Predicting patient-perceived low-back pain through pressure pain sensitivity

Juan Vicente-Mampel[1], Paula Blanco-Giménez[1], Carlos Barrios[2]

[1]Faculty of Medicine and Health Sciences. Department of Physiotherapy. Universidad Católica de Valencia. Torrent. Valencia. [2]Musculoskeletal Disease Research Institute. Faculty of Medicine and Health Sciences. Universidad Católica de Valencia. Valencia.

doi: 10.18176/archmeddeporte.00210

Received: 30/10/2024
Accepted: 06/05/2025

Summary

Introduction: The biopsychosocial model has enabled the assessment of pain as a multidimensional experience, especially in cases of chronic spinal pain, where there is a discrepancy between structural abnormalities and the pain experience, suggesting the influence of biological, psychological, and social factors. In elite athletes with low back pain, both biomechanical and biopsychosocial factors are essential. The objective of this study was to assess whether the indirect measurement of pain sensitivity to pressure was related to the subjective perception of pain in patients with low back pain.
Material and method: A descriptive observational study was designed following STROBE guidelines, with approval from the Ethics Committee of the Catholic University of Valencia (UCV/2019-2020/138). Descriptive data of participants were represented by the mean and standard deviation. Pressure pain thresholds were assessed using pressure algometry, and pain perception was measured with a visual analog scale. Pearson correlation analysis and simple linear regression were used, with a significance level of $P < 0.05$, using SPSS and JASP software.
Results: The results showed a strong linear correlation (R = 0.88) between pressure pain thresholds and pain perception. The analysis revealed that the pressure pain threshold explained 78% of the variability in pain perception ($R^2 = 0.78$). The unstandardized coefficient was 0.659, with a standard error of 0.051, suggesting a moderate impact, with a statistically significant relationship (t = 12.930, $P < 0.001$).
Conclusion: The preliminary results of this research indicated that pressure algometry assessed in the lumbar region is indirectly related to an increased perception of pain in patients.

Key words:
Low back pain. Algometry. Biopsychosocial model. Chronic pain.

Predicción del dolor lumbar percibido por el paciente mediante sensibilidad dolorosa a la presión

Resumen

Introducción: El modelo biopsicosocial ha permitido evaluar el dolor como una experiencia multidimensional, especialmente en el caso del dolor crónico espinal, donde existe una discordancia entre las anomalías estructurales y la experiencia dolorosa, sugiriendo la influencia de factores biológicos, psicológicos y sociales. En atletas de élite con dolor lumbar, tanto los factores biomecánicos como los biopsicosociales son fundamentales. El objetivo de este estudio fue evaluar si la medición indirecta de la sensibilidad dolorosa a la presión estaba relacionada con la percepción subjetiva del dolor en pacientes con dolor lumbar.
Material y método: Se diseñó un es estudio descriptivo observacional, siguiendo las directrices STROBE, con aprobación del Comité de Ética de la Universidad Católica de Valencia (UCV/2019-2020/138). Los datos descriptivos de los participantes fueron representados por la media y la desviación estándar. Los umbrales de dolor a la presión fueron evaluados mediante algometría por presión y la percepción del dolor fue medida con una escala analógica visual. Se utilizó análisis de correlación de Pearson y un de regresión lineal simple, con un nivel de significancia de $p < 0,05$, utilizando los programas SPSS y JASP.
Resultados: Los resultados mostraron una fuerte correlación lineal (R = 0,88) entre los umbrales de dolor a la presión y la percepción del dolor. El análisis reveló que el umbral de dolor a la presión explicó el 78% de la variabilidad en la percepción del dolor ($R^2 = 0,78$). El coeficiente no estandarizado fue de 0,659, con un error estándar de 0,051, sugiriendo un impacto moderado, con una relación estadísticamente significativa (t = 12.930, $p < 0,001$).
Conclusión: Los resultados preliminares de la presente investigación indicaron que la algometría por presión evaluada en la zona lumbar, está relacionada indirectamente con una percepción incrementada del dolor en los pacientes.

Palabras clave:
Dolor lumbar. Algometría. Modelo biopsicosocial. Dolor crónico.

