

## Cross-Sectional Study

# e High Attention-Deficit/Hyperactivity Disorder Scale Scores Among Patients with Persistent Chronic Nonspecific Low Back Pain

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**Background:** Associations between attention-deficit/hyperactivity disorder (ADHD) and chronic pain disorders, such as fibromyalgia, have been reported. However, associations between persistent chronic nonspecific low back pain (CNLBP) and ADHD have not yet been investigated.

**Objectives:** This study aimed to investigate the positive rates of possible ADHD, as assessed by self-reported ADHD scales, in patients with persistent CNLBP, using data from self-reported questionnaires completed by patients and their families. This study also aimed to compare the self-reported scores obtained from existing standardized data for healthy individuals, and to examine whether the ADHD scale scores of patients with persistent CNLBP are associated with pain variables.

**Study Design:** Cross-sectional study.

**Setting:** The specialized pain clinic at our university hospital.

**Methods:** This cross-sectional study included 60 consecutive patients with persistent CNLBP who were diagnosed with a possible somatic symptom disorder and were referred to a psychiatrist in our pain clinic. The Conners' Adult ADHD Rating Scales (CAARS) self-report (CAARS-S) and observer-rated (CAARS-O) questionnaires were utilized. We investigated the CAARS scores, and the association between the CAARS subscale scores and pain variables (pain duration and pain Numeric Rating Scale) in patients with persistent CNLBP.

**Results:** Of the 60 patients, 19 (31.7%) were positive on both CAARS-S and CAARS-O questionnaires (T-score > 65). The ADHD indices, which comprised subscales of the CAARS estimating the necessity of treatment for ADHD, were significantly higher in both male and female patients with persistent CNLBP than in the Japanese standardized sample ( $P < 0.005$ ). CAARS-S hyperactivity/restlessness, CAARS-O hyperactivity/restlessness, and the Diagnostic and Statistical Manual of Mental Disorders, fourth edition hyperactive-impulsive symptom subscale scores also correlated with the pain intensity ( $P < 0.05$ ).

**Limitations:** In this study, ADHD tendency was evaluated using only a self-reported questionnaire. Hence in the future, accurate and precise assessments of ADHD symptoms using structured clinical interviews conducted by ADHD experts are warranted. Additionally, the study only included patients with persistent CNLBP. Therefore in the future, it will be valuable to investigate ADHD scale scores (e.g., CAARS) among patients with CNLBP and nonspecific low back pain with larger sample sizes.

**Conclusions:** Our findings revealed that the subscale scores on an ADHD scale were considerably high in patients with persistent CNLBP. As a previous study of our clinical experience indicates that persistent CNLBP can be substantially relieved by administering ADHD medications, ADHD screening is warranted in the treatment of persistent CNLBP.

**Key words:** Attention-deficit/hyperactivity disorder, neurodevelopmental disorders, chronic nonspecific low back pain, chronic pain, Conners' Adult ADHD Rating Scales (CAARS), Numeric Rating Scale, pain duration, pain clinic, somatic symptom disorder

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**A**pproximately 40% of the global population, and approximately 80% of the people in developed countries complain of low back pain (LBP) at least once in their lifetime (1,2). In the United States alone, the total costs associated with LBP have been estimated to be approximately 120 billion dollars per year (3), making it a major issue for society as a whole. Furthermore, most cases of LBP are classified as nonspecific LBP (NLBP), with no obvious organic spinal abnormalities (4). Psychosocial factors, such as low workplace social support and low job satisfaction, have crucial roles in NLBP (5). Although most cases of NLBP spontaneously resolve after several weeks to 3 months (6,7), 14% of patients experience chronic NLBP (CNLBP), which is defined as NLBP that lasts for over 3 months (8). Furthermore, a small percentage of patients (2%–7%) experience intense, persistent, CNLBP (5,7). Therefore from both health care and socioeconomic perspectives, it is crucial to find treatment methods that can promptly improve this condition (5,9).

