




# Depressive Symptoms as a Potential Mediator in the Association Between Pain and Cognitive Function: A Cross-Sectional Study

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**Objective:** To investigate the association between pain intensity and cognitive function, and to explore the influence of demographic, clinical, and mood factors on this relationship.

**Design:** Cross-sectional study.

**Setting:** A tertiary comprehensive teaching hospital.

**Subjects:** 2661 inpatients admitted for pain management who completed cognitive function screening.

**Methods:** Pain intensity was assessed using the Numeric Rating Scale (NRS). Cognitive function was evaluated with the Montreal Cognitive Assessment (MoCA). Anxiety and depressive symptoms were assessed using the Hamilton Anxiety Scale (HAMA) and the Hamilton Depression Scale (HAMD), respectively. Univariable and multivariable analyses were performed to examine the association between pain intensity and cognitive function, and mediation analysis was conducted to explore potential mediating effects.

**Results:** The median pain duration was 3.0 months (IQR 0.6–12.0), and the median admission NRS score was 6 (IQR 4–6). Among the 2661 patients, 1502 (56.4%) had a MoCA score below 26, indicating mild cognitive impairment. Multiple linear regression model showed that higher pain intensity was significantly associated with higher MoCA ( $\beta = 0.22$ , 95% CI [0.12, 0.33],  $p < 0.001$ ) after controlling for age, sex, education, pain duration, anxiety, and depression. Mediation analysis showed that baseline pain significantly predicted higher depressive symptoms ( $\beta = 0.41$ ,  $p < 0.001$ ), and depressive symptoms were negatively associated with cognitive performance ( $\beta = -0.16$ ,  $p < 0.001$ ).

**Conclusion:** This large-scale cross-sectional study demonstrated a complex association between pain intensity and cognitive performance. While pain was directly associated with cognitive scores, depressive symptoms exerted a significant negative indirect effect, indicating partially opposing pathways. These findings suggest that mood-related mechanisms play a critical role in the pain–cognition relationship, highlighting the importance of integrating mood assessment into pain management.

**Keywords:** pain, cognitive function, depression, cross-sectional study

## Introduction

Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage.<sup>1</sup> Pain is a complex, multidimensional experience influenced by a diverse range of biological, psychological, and social factors.<sup>2</sup>

Pain not only produces abnormal sensory experiences but also significantly impacts cognitive and emotional processing.<sup>3</sup> Increasing evidence shows that people with chronic pain often experience impairments in attention, memory, and executive function.<sup>4</sup> Patients with chronic pain show measurable impairments on cognitive tests, and such deficits are particularly pronounced in conditions like fibromyalgia, neuropathic pain, and rheumatoid arthritis.<sup>5</sup> These findings suggest that pain and cognition share overlapping neural circuits and that chronic nociceptive input may interfere with normal cognitive functioning. Cognitive decline, in turn, further compromises self-care ability and aggravates pain-related disability.

While the direct link between pain and cognitive impairment was documented, the underlying mechanisms driving this association remain incompletely understood. Theoretical models and empirical evidence suggest that psychological distress, particularly depression and anxiety, may serve as a critical mechanistic bridge. Chronic pain acts as a persistent physical and psychological stressor that frequently precipitates depressive symptoms, potentially through shared neurobiological pathways such as altered monoamine neurotransmission, neuroinflammation, and dysregulation of the hypothalamic-pituitary-adrenal axis.<sup>6–8</sup> According to the cognitive load theory, this depletion of cognitive resources inevitably impairs attention, working memory, and executive function.<sup>9</sup> Therefore, it is both biologically and psychologically highly plausible to conceptualize pain as the primary exposure that exacerbates psychological distress, which in turn compromise cognitive performance.

Although previous studies have explored the pairwise relationships among pain, psychological distress, and cognition, most have relied on relatively small samples or examined these clinical features in isolation.<sup>10,11</sup> The extent to which depression quantitatively mediates the pain-cognition pathway within a unified analytic framework remains insufficiently explored.