Correspondence: Juan Vicente Mampel
E-mail: juan.vicente@ucv.es

Introduction

Since 2019, when the World Health Organization issued the International Classification of Diseases, Eleventh Revision (ICD-11)[2], the biopsychosocial model has permitted the application of theoretical concepts in the clinical assessment of patients by defining pain as a multidimensional experience[1]. Specifically, the course of chronic spinal pain is characterised by persistent pain in which structural abnormalities do not align with the experience of pain. This discordance points to the possible role of biological, psychological and social factors in explaining persistent pain and disability associated with neuroplastic changes in the central nervous system, defined as nociplastic pain. Chronic spinal pain involves a variety of diagnostic labels. These can include: i) non-specific low back pain, ii) non-specific non-traumatic cervical pain, and iii) failed low back surgery – recently called persistent spinal pain syndrome[3].

When doing sport, the experience of athletes with low back pain is influenced by a culture in which pain and injuries are tolerated[4]. It should be stressed that activities such as jumping and lifting cause great compression in the L4-L5 lumbar region, resulting in high levels of stress on somatic structures[5]. In addition to biomechanical factors, biopsychosocial aspects are considered crucial for recovery from low back pain in elite athletes[6]. On this basis, it is considered necessary to identify homogeneous subgroups in clinical settings to personalise short-term pain management interventions. However, further studies are required for model validation to refine treatment strategies more effectively in patients with low back pain[7]. An important additional preliminary step towards personalised medicine for the management of low back pain was established by the "BACPAP" recommendations, indicating the predominant etiopathogenesis between nociceptive, neuropathic and nociplastic low back pain[8].

Various strategies for the classification of patients with low back pain have been implemented to date, for example, classifying patients according to their disability so as to assess the effect of treatment in detail[9]. To this end, the Oswestry questionnaire allows functionality to be assessed in a multidimensional manner through disability changes in a patient's status[10]. This provides a suitable indication for therapeutic interventions for patients with low back pain[11]. However, the diagnosis and treatment of low back pain need a comprehensive approach which takes into account both psychological factors and pain sensitivity profiles in order to optimise clinical outcomes[12].

In this context, a mechanism-based approach to pain assessment and management has been proposed in contemporary research. Nevertheless, the application of pain mechanism assessment strategies in clinical practice is still unclear[13]. Preliminary published results suggest that clinical improvement in patients with low back pain is not necessarily linked to changes in the sensory profile of the pain. The need for further research on the usefulness of assessing pain sensitivity in these patients is stressed, given that the population is heterogeneous and the assessment methods used vary in sensitivity[14]. To this end, the objective of this study was to investigate whether there is a relationship between pressure pain thresholds assessed using pressure algometry and the pain perception obtained using a visual analogue scale in patients with low back pain classified on the basis of the Oswestry questionnaire to elucidate the relationship between sensitivity assessment and the patient's subjective response.

Materials and methods

Research design

A descriptive cross-sectional study was conducted with a sample of patients diagnosed with low back pain classified as category 2 on the Oswestry scale. This study was approved by the Universidad Católica de Valencia's Ethics Committee (reference number: UCV/2019-2020/138). All the participants who decided to sign up for the study gave their informed consent before taking part in accordance with the ethical guidelines of the Declaration of Helsinki[15]. The study adhered to the STROBE checklist in both its design and participant progression[16].

Participants

Participants were recruited through advertisements promoting "a new study on chronic low back pain" in leaflets and on posters in Valencia (Spain), and on popular social networks such as LinkedIn, Facebook and Instagram. The data were collected between January 2021 and March 2022. The inclusion criteria were as follows: i) Age between 18 and 65; ii) Diagnosis of chronic non-specific low back pain confirmed by a specialist in traumatology and orthopedics[17] iii) Presence of a moderate disability assessed using the Oswestry Disability Index (ODI). Scores <20 (Category 2)[18].

Variables

Anthropometric characteristics

Information about sex at birth, age and, using a scale, anthropometric measurements was collected.

Pain assessment. Visual analogue scale and hyperalgesia

Subjective perception of pain. Visual analogue scale. Visual Analogue Scale (VAS). The VAS is considered the most representative scale, being the best option because it is easy to understand and use. The scale used was the one with values from 0 to 10. This scale is an effective tool to quantify this range in a subjective and discriminative manner. 0 means that the individual does not experience pain and 10 is the worst pain that he/she can imagine. The VAS has been shown to be extremely reliable (Cronbrach $\alpha = 0.97$) [95% CI = 0.96 to 0.98][19].

