters, and 42.24–100% inter-raters) and to SI (EPM: −1.03% to 1.97%; intra-raters, and −0.17% to 1.51% inter-raters). The internal consistency was appropriate for RULA ($\alpha = 0.88$), and low for SI ($\alpha = 0.65$). Moderate construct validity were observed between RULA and SI, in wrist/hand-wrist posture (rho: 0.61) and strength/intensity of exertion (rho: 0.39).

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Conclusion: The adapted versions of the RULA and SI presented semantic and cultural equivalence for the Brazilian Portuguese. The RULA and SI had reliability estimates ranged from very poor to almost perfect. The internal consistency for RULA was better than the SI. The correlation between methods was moderate only of muscle request/movement repetition. Previous training is mandatory to use of observations methods for biomechanical exposure assessment, although it does not guarantee good reproducibility of these measures.

Introduction

The International Labor Office (ILO)[1] estimates that there are 160 million new cases of work-related diseases per year. Musculoskeletal diseases affect 4% of world population.[1] Almost of 15% of this cases are from exposure at work,[2] in particular the biomechanical factors.[3] This condition can generate productivity reduction, absenteeism and early retirement.[4]

The assessment of biomechanical exposure at workplace allows to propose interventions in order to reduce the physical demands.[5,6] To this propose, the use of appropriate methods to identify the exposure to biomechanical risk factors is essential.[7–9] In this sense, the observational methods are of great relevance, mainly because they are widely used for risk analysis in the workplace.[7–10] There are several observational methods[8] for the biomechanical exposure assessment, which may be classified as methods of analysis of general workload or focused on upper limbs and manual material handling analysis.[8] Among the observational methods available for upper limbs evaluation, the most used in worldwide is the Rapid Upper Limb Assessment (RULA) and the Strain Index (SI).[8,11] However, these methods were developed in English language, requiring cross-cultural adaptation for Brazilian-Portuguese,[12] as well as test of their measurement properties.[10–13] There are only two observational methods for biomechanical risk assessment adapted to Portuguese-Brazilian, the Quick Exposure Check (QEC)[14,15] and the Rapid Entire Body Assessment (REBA),[16] and the Roteiro para Avaliação de Riscos Musculoesqueléticos (RARME).[17] However, these methods assess biomechanical exposure in general, which differs from the RULA and SI that assess, in particular, for the upper limbs. Therefore, this study aimed to cross-culturally adapt the RULA and SI methods for Brazilian Portuguese version and test its measurement properties.

Methods

The study was approved by the Research Ethics Committee from the Universidade Cidade de São Paulo (UNICID), São Paulo, Brazil, approval number: 734,515.

Rapid Upper Limb Assessment (RULA)

RULA uses diagrams of posture for classification the biomechanical exposure.[18] The postures are evaluated in two groups, upper limbs (group A) and neck, trunk and legs (group B). Each group has partial scores range from 0 to 6 points. Then, for each group (A and B) the muscle use and strength/load are scored, which is added to the partial scores. Finally, it is obtained a total score from groups A and B, their values crossed in Table C (Appendix 1) to obtain the final score (from 1 to 7 points). The level of exposure and investigation priorities are classified as acceptable posture if not maintained or repeated for long periods (1 or 2 points); more investigations are needed and changes may be required (3 or 4 points); investigation and changes are required soon (5 or 6 points); investigation and changes are required immediately (7 points).[13]

Strain Index (SI)

SI evaluates six exposure variables: intensity of exertion, duration of exertion, exertion per minute, hand/wrist posture, speed of work, and the duration of the task per day.[8,9,19] Each of these variables has five classification criteria, with different weights (multiplier factors).[19] This score is used to sort the task into three categories: probably safe tasks (<3); tasks associated with risk for the disorder in distal extremities from the upper limb (>5) and task that is probably dangerous (≥7)[19] (Appendix 2).

Cross-cultural adaptation

The creators of the methods allowed the adaptation to Portuguese-Brazilian and Professor Alan Hedge from Cornell University authorized the use of the RULA protocol graph. The process of cross-cultural adaptation was carried out based on the guidelines of Beaton et al.,[20] which consisted of translation, synthesis of translation, back-translation, revision by a committee of experts, pre-test, and the presentation of documentation for analysis by the Experts Committee.[20]

Pre-test of the pre-final version

Two hundred ninety five physical therapists with knowledge, training or job in the area of occupational health and ergonomics were invited via email to perform the pre-test of the pre-final version of the RULA and SI methods through the analysis of 3 video-tasks along with instructions for applying. On the first attempt, the majority of physical therapists did

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