Given these considerations, the present study aimed to investigate the relationship between pain intensity, depression symptoms and cognitive function in a large-scale population. We proposed the following specific hypotheses: 1) Higher pain intensity is independently associated with both more severe depressive symptoms and poorer cognitive performance. 2) Depressive symptoms act as a significant mediator in the association between pain intensity and cognitive function. Understanding these interrelationships may help identify individuals at high risk of cognitive decline. This knowledge could provide a foundation for developing interventions that address both pain and mood to preserve cognitive health.

## Methods

### Study Design and Population

This cross-sectional study was approved by the Ethics Committee of Beijing Jishuitan Hospital, Capital Medical University (Approval No. K2025-021-00) and conducted in accordance with the Declaration of Helsinki. All participants received detailed information about the study and provided written informed consent before enrollment. Inpatients admitted for pain management were consecutively recruited from the Department of Pain Management, Beijing Jishuitan Hospital, Capital Medical University, between June 2023 and November 2024. The sampling frame consisted of all adult patients requiring hospitalization for pain-related conditions during this period. As part of the standard clinical pathway in our department, trained clinical staff routinely administered comprehensive assessments, including evaluations of pain intensity, mood, and cognitive function, within the first 12 hours of admission. During the specified period, a total of 7335 patients were initially screened upon admission. Eligible participants were adults (aged  $\geq 18$  years) who had completed the baseline cognitive function screening and accompanying clinical assessments. Patients were ultimately excluded from the present analysis if they lacked complete data on the primary variables of interest (Numeric Rating Scale, Montreal Cognitive Assessment, Hamilton Anxiety Scale and Hamilton Depression Scale) or were unable to complete the assessments due to severe acute illness or communication barriers at the time of admission.

### Assessment of Patient-Reported Outcomes

Pain intensity was evaluated by pain specialists, while cognitive and emotional assessments were conducted by trained neuropsychology technicians.

### Instrument

#### Numeric Rating Scale (NRS)

Pain intensity was assessed using the NRS. Participants were asked to rate their average pain intensity over the past week on a scale from 0 to 10 where 0 indicates “no pain” and 10 represents “the worst imaginable pain.”

#### Montreal Cognitive Assessment (MoCA)

Cognitive function was assessed using the Beijing version of the Montreal Cognitive Assessment (MoCA-B), version 7.1. Details of the MoCA-B are available at <http://www.mocatest.org>. The MoCA-B evaluates eight cognitive domains:

visuospatial and executive function, naming, memory, attention, language, abstraction, delayed recall, and orientation. Because educational attainment may affect MoCA performance, an education-corrected MoCA score was also calculated by adding 1 point for participants with  $\leq 12$  years of education, following the standard MoCA recommendation. A total score below 26 was considered indicative of mild cognitive impairment (MCI).

### Hamilton Anxiety Scale (HAMA) and Hamilton Depression Scale (HAMD)

Anxiety symptoms were assessed with the 14-item Hamilton Anxiety Scale (HAMA),<sup>12</sup> which includes two dimensions: psychic anxiety (items 1–6, 14) and somatic anxiety (items 7–13). Each item is rated from 0 to 4, with a total score  $\leq 7$  indicating no anxiety symptoms. Depressive symptoms were assessed with the 24-item Hamilton Depression Scale (HAMD),<sup>13</sup> which covers seven dimensions: anxiety and somatic symptoms (items 10–13, 15, 17), weight change (item 16), cognitive impairment (items 2, 3, 9, 19–21), diurnal variation (item 18), retardation (items 1, 7, 8, 14), insomnia (items 4–6), and hopelessness (items 22–24). Each item is rated on a 0–4 scale (some items 0–2), and a total score  $\leq 7$  indicates no depressive symptoms. The Chinese versions of both HAMA and HAMD were used in this study.

## Statistical Analysis

All statistical analyses were performed in R (version 4.0) after data cleaning. Demographic characteristics and screening test results across different pain sites were summarized descriptively. Descriptive statistics included means, standard deviations, medians, interquartile ranges (Q1–Q3), and frequencies with percentages for categorical variables. NRS, MoCA, HAMA, and HAMD scores were treated as continuous variables. The Kolmogorov–Smirnov test was used to assess normality.