In recent years, studies of patients with chronic pain have revealed a common history of involvement in traffic accidents and forgetfulness, which are reportedly caused by symptoms of attention-deficit/hyperactivity disorder (ADHD) (10). ADHD is a developmental disorder caused by functional impairments in the dopamine and noradrenaline systems. It is classified into predominantly inattentive, predominantly hyperactive-impulsive, and combined types (11). Notably, an epidemiologic study of 7,403 people aged 16 years and older reported that there is a strong association between ADHD symptoms and extreme pain (12). The epidemiologic study evaluated ADHD symptoms using the Adult ADHD Self-Report Scale (ASRS) Screener, which is the most frequently used screening tool for adult ADHD and consists of 6 items (13). Additionally, pain was evaluated using the pain interference item of the Medical Outcomes Study 12-Item Short-Form Health Survey questionnaire (“During the past 4 weeks, how much did the pain interfere with your normal work?”) (14).

Fibromyalgia (FM) should be considered or confirmed when a patient complains of spreading muscle soreness, fatigue, or sleep disturbance, in the absence of physical abnormalities. Interestingly, FM is also associated with ADHD (15–18). Patients with FM exhibit considerable forgetfulness in comparison with controls, which may be owing to high levels of distractibility (19). A high frequency of ADHD among patients with FM (25%–80%) has been reported (15–21). Conversely,

reports have indicated that many patients whose chief complaints include ADHD-type symptoms also have a history of FM (17,22). In patients with FM accompanied by ADHD, improvements in both ADHD and pain symptoms have been observed on treatment with ADHD medications such as psychostimulants (17). However, no studies have been conducted on patients with ADHD with CNLBP or persistent CNLBP.

In the present study, we evaluated patients with persistent CNLBP who were diagnosed with a probable somatic symptom disorder and referred to the specialized pain clinic at our university hospital owing to previous treatment failures at other clinics. These patients were considered to be affected by substantial psychosocial factors, which would explain why previous treatments administered by pain clinicians were unsuccessful. Consequently, the pain clinicians requested a psychiatrist in the pain clinic to assist with the treatment of these patients.

This study aimed to investigate the positive rates of possible ADHD among patients with persistent CNLBP. In this study, we decided to objectively evaluate the ADHD score, rather than focusing on a clinical diagnosis of the condition, as the diagnosis of ADHD by an author (a psychiatrist) alone could lead to doubts regarding the impartiality of the diagnosis. Possible ADHD was assessed using the long version of the Conners’ Adult ADHD Rating Scales (CAARS) self-report (CAARS-S) or the observer-rated (CAARS-O) questionnaire, with both patients and their families providing self-reported answers (23). The earlier-mentioned ASRS, which was used in a previous epidemiologic study, is a 6-item screening scale that only the patient completes; it is often used in epidemiologic surveys. The CAARS, however, is standardized according to gender and age group and is the most commonly used ADHD scale in controlled clinical trials of adult ADHD therapeutics to measure the severity of ADHD symptoms (24). There are 3 versions of the CAARS: the screening version (30 items), short version (26 items), and long version (66 items). The CAARS long version has been reported as desirable for use in the survey of a broad spectrum of ADHD symptoms (24); thus we adopted the CAARS long version in this study. This study also aimed to compare the data to self-reported scores obtained from existing standardized data for healthy individuals and to examine whether the ADHD scale scores of patients with persistent CNLBP were associated with pain variables, such as the duration and intensity of pain.

## METHODS

### Patients

This study consecutively enrolled 60 patients with persistent CNLBP who had been diagnosed with a probable somatic symptom disorder and referred to a psychiatrist (S.K.) at our university hospital by their attending physicians between May 2016 and March 2019. According to the European guidelines for the management of CNLBP, CNLBP was defined as LBP that lasted for at least 3 months, owing to causes that could not be identified despite a thorough medical examination by an orthopedist (5). As there is currently no established definition of persistent CNLBP, for the purposes of this study, we defined this condition as intense, lasting NLBP that did not respond to any combination of available treatments (e.g., drug therapy, physical therapy, or surgery) or to 3 or more analgesics. These patients received treatment from their attending anesthesiologists and were subsequently referred to our university hospital for consultation. To be included, patients had to be over 18 years of age and be able to sign an informed consent form. Patients with impaired judgment because of conditions, such as severe psychosis, severe depression, or manic status, were excluded from the study. In addition, as it has been shown that the total CAARS score is positively correlated with the bipolar disorder diagnostic score on the Mini-International Neuropsychiatric Interview (25), we excluded patients with bipolar disorder. Of the 60 patients, 25 (41.7%) had a history of psychiatric treatment, with depression in 17 (63.0%), anxiety disorders in 3 (11.1%), adjustment disorder in 2 (7.4%), autism spectrum disorder in 1 (3.7%), epilepsy in 1 (3.7%), and FM in 1 patient (3.7%). All 25 of these patients were under psychiatric medication, but without improvement in chronic pain symptoms.

