Natural Resources for Human Health

eISSN: 2583-1194

Original Research

Received 9 August 2026
Revised 12 September 2026
Accepted 11 October 2026

Natural Resources for Human Health 2026, Vol. 6 (21s): 176–182

KEYWORDS:
Chronic Low Back Pain, Outcome Measure, Data Correlation.

Correlation between Pain, Back Function, Lumbar Flexibility, Hamstring Flexibility, and Pain Pressure Threshold in Subjects with Chronic Non-Specific Low Back Pain: A Cross-Sectional Analysis

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ABSTRACT:

Background: Chronic nonspecific low back pain (CNSLBP) is a multifactorial condition in which pain, back function, lumbar mobility, hamstring flexibility, and pain sensitivity may be interrelated. This study aimed to examine the association between pain, pressure pain threshold (PPT), back function, hamstring flexibility, and lumbar flexion/extension mobility in patients with CNSLBP.

Materials and Methods: Thirty-four subjects with a mean age of 31.32 ± 0.99 years who were diagnosed with CNSLBP were recruited. Pain intensity was measured using the Numeric Pain Rating Scale (NPRS), Pain pressure threshold (PPT) using a pressure algometer (PA), functional disability using Oswestry disability index (ODI). In addition, lumbar flexion and extension flexibility were measured using the Modified-Modified Schober's test, and hamstring flexibility using Active Knee Extension test (AKE) and a bubble inclinometer. Spearman's correlation coefficient analysis was performed.

Results: A negative correlation was found between pain and lumbar flexion ($r = -0.51$, $p = .002$) and between pain and lumbar extension ($r = -0.36$, $p = .038$). An inverse correlation was also detected between pain and the right ($r = -0.50$, $p = .003$) and left ($r = -0.55$, $p < .01$) hamstring flexibility, while Lumbar extension correlated positively with the right ($r = 0.59$, $p < .01$) and left ($r = 0.52$, $p = .002$) hamstring flexibility.

Conclusion: Subjects with CNSLBP demonstrate multi-factorial, inter-related outcomes supporting the use of a multi-factorial approach to assessment in future research.

INTRODUCTION

Chronic low back pain (CLBP) ranks among the most frequent musculoskeletal disorders worldwide. It significantly impairs quality of life, creating significant pressure on healthcare systems and social well-being (1). Approximately 30%–40% of subjects with Low Back Pain (LBP) are classified as 'non-specific' LBP as they have no precise diagnosis (2,3). Research efforts suggested several contributing factors such as genetic factors, aging, obesity, smoking, Physiology (such as reduced physical fitness and trunk strength) and work related conditions. Also, Psychosocial factors such as poor job satisfaction and repetitive work are important contributing factors for LBP (4).

While pain intensity is variable in subjects with CNSLBP and is usually accompanied with alterations in pain processing mechanisms, persistent pain may cause peripheral and central sensitization, resulting in Hyperalgesia. Pressure pain threshold

(PPT), measured by algometry, is a validated quantitative sensory testing method used to assess mechanical pain sensitivity. It is markedly reduced in subjects with chronic low back pain compared with healthy subjects (5,6).

Reduced hamstring flexibility is frequently observed in subjects with CNSLBP. The hamstring muscles are kinematically interconnected to lumbar spine movement and pelvic positioning through the lumbopelvic rhythm. Hamstring tightness may prevent anterior pelvic tilt during trunk flexion, causing compensatory lumbar movements and increased biomechanical stress on spinal structures. Multiple studies have indicated a relationship between decreased hamstring flexibility and the development of low back pain (7–9).

Restricted lumbar mobility is another important factor that may cause CNSLBP. Reduced lumbar range of motion has been associated with pain, movement dysfunction, and limitations in daily activities causing abnormal spinal kinematics (10).

Functional disability is commonly examined in subjects with CNSLBP to analyze the effect of lumbar pain on daily living activities. They often face notable restrictions in occupational activities, leisure, and daily self-care activities, causing impaired physical function. Previous investigations have demonstrated that increased pain intensity, limited flexibility, and impaired pain sensitivity are associated with decreased functional ability (11,12).

Understanding the underlying bio-mechanical causes of CNSLBP is necessary for better therapeutic approaches. A cross-sectional study has detected a positive relationship between reduced spinal mobility and pressure pain threshold among those experiencing persistent non-specific LBP denoting high pressure pain thresholds associated with high degrees of stiffness (13). Other studies have indicated that hamstring muscle tightness may influence pelvic tilt and lumbar spine mechanics, causing altered movement patterns and contributing to functional limitations in subjects with chronic low back pain(14). However, the overall quality of evidence supporting a direct association between hamstring flexibility and low back pain remains limited (15). Similarly, other clinical investigations have reported weak or non-significant correlations between hamstring tightness, functional disability, and pain intensity, suggesting that these relationships are complex and not yet clearly established (16).