Between-group comparisons were conducted using appropriate methods according to variable type. Independent-samples *t*-tests or Mann–Whitney *U*-tests were applied for continuous data, depending on distribution, while Pearson's chi-square test or Fisher's exact test (when applicable) was used for categorical data. Linear regression was performed to evaluate associations between continuous variables. All tests were two-tailed, and  $p < 0.05$  was considered statistically significant. We selected covariates based on literature<sup>6,11</sup> and clinical experience identifying them as confounders of pain, mood, and cognition literature.

## Missing Data Imputation

Patients were included in the final analysis only if they had complete data for NRS, MoCA, HAMA, and HAMD. For the included cohort, missing data were present in certain secondary covariates. To address this and minimize potential bias from excluding cases with missing covariates, multiple imputation by chained equations (MICE) was utilized to impute these missing values. Summary statistics and missing-data patterns were reviewed to verify data completeness before analysis.

## Multivariable Analysis

Multiple linear regression models were used to examine the association between pain-related characteristics and cognitive performance measured by the MoCA. Variance Inflation Factors (VIFs) were calculated for all predictors. Generalized additive models (GAMs) were fitted to test potential nonlinear associations between pain intensity and cognitive function, adjusting for covariates. The fitted smoothed curves with 95% confidence intervals were illustrated.

## Mediation Analysis

Structural equation modeling (SEM) was used to examine whether depressive symptoms mediated the association between pain intensity and cognition. Standardized path coefficients were reported for direct, indirect, and total effects, and mediation significance was tested using 5000 bootstrap samples.

## Results

### Study Participants

Of the 7335 participants enrolled, 2661 had complete data on NRS, MoCA, HAMA, and HAMD and were included in the cross-sectional analysis (Table 1). Comparison of baseline characteristics between the included and excluded participants revealed no clinically meaningful differences, indicating that the missing data did not introduce substantial selection bias (Table S1). The median age was 61 years (interquartile range [IQR], 51–69), and 57.5% were female. Nearly half (48.0%) had an education level of junior high school or below.

The most common pain diagnosis was back pain (70.0%), followed by neck pain (14.2%), shoulder pain (8.8%), knee pain (5.6%), and hip pain (1.4%). Chronic pain was reported by 60.0% of individuals. Regarding pain duration, 40.0% reported pain lasting < 3 months, 39.8% reported 3–12 months, and 20.2% reported > 12 months, with a median duration of 3.0 months (IQR 0.6–12.0). The median admission NRS score was 6 (IQR 4–6), and 74.6% of participants reported sleep disturbance.