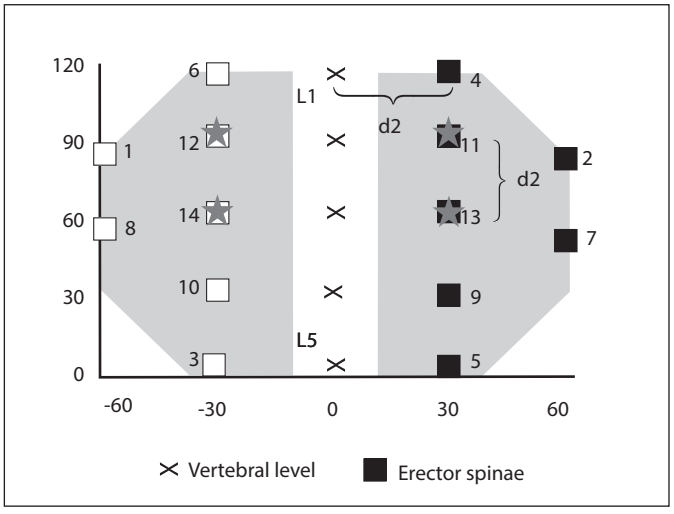
Pain sensitivity. Pressure pain thresholds (PPT). Pressure algometry is considered a useful method for calculating the degree of deep-tissue sensitivity[20]. Pressure algometry allows us to quantify pain, which is why it is one of the most used measuring instruments. The assessment was

carried out with a measuring instrument called an algometer. The pressure algometer used was a *Wagner Fdk/Fdn series Force Dial analogue Fisher algometer* (Wagner Instruments, Greenwich, CT). The algometer in this study consists of a pressure gauge attached to a 1cm cylindrical rubber tip[2]. The rubber part is used to exert pressure on the subject's muscle tissues. The pressure gauge measures the pressure applied through the rubber and the patient should indicate when this pressure begins to be painful, establishing the pressure pain threshold (PPT). The reliability of pressure algometry is relatively high, with coefficients between 0.9 and 0.95[22]. The force of the algometer was applied perpendicular to the muscle, maintaining the pressure exerted. This pressure was gradually increased (1kg/sec) until the subject, with a signal, indicated that the pressure was painful[23]. Four structures were located by palpation and the algometer was applied to each of them to obtain the PPT value. The four points selected were lateral to the lumbar spinous processes. Each measurement was taken three consecutive times, discarding the highest value. The mean of the remaining values was then calculated[24]. The spinous processes from L1 to L5 were located and marked. The distance between L1 and L5 was then measured (d1) and a new figure (d2) was calculated by dividing this by 4 to arrive at the distance between each spinous process. Two parallel lines were then drawn by measuring d2 horizontally on each side of the spinous process[25]. These lines were over the lumbar paraspinal muscles. Two points on each of the paraspinal lines were then marked at the height of the L2 and L3 processes, 4 points in all. The mean of the measurements taken at these points was calculated to arrive at a single value. 3 measurements were taken at these 4 points (Figure 1).

Statistical method

All the participants who agreed to provide data were included. The descriptive data were presented as sums and percentages for categorical data, and as a mean, 95% confidence interval (CI), interquartile ranges and standard deviation (SD) for continuous data with normal distribution. Correlations between the study variables were analysed by correlation analysis. Specifically, the Pearson correlation coefficient between the study variables was calculated and multicollinearity was also evaluated by calculating the variance inflation factor (VIF) and the tolerance values for the predictor variables. Two simple linear regression analyses were performed to test the study hypotheses. The criterion variable in the first simple linear regression analysis was the measure of pain perception. The bias-corrected confidence interval (CI) was calculated with 5,000 bootstrap resamples. The significance level was set at P <0,05. Analysis was performed using Statistical Package for Social Sciences (SPSS) version 25 (IBM Corp, Armonk, NY, USA) and JASP (Version 00.15.0.0.0, 2023). The statistical analysis was carried out by a researcher who did not participate in any of the data collection stages and received the data in coded form.

Figure 1. Lumbar area PPTs.



Results

Participation flow and characteristics of the sample

A total of 48 participants diagnosed with low back pain signed up for this study. A descriptive analysis of the demographic and clinical characteristics of the participants included in the study was conducted. Of the 48 participants, 56.25% were men and 43.75%, women. The mean age of the participants was 45.38 years (±15.11). The mean weight of the participants was 69.24 kg (±13.39), with a range of 50 kg to 99 kg. The mean height was 1.70 m (±0.10), with a range of 0.38 m. The mean score in the pressure pain threshold assessment was 8.12 (±1.17), with a range of 5.90. Finally, the mean of subjective perception of pain assessed using the VAS scale was 5.56 (±2.57), with a range of 9.00.