This study was conducted in accordance with the World Medical Association's Declaration of Helsinki and was approved by the Research Ethics Committee of Tokyo University Hospital (approval no. 3678).

### Assessment of ADHD Scale Scores

During the initial medical examination for this study, all patients and their families responded to either the long version of the CAARS-S or the CAARS-O questionnaire (23). Patients with a T-score of greater than 65 on either the CAARS-S or CAARS-O questionnaire were designated as CAARS-positive, indicating the presence of clinically significant ADHD symptoms. The CAARS is a widely used scale to assess ADHD symp-

toms in patients aged older than 18 years. Both CAARS-S and CAARS-O questionnaires calculate the patient's T-score for 8 subscales; when the T-score exceeds 65, the symptoms of ADHD are considered to be clinically significant. Notably, CAARS employs the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) criteria rather than DSM-5 criteria. In 2013, the DSM was revised from version IV to version 5; however, the CAARS was devised in 1999, during the DSM-IV era (1994–2013). Thus the CAARS and its subscales follow the DSM-IV criteria.

### Assessment of Pain

Pain duration (months) was defined as the period from the onset of LBP to the patient's first examination at our pain clinic. Subjective pain intensities were rated using the Numeric Rating Scale (NRS-11) (26). The NRS-11 is an 11-point pain rating scale in which 0 represents the absence of pain and 10 represents the most intense pain. We asked the patients to report their maximum, minimum, and average pain intensity using the NRS-11.

### Statistical Analysis

Statistical analyses were performed using JMP Pro version 14 (SAS Institute Japan, Tokyo, Japan). Intergroup differences in age, pain duration, NRS-11 pain score (26), and CAARS subscale scores were analyzed using 2-tailed independent samples t-tests and are expressed as mean differences and 95% confidence intervals (CI). Intergroup gender differences were analyzed using the Pearson  $\chi^2$  test. The association between CAARS-S and CAARS-O subscale scores, as well as pain NRS-11 scores and pain duration, was assessed using the Pearson correlation coefficient. *P* values < 0.05 were considered statistically significant.

## RESULTS

Of the 60 patients with persistent CNLBP (29 men and 31 women) who participated in this study, 29 (48.3%; 13 men and 16 women) had positive CAARS-S scores (> 65) (Fig. 1A), and 36 (60.0%; 20 men and 16 women) had positive CAARS-O scores (> 65) (Fig. 1B). Of these 60 patients, 46 (76.7%; 25 men and 21 women) had either positive CAARS-S, or positive CAARS-O scores (> 65) (Fig. 1C), whereas only 19 (31.7%; 8 men and 11 women) had positive scores on both the CAARS-S and CAARS-O questionnaires (> 65) (Fig. 1D).

No significant differences in the age, gender, pain duration, or NRS-11 pain score were observed between the group that scored positive on both CAARS-S and

CAARS-O questionnaires, and the group that did not score positive on either the CAARS-S or CAARS-O questionnaire (Table 1). The 19 patients who had positive scores on both CAARS-S and CAARS-O questionnaires (mean age  $\pm$  standard deviation, 60.7  $\pm$  14.9 years) comprised 11 women (65.5  $\pm$  11.5 years) and 8 men (54.0  $\pm$  17.1 years).