**Table 1** Baseline Characteristics of Participants Included in the Study

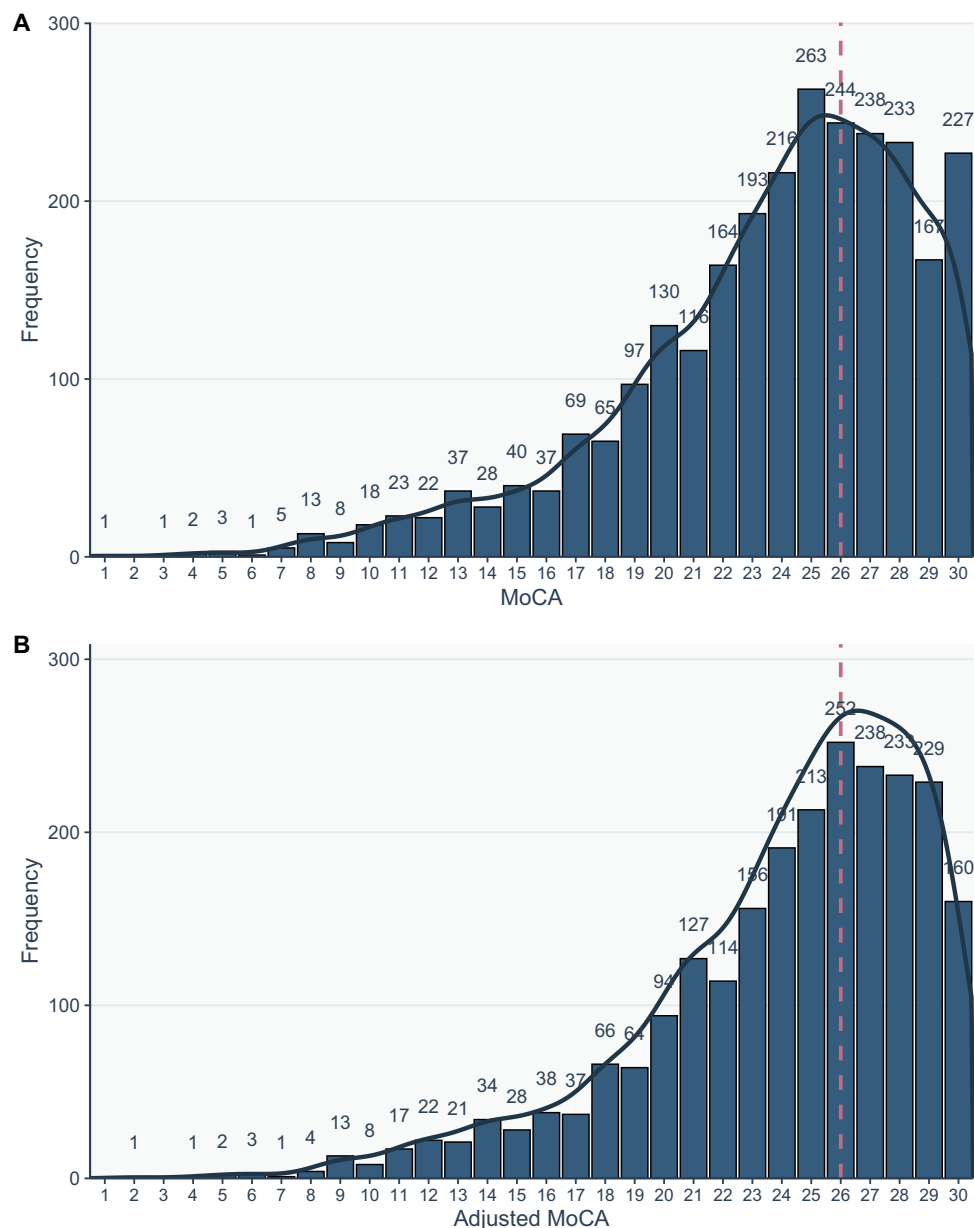
Variables	Total (n = 2661)
<b>Age</b>	61.00 [51.00–69.00]
<b>Sex</b>	
Male	1132 (42.5%)
Female	1529 (57.5%)
<b>Education level</b>	
Junior high school or below	1278 (48.0%)
High school	547 (20.6%)
College or above	836 (31.4%)
<b>Diagnosis</b>	
Knee pain	148 (5.6%)
Back pain	1863 (70.0%)
Neck pain	379 (14.2%)
Shoulder pain	235 (8.8%)
Hip pain	36 (1.4%)
<b>Chronic pain</b>	1596 (60.0%)
<b>Pain duration</b>	
<3 months	1065 (40.0%)
3–12 months	1059 (39.8%)
>12 months	537 (20.2%)
<b>Pain duration (months)</b>	3.00 [0.60–12.00]
<b>Admission NRS</b>	6.00 [4.00–6.00]
<b>Sleep disturbance</b>	1986 (74.6%)
<b>MoCA</b>	25.00 [21.00–27.00]
Visuospatial/executive	4.00 [2.00–5.00]
Naming	3.00 [3.00–3.00]
Attention	6.00 [5.00–6.00]
Language	3.00 [2.00–3.00]
Abstraction	1.00 [1.00–2.00]
Delayed recall	3.00 [2.00–4.00]
Orientation	6.00 [6.00–6.00]
<b>Adjusted MoCA</b>	26.00 [22.00–28.00]
<b>HAMA</b>	1.00 [0.00–4.00]
<b>HAMD</b>	2.00 [0.00–4.00]

**Abbreviations:** HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale; CMMS, Chinese Mini Mental Status; MoCA, Montreal Cognitive Assessment; NRS, Numeric Rating Scale.

