



# Temporal and kinematic analyses of timed up and go test in chronic low back pain patients<sup>☆</sup>

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## ABSTRACT

**Purpose:** To analyze temporal and kinematic parameters of chronic Low-Back Pain (cLBP) subjects compared to healthy subjects during Timed Up and Go Test (TUG) execution implemented with an Inertial Measurement Unit and to explore the correlations of those parameters with pain and disability.

**Methods:** Observational cross-sectional study. Thirty-one subjects with cLBP [(19 females - 61%), mean age  $61 \pm 19$ ] were allocated to the case group, and 14 healthy [(10 females - 71%), mean age  $62 \pm 6$ ] subjects to the control group. Instrumented TUG was administered to both groups. The Roland Morris Disability Questionnaire and Numerical Pain Rating Scale (NPRS) were also administered for disability and pain assessment in the case group.

**Results:** Mean TUG time to completion [ $12.2 \pm 3.5$  s for cLBP;  $8.1 \pm 0.9$  s for healthy] and the most of sub-phases duration significantly differed between groups ( $p < 0.05$ ). As for kinematic parameters, significant differences ( $p < 0.05$ ) were mainly retrieved in acceleration components during the sit-to-stand and stand-to-sit phase, with the cLBP group showing lower accelerations. Significant correlation [from strong ( $\rho = 0.75$  of time to completion) to moderate ( $\rho = 0.43$  of sit-to-stand)] was observed between RMQD score and all temporal parameters and with most of the kinematic parameters. No correlation with NPRS score was found.

**Conclusions:** Instrumented TUG application into a cLBP population provides valuable information about movement behaviors with a deeper assessment of objective functional impairment and disability in respect of the classical stop-watch outcome of TUG, possibly allowing a better design of the rehabilitative intervention.

## 1. Introduction

The kinematic and temporal analyses of movement help researchers and clinicians to better understand the ways humans move and interact within the environment in which they live [1], better describe the alterations coming from impairments [2], and finally allow to better tailor interventions for patients [3]. In this perspective, motion analysis has become, in the last 30 years, a remarkable and essential field of research [4]. Movement assessment should be a cornerstone for the definition and modulation of rehabilitation interventions. There are still few motion analysis devices that can influence the clinical decision process [5]. Motion analysis labs are among these, but their use is, unfortunately,

limited due to the costs of instruments and analysis. Other small unobtrusive wearable devices, easier to use and cost-effective, have been developed, such as inertial measurement units (IMUs), composed of accelerometers and gyroscopes. Therefore, they could represent an incentive for more widespread motion analysis use within daily clinical rehabilitation activities.

The Timed Up and Go Test (TUG) is a simple, widely used functional test that involves standing up from a chair, walking 3 m, turning, and going back to sit. It evaluates movement, mobility, and dynamic and static balance in people with musculoskeletal impairments [6], neurological diseases [7], and aging-related conditions [8], as well as the quality of life [9], pain and function [10] in people with low back pain

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