Main results

Pearson correlation coefficient

The primary results are listed in Table 1.

Prediction of perception of pain

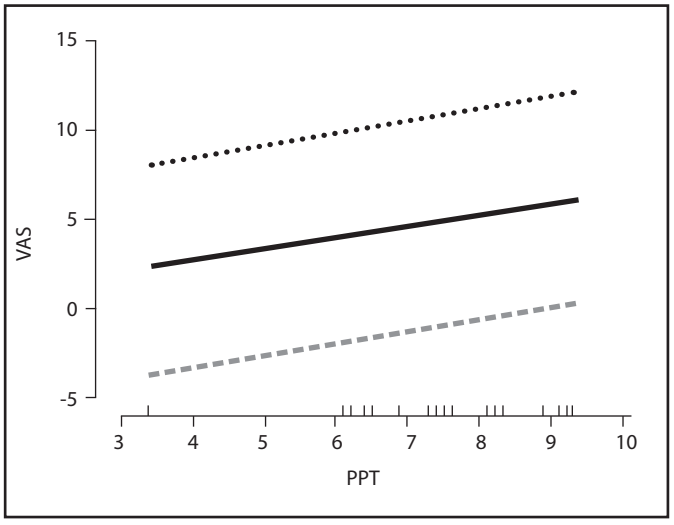
A regression analysis was carried out to evaluate the relationship between pain perception and the dependent variable pressure pain sensitivity assessed by means of algometry. The correlation coefficient r (0.88) showed a strong linear relationship between pressure pain

Table 1. Correlation analysis.

Variables	Pain perception (Pearson's r and *P*-value)
Edad	-0.20 (0.16)
Peso	-0.11 (0.43)
Altura	-0.12 (0.39)
PPT	-0.29 (0.04) *

PPT (Pain Pressure Threshold); Pearson's r (the Pearson correlation coefficient);*P-value* (statistical significance of the results) and * P <0.05: the null hypothesis is rejected, indicating that the results are statistically significant.

Figure 2. The graph represents a linear regression between VAS (on the vertical axis) and PPT (on the horizontal axis).



thresholds and pain perception. The r^2 value (0.78) indicated that the control variable (PPT) explained 78% of the variance in the criterion variable. The non-standardised coefficient for PPT was 0.659, with a standard error of 0.051, indicating an accurate estimate of effect. The standardised coefficient was 0.299, suggesting a moderate impact on pain perception. The associated t-value was 12.93, showing that the relationship was statistically significant (P = <0.001) (Figure 2).

Discussion

The findings of this study underscore the relevance of the PPT variable as a significant predictor of pain perception in patients with low back pain classified in category 2 of the Oswestry index. The results of the analysis indicate that the higher the PPT score, the greater the intensity of pain reported on VAS. This implies that patients with less pressure pain sensitivity tend to experience and report higher levels of pain than their self-assessment using VAS. In summary, the findings suggest that lower sensitivity is strongly associated with increased subjective perception of pain in patients with low back pain. This relationship is not only relevant to our understanding of pain, but it also has important implications for patient treatment and management. In line with the present results, the prediction of pain intensity perceived by patients with low back pain is dependent not only on physiological parameters such as PPTs but also on psychosocial or even demographic factors such as gender[26].

Patients who experience chronic pain have a significantly lower pressure pain threshold compared to healthy controls[27]. Traditionally and from a clinical perspective, the assessment of the effect of any treatment has been based on one-dimensional questionnaires which only assess a single aspect of the experience of pain – visual analogue scale. For this reason, and due to the subjectivity of the assessment, other means of assessment have been used, which, although indirect, can provide objective information, such as pressure pain thresholds assessed by means of pressure algometry. Evidence suggests that the pressure pain threshold is lower in a number of musculoskeletal disorders and, although PPT has been shown to be a reliable measure in patients with acute conditions, there is great variability in the methods and outcomes observed in studies and only scant evidence to confirm its reliability with chronic conditions[14].

The above aligns with the results of this research, but these decreased pressure pain thresholds do not represent the experience of pain in patients with low back pain, although lower hyperalgesia is accompanied by clinical improvements in pain and function[28]. Preliminary results already published observe that patients with psychosocial risk factors presented significantly lower PPT both locally and peripherally. That is to say, psychosocial factors may play a critical role in modulating pain sensitivity in chronic conditions. So considering other meaningful interactions in clinical practice may be important for the treatment of some patients[29]. Patients' pain-related cognitions have an adverse effect on their physical health-related quality of life by negative influencing pain intensity in people with low back pain[30].