The median MoCA scores was 25 (IQR 21–27), respectively. After applying the education correction, the median MoCA score was 25 (IQR 22–28). The distributions of both the unadjusted and adjusted MoCA scores are presented in Figure 1. Median HAMA and HAMD scores were 1 (IQR 0–4) and 2 (IQR 0–4).

## The Association of Pain Intensity and Cognition

In the simple linear regression analysis, pain intensity was not significantly associated with the MoCA total score ( $\beta = -0.018$ ,  $p = 0.773$ ,  $R^2 = 0.00003$ ). After adjusting for age, sex, education, pain duration, anxiety, and depression in the multiple linear regression model, higher pain intensity was significantly associated with higher MoCA scores ( $\beta = 0.22$ , 95% CI [0.12, 0.33],  $p < 0.001$ ) (Table 2). Age, sex, education level, and pain duration were also significant predictors of cognitive function. Higher HAMD scores ( $\beta = -0.12$ , 95% CI [-0.2, -0.05],  $p = 0.002$ ) were associated with poorer cognitive



**Figure 1** Distribution of unadjusted and education-corrected MoCA scores. **(A)** the distribution of unadjusted MoCA score. **(B)** the distribution of education-corrected MoCA score. The histogram shows the number of participants across MoCA total score levels. The black line represents the smoothed density curve of the score distribution, and the red dashed line marks the conventional cutoff of 26 points, which indicates possible mild cognitive impairment.

**Abbreviation:** MoCA, Montreal Cognitive Assessment.

**Table 2** Multiple Linear Regression Analysis of Pain Intensity and Cognitive Function (n = 2661)

Characteristic	$\beta$	SE	95% CI	p-value
<b>Pain intensity</b>	0.22	0.054	0.12, 0.33	<0.001
<b>Age (years)</b>	-0.13	0.006	-0.14, -0.11	<0.001
<b>Sex (ref: male)</b>				
Male	—	—	—	
Female	-0.39	0.164	-0.72, -0.07	0.017
<b>Education level</b>				
Junior high school or below	—	—	—	
High school (including vocational)	2.5	0.211	2.1, 3.0	<0.001
College or above	3.4	0.197	3.0, 3.8	<0.001
<b>Pain duration (months)</b>	-0.01	0.002	-0.01, 0.00	0.016
<b>HAMA</b>	-0.04	0.035	-0.11, 0.03	0.2
<b>HAMD</b>	-0.12	0.040	-0.20, -0.05	0.002

Note: Adjusted R<sup>2</sup>: 0.307.

Abbreviations: CI, confidence interval; HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale; SE, standard error.

performance, while HAMA scores were not significantly related to MoCA results. All VIF values were well below the strict threshold of 5 (ranging from 1.02 to 2.14), indicating that severe multicollinearity did not bias the regression estimates. In the sensitivity analysis excluding HAMA, the results remained steady (Table 3).

In the sensitivity analysis including participants with pain duration longer than three months (n = 1596), results were generally consistent with the primary model. Higher pain intensity remained significantly associated with higher MoCA scores ( $\beta=0.18$ , 95% CI [0.05, 0.32],  $p=0.01$ ) (Table 4).

A generalized additive model (GAM) was further fitted to examine the potential nonlinear relationship between pain intensity and MoCA while adjusting for confounders (Figure 2). The smooth term for pain intensity was statistically significant (edf = 2.39,  $F=8.96$ ,  $p<0.001$ ), indicating a nonlinear association. Specifically, MoCA increased with increasing pain intensity, particularly at moderate-to-high pain levels. In the parametric component, older age ( $\beta=-0.13$ ,  $p<0.001$ ), female gender ( $\beta=-0.39$ ,  $p=0.018$ ), and higher HAMD ( $\beta=-0.13$ ,  $p<0.001$ ) were independently associated with lower MoCA scores, whereas higher education levels were positively associated with cognitive performance. The model explained approximately 31% of the variance in MoCA scores (adjusted R<sup>2</sup> = 0.31) (Table S2).