The interaction between musculoskeletal factors such as lumbar range of motion, muscle flexibility, and pain perception likely involves various biomechanical and neuromuscular mechanisms that are not yet completely understood (17). Thus, the inconsistencies in the existing literature highlight the need for further investigations to clarify the relationships between these outcomes and provide valuable insights for clinicians to help optimize rehabilitation strategies and treatment planning. Therefore, the current study was designed to examine the correlations between pain, pressure pain threshold, back performance, lumbar mobility, and hamstring flexibility in subjects experiencing CNSLBP.

MATERIALS AND METHODS

Study design

This cross-sectional correlation study was designed to investigate the relationships between pain intensity, back function, hamstring flexibility and lumbar flexibility in subjects with CNSLBP. The study included thirty-four subjects aged between 20 to 45 years old with BMI less than 30 kg/m^2, they were referred by their primary care physicians after being diagnosed with chronic non-specific low back pain to the outpatient clinic seeing primarily patients with orthopedic condition. The study was approved by the Ethical Review Board of the Faculty of Physical Therapy, Cairo University [P.T.REC/012/004035].

The study was carried out in accordance with the ethical standards of the Declaration of Helsinki, and a written consent form was obtained by all subjects prior to the study. All subjects were expected to have no lower back pain treatment for at least one month before enrollment in the study. Subjects who were pregnant or present with fibromyalgia, disc lesions, degenerative spinal disorders, spinal fractures, tumors, infections, or prior lumbar surgeries were excluded from the study.

Outcome measurements

Pain intensity was assessed using the Numeric Pain Rating scale (NPRS). Subjects were asked to rate their pain intensity on an 11-point scale ranging from 0 to 10, where 0 represents “no pain” and 10 is “the worst imaginable pain.” The NPRS is a well-established subjective instrument for assessing pain intensity in adults, demonstrating good to excellent test retest reliability (18,19).

Pain Pressure Threshold was measured using a digital pressure algometer (PA) (JTECH Medical, Midvale, Utah, USA). The PA provides numerical data on pain sensitivity, making it a more objective tool for monitoring tenderness. It has excellent intra-

rater reliability with intraclass correlation coefficient (ICC) of 0.94 (95% CI: 0.89–0.96) for lumbar measurements, indicating a high level of consistency in repeated assessments.

The algometer was positioned perpendicular to the skin surface in the lumbar paraspinal region. Subjects were instructed to verbally indicate the moment at which the sensation of pressure first converted to pain, at which point the examiner immediately ceased the application and recorded the value. The average value of the three repetitive measurements was recorded with an interval of 30-60 seconds, expressed in kilograms per centimeter square (20).

The Oswestry disability index (ODI) is a commonly used questionnaire for measuring functional disability and is often considered a gold standard outcome measure for low back disability. ODI reported validity (ICC = 0.60-0.74) and reliability (ICC =0.84-0.94) for functional disability assessment (21). The minimal clinical important difference (MCID) is 10 points for subjects with low back pain (22,23), with sensitivity and specificity 76% and 63% respectively (24). The ODI evaluates back function and consists of 10 item, including personal care, pain intensity, walking, lifting, sitting, standing, social life, sleeping, travel, and sexual activity. The subjects were asked to choose the answer that best reflects their current functional status. Each item scored on a scale from 0 (no limitation) to 5 (maximum limitation). The total score was calculated as a percentage, where 0% indicates no disability and 100% reflects the worst possible disability (21).

Lumbar spine flexibility was assessed using the Modified-Modified Schober's test, a valid and reliable procedure for lumbar flexion and extension flexibility demonstrating high Intraclass Correlation Coefficients (ICCs) of 0.85 for flexion and 0.73 for extension (25). During assessment of lumbar flexion flexibility, subjects were in standing position, and the investigator was kneeling behind them. The examiner identified the posterior superior iliac spines (PSISs) and a horizontal line was marked between them.

A single ink mark was applied halfway on the line at S2 vertebral level, the other mark was applied 15 cm above the first mark. The investigator fixed a tape measure between the two marks, then subjects were asked to maximally lean forward, and the newly measured distance between the two marks was recorded. The new recorded measurement was the amount of lumbar flexion. Lumbar extension was measured in the same way except that the subjects were instructed to lean backward, and the new recorded distance between the two marks was the amount of lumbar extension (25).

Finally, hamstring flexibility was measured using AKE test and a bubble inclinometer. The AKE test has excellent reliability, with intraclass correlation coefficient (ICC) values ranging (0.94-0.99) and inter-rater ICC values of (0.92-0.98) (26). Bubble inclinometers are also a common tool that are used to measure joint range of motion (ROM) with excellent intra- and inter-rater correlation coefficients for the measurements (0.97 and 0.97 respectively) (27).

The subject was positioned in a supine lying position, with the hip flexed to 90°, and was maintained either by using manual stabilization or a support device to prevent compensatory pelvic movement. From this position, the subject was instructed to actively extend the knee as far as possible until a strong but tolerable stretch was felt in the posterior thigh, without allowing movement at the hip. The angle of knee flexion was then measured using an inclinometer, with greater extension indicating increased hamstring flexibility. Trials were performed three times on each leg, and the average was used for the statistical analysis (26).