The average scores of the 8 subscales (A–H) for both CAARS-S and CAARS-O questionnaires, for all patients with persistent CNLBP, as well as the average scores for male and female patients, are summarized in Table 2. The comparison between patients with persistent CNLBP (male: n = 29, female: n = 31) and the general population who completed the Japanese

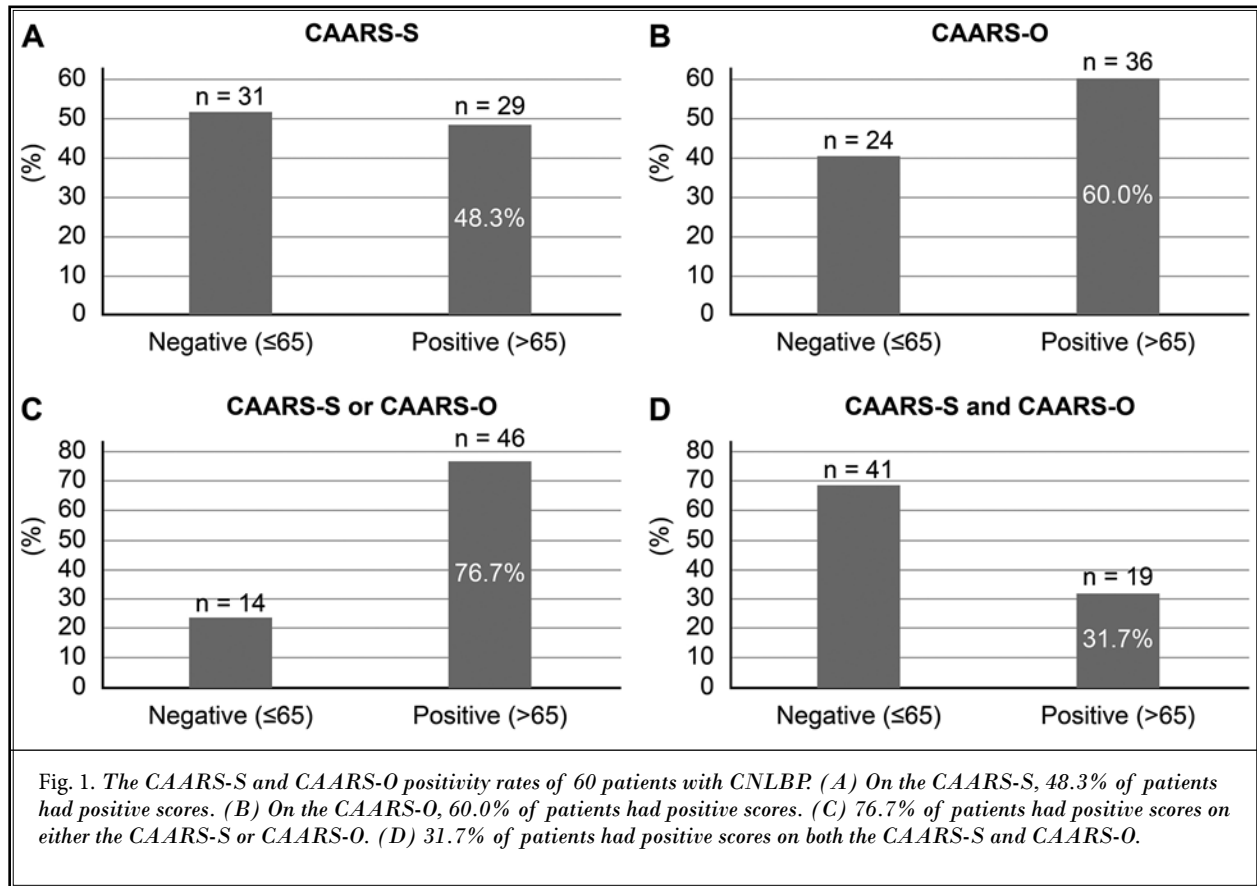


Table 1. Patient characteristics

Variable	PCNLBP (n = 60)	PCNLBP (CAARS-S and CAARS-O > 65) (n = 19, 31.7%)	PCNLBP (CAARS-S or CAARS-O ≤ 65) (n = 41, 68.3%)	Mean difference /OR	95% CI	P
Age, years	54.9 $\pm$ 17.3	60.7 $\pm$ 14.9	52.1 $\pm$ 17.8	8.5	-0.9–18.0	0.07
Woman (n)	31 (51.7%)	11 (57.9%)	20 (48.8%)	0.7	0.2–2.1	0.5
Pain duration, months	97.0 $\pm$ 104.4	119.6 $\pm$ 131.4	86.6 $\pm$ 89.1	33.1	-24.7–91.0	0.3
Pain NRS maximum	6.9 $\pm$ 2.1	7.3 $\pm$ 1.9	6.7 $\pm$ 2.2	0.6	-0.6–1.8	0.3
Pain NRS minimum	3.2 $\pm$ 2.4	3.6 $\pm$ 3.0	3.0 $\pm$ 2.1	0.6	-0.8–2.0	0.4
Pain NRS average	5.9 $\pm$ 2.0	6.3 $\pm$ 2.0	5.8 $\pm$ 2.0	0.5	-0.6 to 1.6	0.4

CAARS-O: Conners' Adult ADHD Rating Scale observer rated, CAARS-S: Conners' Adult ADHD Rating Scale self-reported; CI: confidence interval; NRS: numerical rating scales; OR: odds ratio. PCNLBP: persistent chronic nonspecific low back pain

Low Back Pain and ADHD

Table 2. Comparison of CAARS-S/O subscale scores between patients with PCNLBP and healthy controls

Variable	ALL	Male						Female				
	PCNLBP (n = 60)	PCNLBP (n = 29)	Healthy (n = 245)	Mean difference	95% CI	P	PCNLBP (n = 31)	Healthy (n = 270)	Mean difference	95% CI	P	
	M ± SD	M ± SD	M ± SD				M ± SD	M ± SD				
CAARS-S	A. Inattention/Memory Problems	55.3 ± 12.5	56.0 ± 12.5	50 ± 10	6.0	2.0–10.0	< 0.005	54.7 ± 12.6	50 ± 10	4.7	0.9–8.5	< 0.05