**Table 3** Multiple Linear Regression Analysis of Pain Intensity and Cognitive Function Without Adjusting for Anxiety (n = 2661)

Characteristic	$\beta$	SE	95% CI	p-value
<b>Pain intensity</b>	0.22	0.054	0.12, 0.33	<0.001
<b>Age (years)</b>	-0.13	0.006	-0.14, -0.11	<0.001
<b>Sex (ref: male)</b>				
Male	—	—	—	
Female	-0.41	0.164	-0.73, -0.09	0.012
<b>Education level</b>				
Junior high school or below	—	—	—	
High school (including vocational)	2.5	0.211	2.1, 3.0	<0.001
College or above	3.4	0.197	3.0, 3.8	<0.001
<b>Pain duration (months)</b>	-0.01	0.002	-0.01, 0.00	0.016
<b>HAMD</b>	-0.16	0.028	-0.21, -0.10	<0.001

Note: Adjusted R<sup>2</sup>: 0.307.

Abbreviations: CI, confidence interval; HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale; SE, standard error.

**Table 4** Multiple Linear Regression Analysis of Pain Intensity and Cognitive Function in Participants with Pain Duration Longer Than Three months (n=1596)

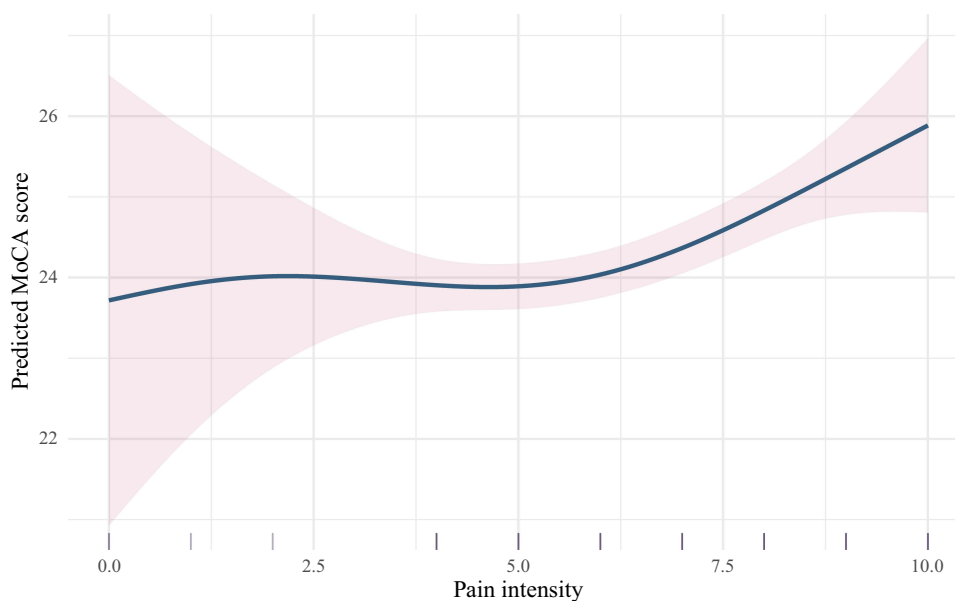
Characteristic	$\beta$	SE	95% CI	p-value
<b>Pain intensity</b>	0.18	0.071	0.05, 0.32	0.010
<b>Age (years)</b>	-0.14	0.009	-0.15, -0.12	<0.001
<b>Sex (ref: male)</b>				
Male	—	—	—	
Female	-0.43	0.217	-0.85, 0.00	0.049
<b>Education level</b>				
Junior high school or below	—	—	—	
High school (including vocational)	2.6	0.278	2.0, 3.1	<0.001
College or above	3.2	0.264	2.7, 3.7	<0.001
<b>Pain duration (months)</b>	0.00	0.002	-0.01, 0.00	0.079
<b>HAMA</b>	0.00	0.047	-0.09, 0.09	>0.9
<b>HAMD</b>	-0.17	0.053	-0.27, -0.07	0.001

**Notes:** Adjusted  $R^2$ : 0.308. Multicollinearity was assessed for all predictors in the model; all Variance Inflation Factor (VIF) values were < 2.5, indicating no severe multicollinearity.