Statistical analysis

IBM SPSS Statistics for Windows, version 29 (IBM Corp., Chicago, IL, USA) was used to perform statistical analysis. Continuous variables were expressed as the mean ± standard deviation and the categorical variables were expressed as frequency distribution (%) in the descriptive statistics. Normality of the data was determined using Shapiro-Wilk test. The significance level of all statistical tests was set at $p < 0.05$.

RESULTS

Thirty-four subjects were included in the study. The mean age of the studied population was 31.7 ± 8.4 years, and the mean body mass index (BMI) was 25.2 ± 2.4 kg/m², indicating that, on average, subjects fell within the overweight range. Regarding sex distribution, the majority of subjects were male (n = 20, 58.8%), while females constituted 41.2% (n = 14) of the sample.

Shapiro-Wilk showed that all variables were not normally distributed ($p<0.05$), therefore, Spearman's correlation coefficient was calculated for all variables.

Table 1. Correlation between pain, back function, lumbar flexibility, hamstring flexibility and pain pressure threshold

Variable	Pain	Function	FLEX (M-M Schober)	EXT (M-M Schober)	RT Ham. Flex.	LT Ham. Flex.	RT PPT
Function	.31						
FLEX-M-M Schober	-.51**	.11					
EXT-M-M Schober	-.36*	-.17	.03				
RT Ham. Flex.	-.50**	.20	.06	.59**			
LT Ham. Flex.	-.55**	.17	.06	.52**	.90**		
RT PPT	.01	.04	.16	.03	.09	-.02	
LT PPT	.04	.09	.12	-.03	.11	.15	.87**

**Correlation is significant at p < .05 (2-tailed). **Correlation is significant at p < .01 (2-tailed).*

Abbreviations: PPT = Pressure Pain Threshold; RT/LT Ham. Flex. = Right/Left Hamstring Flexibility; FLEX/EXT-M-M Schober = Lumbar Flexion/Extension measured by the Modified-Modified Schober test; Pain = Numeric Pain Rating Scale (NPRS); Function = Oswestry Disability Index (ODI).

There was no correlation between pain and back function ($r = 0.31$, $p > .05$), however, pain was inversely correlated with both, lumbar flexion ($r = -0.51$, $p = .002$) and lumbar extension ($r = -0.36$, $p = .038$). An inverse correlation was also found between pain and the right ($r = -0.50$, $p = .003$) and left ($r = -0.55$, $p < .01$) hamstring flexibility and finally, lumbar extension related positively with right ($r = 0.59$, $p < .01$) and left ($r = 0.52$, $p = .002$) hamstring flexibility.

DISCUSSION

The non-significant correlation that was found between pain intensity and back function ($r = 0.31$, $p > .05$) in the current sample was contrary to earlier studies (13). Rather than a brief dismissal, these finding merits careful consideration because it may reflect several different explanations of which each may lead to a different interpretation to the observed finding. One possibility is that the sample size may not have been enough to identify the expected results. Therefore, the lack of statistical significance may be due to limited sample size rather than a real correlation.

Another explanation concerns the multifactorial nature of disability in CNSLBP, which arises from pain severity together with fear of movement, psycho-social factors, and work-related aspects, which each may cause variation in disability beyond that explained by pain intensity alone (11,12). Thus, two subjects recording same pain intensity may experience different degrees of functional restriction. Also, the absence of psycho-social measures in the current study may have consequently left an important proportion of the variance in ODI unexplained and future studies may include these measures to directly examine this possibility.

The inverse correlation between PNRS and hamstring flexibility aligns with the evidence that the interventions that improve flexibility can reduce pain and improve function in low back pain populations: A recent meta-analysis has discovered that increased hamstring flexibility can significantly reduce pain and Oswestry Disability Index scores in subjects with low back pain, supporting the clinical relevance of posterior chain flexibility despite minimal correlations (28).

One possible biomechanical explanation is that increased flexibility in the posterior chain improves pelvic and lumbar movement during forward bending, reducing the load on lumbar structure, but this explanation remains a hypothesis, because our study measured both, hamstring flexibility and pain intensity during rest, but did not evaluate lumbopelvic movement during functional activities. Therefore, this correlation supports an association, but not the proposed loading mechanism.

Similarly, the inverse correlation between pain and lumbar flexion and lumbar extension aligns with previous assumptions in which increased lumbar mobility is generally considered to accompany lower pain intensity and better function. (29). Finally, the positive correlation of lumbar extension with the right and left hamstring flexibility validates the biomechanical relationship between trunk extension and posterior chain extensibility and align with prior research on posterior chain biomechanics (30).

CONCLUSION

Subjects with CNSLBP exhibit multi-factorial, inter-related outcomes supporting the use of a comprehensive, multi-domain assessment approach in future research.

Source of funding

This study was conducted without receiving any financial support from public, commercial, or non-profit funding sectors.

Conflict of interest

The authors report there are no conflicts of interest related to this work.

Author contributions

EM, MA and EK designed the study, participated in providing assessments, and contributed to data collection and analysis. SA assisted with portions of the assessment and was involved in manuscript revision.

Acknowledgment

The authors would like to express their appreciation for the subjects and their valuable contribution to this study.

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