Various limitations must be taken into account in this research. Although high intra- and inter-observer reliability was observed in all the studies, variation in PPT measurement protocols could affect validity and absolute reliability. Therefore, it is recommended that standard guidelines be developed for clinical use, recommending caution when performing tests in the low back pain area because a systematic difference was observed between the test and repetition of the test[31]. Furthermore, the data were not classified taking into account the sex of the participants. The women reported lower pressure pain thresholds and greater sensitivity to mechanical stimuli. In short, biological and psychological factors differ between men and women, and appear to intervene in the individual experience of pain. Future lines of research should broaden the results with patients classified in different categories of the Oswestry index and take into account more specific parameters which could be associated with the individual experiences of pain in patients with low back pain, which it would be advisable to apply in clinical practice.

Conclusion

The findings of this study indicate that hypersensitivity, measured through pressure algometry in the lumbar area, is negatively related to an increased perception of pain in patients. Understanding these relationships may open new avenues for the development of more effective and personalised interventions which can improve the quality of life of those suffering from low back pain classified as score category 2 of the Oswestry multidimensional questionnaire.

Availability of the data

The datasets compiled and/or analysed in this study are available from the corresponding author on reasonable request.

Funding

This study did not receive external funding.

Acknowledgements

We would like to thank the patients who participated in the research.

Conflict of interest

The authors declare no conflict of interest.