**Abbreviations:** CI, confidence interval; HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale; SE, standard error.

## Mediation Analysis

SEM revealed that baseline pain intensity was significantly associated with higher depressive symptoms ( $\beta = 0.41$ ,  $p < 0.001$ ), and depressive symptoms were negatively associated with cognitive performance ( $\beta = -0.16$ ,  $p < 0.001$ ). The statistical indirect effect of pain on cognition through depression was significant (ACME =  $-0.06$ , 95% CI [ $-0.09$ ,  $-0.04$ ],  $p < 0.001$ ), indicating that greater pain severity was associated with poorer cognitive performance, a relationship partially explained by increased depressive symptoms. The direct effect of pain on cognition remained significant after adjusting for depression (ADE =  $0.23$ , 95% CI [ $0.13$ ,  $0.34$ ],  $p < 0.001$ ), suggesting that pain is linked to cognition through additional mechanisms beyond depression. The total effect of pain on cognition was  $0.17$  (95% CI [ $0.07$ ,  $0.28$ ],  $p < 0.001$ ), of which



**Figure 2** Association between pain intensity and predicted cognitive performance based on the generalized additive model (GAM). The x-axis represents pain intensity measured by the NRS, and the y-axis represents the predicted MoCA score. The solid line indicates the GAM-fitted smooth curve, and the shaded area denotes the 95% confidence interval. The rug plot on the x-axis displays the distribution of individual observations.

**Abbreviations:** GAM, generalized additive model; MoCA, Montreal Cognitive Assessment; NRS, Numeric Rating Scale.



cognitive distraction significantly decreased pain scores regardless of cognitive load, supporting a unidirectional effect of cognition on pain up to a certain pain threshold.<sup>17</sup> Our results suggest that pain intensity is indeed linked to cognitive performance, even after adjusting for covariates. However, the direction and magnitude of this relationship appear to vary depending on contextual and individual factors, indicating a complex interplay between nociceptive processing and cognitive control systems. Pain–cognition relationship is complex and partly suppressed by mood and demographic factors.

Former studies also showed the relationship between pain and cognitive function is critically moderated by age, with older adults showing reduced cognitive pain modulation effectiveness that depends on preserved executive function,<sup>22</sup> and by affective factors, as depression and anxiety consistently mediate pain–cognition interactions. Duan et al, using data from the 2018 China Health and Aging Longitudinal Study (CHARLS), found that chronic pain and depressive symptoms were significantly associated with cognitive impairment in older Chinese adults.<sup>23</sup> After adjusting for depression scores, pain intensity was no longer directly associated with the impairment of cognitive function, but mediation analysis suggested that depressive symptoms partially mediated the relationship between pain and cognitive decline. Duan et al study mainly focused on elderly patients with an average age of 71, while our study extends this investigation to a broader adult population, albeit within a specific clinical inpatient setting rather than the general community.

In our study, the MoCA score was not associated with pain intensity in the univariate analysis. After adjusting for age, sex, education, pain duration, anxiety, and depression, multiple linear regression indicated that higher pain intensity was associated with better MoCA scores ( $\beta=0.22$ ,  $p<0.001$ ). The unstandardized coefficient (0.22) indicates that a 1-point increase in pain intensity corresponds to a 0.22-point increase on MoCA. Although statistically significant, this modest coefficient lacks clinical magnitude and should not be misinterpreted as a meaningful cognitive enhancement.

When integrating these variables into a mediation framework, depressive symptoms emerged as a significant indirect pathway linking pain to poorer cognitive outcomes. Thus, while the direct regression suggested a positive association between pain intensity and cognitive performance, the mediation model revealed an opposing indirect negative effect through mood-related mechanisms. This divergence likely reflects a suppression effect, whereby the shared variance with age, education, and mood variables reverses the direction of the adjusted pain–cognition association.