	B. Hyperactivity/Restlessness	56.2 ± 10.5	53.3 ± 8.3	50 ± 10	3.3	-0.5–7.1	0.09	58.8 ± 11.8	50 ± 10	8.8	5.0–12.6	< 0.001
	C. Impulsivity/Emotional Liability	52.6 ± 12.8	53.9 ± 14.1	50 ± 10	3.9	-0.2–8.0	0.06	51.4 ± 11.6	50 ± 10	1.4	-2.4–5.2	0.5
	D. Problems with Self-Concept	55.1 ± 12.0	55.6 ± 13.3	50 ± 10	5.6	1.6–9.6	< 0.01	54.7 ± 10.8	50 ± 10	4.7	0.9–8.5	< 0.05
	E. DSM-IV Inattentive Symptoms	57.1 ± 13.8	57.5 ± 12.7	50 ± 10	7.5	3.5–11.5	< 0.001	56.6 ± 14.9	50 ± 10	6.6	2.7–10.6	< 0.005
	F. DSM-IV Hyperactive-Impulsive Symptoms	55.4 ± 11.5	54.1 ± 9.0	50 ± 10	4.1	0.3–7.9	< 0.05	56.6 ± 13.4	50 ± 10	6.6	2.7–10.5	< 0.005
	G. DSM-IV ADHD Symptoms Total	56.8 ± 12.2	56.6 ± 10.0	50 ± 10	6.6	2.7–10.5	< 0.005	57.1 ± 14.2	50 ± 10	7.1	3.2–11.0	< 0.001
	H. ADHD Index	56.6 ± 9.7	56.6 ± 10.9	50 ± 10	6.6	2.7–10.5	< 0.005	56.7 ± 8.5	50 ± 10	6.7	3.0–10.4	< 0.001
CAARS-O	A. Inattention/Memory Problems	56.0 ± 13.4	57.5 ± 15.3	50 ± 10	7.5	3.4–11.6	< 0.001	54.6 ± 11.4	50 ± 10	4.6	0.8–8.4	< 0.05
	B. Hyperactivity/Restlessness	54.6 ± 12.1	55.1 ± 13.7	50 ± 10	5.1	1.1–9.1	< 0.05	54.2 ± 10.7	50 ± 10	4.2	0.4–8.0	< 0.05
	C. Impulsivity/Emotional Liability	56.4 ± 14.8	59.4 ± 15.3	50 ± 10	9.4	5.3–13.5	< 0.001	53.5 ± 13.9	50 ± 10	3.5	-0.4–7.4	0.08
	D. Problems with Self-Concept	59.6 ± 11.5	60.9 ± 12.0	50 ± 10	10.9	7.0–14.9	< 0.001	58.3 ± 11.0	50 ± 10	8.3	4.5–12.1	< 0.001
	E. DSM-IV Inattentive Symptoms	57.1 ± 14.5	59.4 ± 16.2	50 ± 10	9.4	5.2–13.6	< 0.001	54.9 ± 12.6	50 ± 10	4.9	1.1–8.7	< 0.05
	F. DSM-IV Hyperactive-Impulsive Symptoms	53.5 ± 12.7	57.1 ± 13.9	50 ± 10	7.1	3.1–11.2	< 0.005	50.2 ± 10.5	50 ± 10	0.2	-3.6–4.0	0.9
	G. DSM-IV ADHD Symptoms Total	56.3 ± 13.6	59.8 ± 15.6	50 ± 10	9.8	5.7–13.9	< 0.001	53.0 ± 10.6	50 ± 10	3.0	-0.8–6.8	0.1
	H. ADHD Index	59.1 ± 12.8	62.1 ± 14.6	50 ± 10	12.1	8.0–16.2	< 0.001	56.2 ± 10.1	50 ± 10	6.2	2.5–9.9	< 0.005

