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Original Research Article

Response inhibition, set shifting, and complex executive function in patients with chronic lower back pain

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ABSTRACT

Objective: The aim of our study was to evaluate how response inhibition, set shifting, and complex executive function (represented by risky decision-making) are altered in chronic lower back pain patients.

Materials and methods: A total of 29 patients with chronic lower back pain (CLBP >6 months) aged 49–69 years and 30 healthy volunteers matched for age, gender, and education were enrolled in a case–control study. The study was conducted in the Departments of Neurology and Neurosurgery of Panevėžys Regional Hospital, Lithuania. Pain was evaluated by the visual analog scale, Pakula Pain Questionnaire (Lithuanian analog of McGill Pain Questionnaire), and Fibromyalgia Tender Points Examination. A battery of neuropsychological tests used included Stroop Test Victoria version, Trail Making Test parts A and B, and Game of Dice Task (GDT).

Results: CLBP patients did not score significantly worse in any examined neuropsychological tests. Response Inhibition correlated inversely with number of tender points in CLBP patients. GDT performance showed no significant difference in net score (number of safe minus risky decisions). Unexpectedly, both groups favored risky decisions.

Conclusions: We found no statistically significant difference in response inhibition, set shifting, or complex executive function between CLBP patients and healthy older adults. Moreover, a risky decision-making pattern found in the Lithuanian population may underscore the importance of cultural context when examining complex executive function. However, further studies are needed to prove this point.

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1. Introduction

The relationship between chronic pain and cognition is bidirectional: pain may alter cognitive functions [1], while cognitive processes may influence pain perception [2], and predispose pain chronicity [3]. Researchers proposed several mechanisms to explain the impact of chronic pain on cognition [4–9], although they failed to observe a common neuropsychological pattern [1].

Executive function – a subset of cognitive processes – represents a set of abilities that are crucial for guiding one's thoughts and everyday life actions. These are elusive to define [10], and difficult to measure. They include the capacity of intentional behavior, planning and decision-making, purposive action and ability to monitor, self-correct and regulate performance [11].

Chronic pain and executive function have a shared neural substrate mainly in prefrontal regions [2,12–14], however, the evidence for impairment of executive function in pain patients is inconsistent [15–17]. It is important to investigate the link between executive function and pain, because its impairment may translate to the deterioration of the aforementioned capacities in the activities of everyday life.

The unity/diversity framework classifies executive function into four cognitive components: updating, set shifting, response inhibition, and complex executive function [18,19]. A recent meta-analytical review, based on the unity/diversity framework, found a small-to-moderate impairment in executive function performance in people with chronic pain, although 25 studies included in the review had a high risk of bias [20]. Three of them specifically involved patients with chronic lower back pain (CLBP) and had conflicting conclusions: in one of them healthy controls performed significantly better in set shifting [17], another showed no difference in response inhibition [15], while in the third CLBP patients performed significantly better in response inhibition in walk, but not in sit condition [21]. This indicates that study design may play an important role in measuring executive function performance.

In addition, some previous studies found correlation between pain intensity and response inhibition (defined as executive function) [16,22], while others reported a significant association with set shifting (defined as psychomotor speed), but not with executive function [23]. There are also studies that reported a positive relation between executive function and chronic pain in a subset of older adults [24,25]; however, the evidence is scarce.

The aim of our study was to evaluate how response inhibition, set shifting, and complex executive function are altered particularly in chronic lower back pain condition. In this case–control study, we compared two homogeneous populations of CLBP patients and healthy controls by numerous pain parameters and multiple executive function tests.

2. Materials and methods

2.1. *Participants*

The study population comprised 29 patients (13 men and 16 women, aged 49–69 years), treated for constant chronic (>6 months) lower back pain of any etiology in the Departments of Neurology and Neurosurgery of Panevėžys Regional Hospital. Among them, 13 patients were aged less than 60 years, whereas 16 were aged 60 years and more. Before being examined, subjects had to indicate that they did not meet any of the exclusion criteria, which were a history of a neurological or psychiatric illness, brain injury or trauma as well as use of neuromodulating drugs, other than analgesics. Subjects had to complete a pain drawing by shading all painful areas – only those with lower back pain as their primary complaint were included in the study. Sociodemographic data are summarized in Table 1.

The control group (CG) included 30 healthy volunteers (14 men and 16 women, aged 49–74 years) without pain, mostly recruited museum and dormitory guards of nearby towns, not meeting the exclusion criteria. Thirteen subjects were under 60 years old, whereas 17 were sixty and older. The groups were matched for age, gender and education.

The Hospital Anxiety and Depression Scale (HADS) [26] was administered to account for possible differences in anxiety and depression.

Overall 83 subjects were surveyed for both groups of whom 24 were excluded after a careful revision (16 CLBP patients and 8 healthy volunteers accordingly): 5 were excluded due to age (over 75 years old), 3 did not meet our chronic pain criterion (>6 months), 10 were found to have a history of neurological or psychiatric disease, 5 had most intense pain location different than lower back, and 1 subject had 22 years of education and was excluded as an outlier not to skew the sample.

Table 1 – Sociodemographic and pain-related data.

	CLBP patients (n = 29)	CG (n = 30)	P
Gender, *n*			
Male	13	14	0.887
Female	16	16	
Age, years	59.6 (6.0)	60.7 (7.0)	0.606
Education, years	13.0 (2.9)[b]	13.7 (2.6)[c]	0.339
Subjective health state in VAS	60 (24)	33 (25)	<0.001
HADS depression score	5.4 (3.5)	3.8 (2.9)	0.086
HADS anxiety score	6.6 (3.5)	4.3 (2.9)	0.015
Pain duration, months	91 (159)[d]		
Current pain in VAS	56 (24)		
Pain last week in VAS	61 (17)		
Worst pain last week in VAS	81 (13)		
Pakula Pain Questionnaire[a]			
Affective component	28.0 (12.0)		
Sensory component	37.3 (15.3)		
Tender Points Examination tender points	6.9 (5.4)[d]		

Values are mean (standard deviation) unless otherwise stated. CLBP, chronic lower back pain; CG, control group; HADS, Hospital Anxiety and Depression Scale; VAS, visual analog scale (0–100 mm) with a higher score indicating poorer health and worse pain.

[a] Lithuanian analog to McGill Pain Questionnaire.

[b] n = 26.

[c] n = 27.

[d] n = 28.