The mediation analysis revealed a significant negative indirect effect of pain on cognition through depressive symptoms, alongside a positive direct effect. This pattern indicates inconsistent mediation (a suppression effect), where opposing pathways operate simultaneously. Beyond this statistical suppression, the counterintuitive positive direct association might be partially explained by acute alertness. Pain acts as a salient stressor triggering sympathetic nervous system arousal, which may temporarily mobilize attentional resources and slightly enhance performance on brief screening tools like the MoCA.<sup>24</sup> Besides, current understanding posits that depression is a multifactorial and heterogeneous clinical continuum involving somatic and cognitive symptoms, sharing common neurobiological underpinnings rather than existing as discrete categories.<sup>25</sup> Together, these findings suggest that pain exerts complex, partially competing influences on cognitive function through both direct physiological and indirect mood-related pathways. Finally, given the cross-sectional design of this study, the exact temporal sequence among pain, depressive symptoms, and cognition cannot be established; therefore, these mediation findings should be interpreted as indicative rather than causal.

Several limitations of this study should be acknowledged. First, as a single-center cross-sectional design, the findings can only demonstrate associations between pain and cognitive performance rather than establish causal relationships. Longitudinal or intervention studies are warranted to clarify the temporal and mechanistic links among pain, depression, and cognition. Additionally, relying exclusively on an inpatient sample from a single institution inherently introduces selection bias and restricts the generalizability of our results. Second, relying on the MoCA as our sole metric for cognitive classification is a key limitation. As a brief screening tool, it provides a global estimate but cannot capture nuanced deficits across distinct cognitive domains or replace comprehensive neuropsychological testing for formal clinical diagnosis. Third, this study employed multiple linear regression to explore the continuous relationship between pain intensity and cognitive function. While this approach allows for a nuanced examination across the full spectrum of pain severity, it may be less sensitive than categorical or logistic regression models in identifying threshold or nonlinear effects. Fourth, the sample included participants with various types, sites, and durations of pain without further stratification. Although this broad inclusion enhances the generalizability of the findings to the overall pain population, it may also introduce heterogeneity and reduce the stability of the associations observed. Future studies could benefit from differentiating by pain phenotype and chronicity. Fifth, a critical unresolved

limitation is the absence of medication data in this inpatient pain sample. Pharmacological agents common in hospitalized patients (eg, opioids, sedatives, or analgesics) act as major unmeasured confounders that profoundly and independently influence both cognitive arousal and mood states. Finally, the mediation analysis provides preliminary evidence suggesting that depressive symptoms may partially mediate the pain–cognition relationship; however, these indirect effects should be interpreted with caution given the cross-sectional nature of the data. Nevertheless, this finding offers a valuable direction for future longitudinal and experimental research examining the role of depression in the cognitive consequences of chronic pain.

## Conclusion

This cross-sectional study identified a complex association between pain intensity and cognitive performance in hospitalized patients with pain. While higher pain intensity was associated with cognitive scores after adjustment, depressive symptoms exerted a significant negative indirect effect, indicating partially opposing pathways. These findings suggest that mood-related mechanisms may play an important role in the pain–cognition relationship. While these correlational findings may highlight the importance of addressing mood symptoms in pain management, the practical clinical impact requires further quantification through longitudinal studies.

## Abbreviations

GAMs, Generalized additive models; HAMA, Hamilton Anxiety Scale; HAMD, Hamilton Depression Scale; MCI, Mild cognitive impairment; MoCA, Montreal Cognitive Assessment; NRS, Numeric Rating Scale; SEM, Structural equation modeling.

## Ethics Approval and Informed Consent

This cross-sectional study was approved by the Ethics Committee of Beijing Jishuitan Hospital, Capital Medical University (Approval No. K2025-021-00). All participants received detailed information about the study and provided written informed consent before enrollment.

## Consent for Publication

All authors approved consent for publication.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare no competing interest.

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