Bibliography

1. El dolor y su clasificación: revisión de algunas propuestas. *J Health Psychol.* 1994;27.
2. Margarit C. La nueva clasificación internacional de enfermedades (CIE-11) y el dolor crónico. Implicaciones prácticas. *Rev Soc Esp Dolor.* 2019;264:209-10.
3. Nijs J, Meeus M, Cagnie B, Roussel NA, Dolphens M, Van Oosterwijck J, *et al*. A modern neuroscience approach to chronic spinal pain: combining pain neuroscience education with cognition-targeted motor control training. *Phys Ther*. 2014;94:730-8.
4. Wall J, McGowan E, Meehan W, Wilson F. Back pain is part of sport. I'm just gonna have to live with it: Exploring the lived experience of sport-related low back pain in adolescent athletes. *Phys Ther SPORT.* 2023;62:71-8.
5. Schaefer R, Trompeter K, Fett D, Heinrich K, Funken J, Willwacher S, *et al*. The mechanical loading of the spine in physical activities. *Eur SPINE J.* 2023;32:2991-3001.
6. Trease L, Mosler AB, Donaldson A, Hancock MJ, Makdissi M, Wilkie K, *et al*. What factors do clinicians, coaches, and athletes perceive are associated with recovery from low back pain in elite athletes? a concept mapping study. *J Orthop Sports Phys Ther.* 2023;53:610-25.
7. Wilson AT, Riley JL, Bishop MD, Beneciuk JM, Cruz-Almeida Y, Markut K, *et al*. Pain phenotyping and investigation of outcomes in physical therapy: An exploratory study in patients with low back pain. *PloS One.* 2023;18:e0281517.
8. Nijs J, Kosek E, Chiarotto A, Cook C, Danneels LA, Fernández-de-Las-Peñas C, *et al*. Nociceptive, neuropathic, or nociplastic low back pain? The low back pain phenotyping (BACPAP) consortium's international and multidisciplinary consensus recommendations. *Lancet Rheumatol.* 2024;6:e178-88.
9. Henry SM, Van Dillen LR, Trombley AR, Dee JM, Bunn JY. Reliability of novice raters in using the movement system impairment approach to classify people with low back pain. *Man Ther.* 2013;18:35-40.
10. Sheng Y, Duan Z, Qu Q, Chen W, Yu B. Kinesio taping in treatment of chronic non-specific low back pain: a systematic review and meta-analysis. *J Rehabil Med.* 2019;51:734-40.
11. Mehra A, Baker D, Disney S, Pynsent P. Oswestry disability index scoring made easy. *Ann R Coll Surg Engl.* 2008;90:497-9.
12. Palsson TS, Christensen SWM, De Martino E, Graven-Nielsen T. Pain and disability in low back pain can be reduced despite no significant improvements in mechanistic pain biomarkers. *Clin J Pain.* 2021;37:330-8.
13. Jayaseelan DJ, Scalzitti DA, Courtney CA. Physical therapist perceptions and use of clinical pain mechanism assessment in the musculoskeletal setting: a survey analysis. *BMC Musculoskelet Disord.* 2023;24:509.
14. Zicarelli CAM, Santos JPM, Poli-Frederico RC, Silva RA, Barrilec F, Barrette G, *et al*. Reliability of pressure pain threshold to discriminate individuals with neck and low back pain. *J Back Musculoskelet Rehabil.* 2021;34:363-70.
15. Association. WM. World medical association declaration of helsinki: Ethical principles for medical research involving human subjects. Vol. 79, Bulletin of the World Health Organization. World Health Organization; 2001. p. 373-4.
16. Cuschieri S. The STROBE guidelines. *Saudi J Anaesth.* 2019;13(Suppl 1):S31-4.
17. Childs JD, Piva SR, Fritz JM. Responsiveness of the numeric pain rating scale in patients with low back pain. *Spine.* 2005;30:1331-4.
18. Chiarotto A, Boers M, Deyo RA, Buchbinder R, Corbin TP, Costa LO, *et al*. Core outcome measurement instruments for clinical trials in nonspecific low back pain. *Pain.* 2018;159:481.
19. Fähndrich E, Linden M. Reliability and validity of the Visual Analogue Scale (VAS) (author's transl). *Pharmacopsychiatria.* 1982;15:90-4.
20. Lozano AH, Morales MA, Lorenzo CM, Sánchez AC. Dolor y estrés en fisioterapia: algometría de presión. *Rev Iberoam Fisioter Kinesiol.* 2006;9:3-10.
21. Strong J. Assessment of pain perception in clinical practice. *Man Ther.* 1999;4:216-20.
22. Park G, Kim CW, Park SB, Kim MJ, Jang SH. Reliability and usefulness of the pressure pain threshold measurement in patients with myofascial pain. *Ann Rehabil Med.* 2011;35:412.
23. Smythe H, Gladman A, Dagenais P, Kraishi M, Blake R. Relation between fibrositic and control site tenderness; effects of dolorimeter scale length and footplate size. *J Rheumatol.* 1992;19:284-9.
24. Plaza-Manzano G, Cancela-Cilleruelo I, Fernández-de-las-Peñas C, Cleland JA, Arias-Buría JL, Thoomes-de-Graaf M, *et al*. Effects of adding a neurodynamic mobilization to motor control training in patients with lumbar radiculopathy due to disc herniation: a randomized clinical trial. *Am J Phys Med Rehabil.* 2020;99:124.
25. Hirayama J, Yamagata M, Ogata S, Shimizu K, Ikeda Y, Takahashi K. Relationship between low-back pain, muscle spasm and pressure pain thresholds in patients with lumbar disc herniation. *Eur Spine J.* 2006;15:41-7.
26. Steinmetz A, Hacke F, Delank KS. Pressure pain thresholds and central sensitization in relation to psychosocial predictors of chronicity in low back pain. *Diagnostics.* 2023;13:786.
27. Amiri M, Alavinia M, Singh M, Kumbhare D. Pressure pain threshold in patients with chronic pain: a systematic review and meta-analysis. *Am J Phys Med Rehabil.* 2021;100:656-74.
28. Chapman KB, van Roosendaal BK, Yousef TA, Vissers KC, van Helmond N. Dorsal root ganglion stimulation normalizes measures of pain processing in patients with chronic low-back pain: a prospective pilot study using quantitative sensory testing. *Pain Pract off J World Inst Pain.* 2021;21:568-77.
29. Rabey M, Buldo B, Duesund Helland M, Pang C, Kendell M, Beales D. Significant other interactions in people with chronic low back pain: Subgrouping and multidimensional profiles. *Br J Pain.* 2022;16:326-40.
30. Van Bogaert W, Liew BXW, Fernández-de-Las-Peñas C, Valera-Calero JA, Varol U, Coppieters I, *et al*. Exploring interactions between sex, pain characteristics, disability, and quality of life in people with chronic spinal pain: a structural equation model. *J Pain.* 2024;25:791-804.
31. de Oliveira FCL, Cossette C, Mailloux C, Wideman TH, Beaulieu LD, Massé-Alarie H. Within-Session Test-Retest Reliability of pressure pain threshold and mechanical temporal summation in chronic low back pain. *Clin J Pain.* 2023;39:217.