M: mean, SD: standard deviation, ADHD: attention-deficit/hyperactivity disorder, CAARS-S/O: Conners' Adult ADHD Rating Scale self-reported (CAARS-S)/Conners' Adult ADHD Rating Scale observer-rated (CAARS-O), CI: confidence interval, PCNLBP: persistent chronic nonspecific low back pain, DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, fourth edition

version of the CAARS (male:  $n = 245$ , female:  $n = 270$ ) (27) are also presented in Table 2, with the results of the 8 CAARS-S/O subscales for male and female patients shown separately. The CAARS subscale T-scores were classified at 5-point intervals, with T-scores ranging from 45 to 55 being classified as "average," 56 to 60 as "slightly atypical," 61 to 65 as "mildly atypical," 66 to 70 as "moderately atypical," and 71 or greater as "markedly atypical." As indicated in the earlier description, ADHD symptom severity increases as the T-score increases. Furthermore, although not shown in Table 1, among the CAARS-S/O subscales for patients with persistent CNLBP, female patients scored significantly higher than male patients on the CAARS-S B scale (mean difference: 5.5; CI, 0.2.10.8;  $P = 0.04$ ), and male patients scored significantly higher than female patients on the CAARS-O F scale (mean difference: 6.9; CI, 0.6.13.3;  $P = 0.03$ ). There were several statistically significant correlations between the

CAARS-S/O subscales and pain scales. A weak positive correlation was observed between the subscale score for hyperactivity/restlessness on the CAARS-S (subscale B in Table 2) and the maximum pain intensity ( $r = 0.27$ ;  $P < 0.05$ ), as well as between the subscale score for DSM-IV hyperactive-impulsive symptoms on the CAARS-S (subscale F in Table 2) and the pain duration ( $r = 0.34$ ;  $P < 0.01$ ) (Fig. 2).

Moderate positive correlations were observed between the subscale score for hyperactivity/restlessness on the CAARS-O (subscale B in Table 2) and the maximum pain intensity ( $r = 0.44$ ;  $P < 0.001$ ), as well as the average pain intensity ( $r = 0.44$ ;  $P < 0.001$ ). There was a weak positive correlation between the subscale score for the DSM-IV hyperactive-impulsive symptoms on the CAARS-O (subscale F in Table 2) and the average pain intensity ( $r = 0.28$ ;  $P < 0.05$ ). Pain intensity was not correlated with any of the other CAARS subscale scores (Fig. 3).

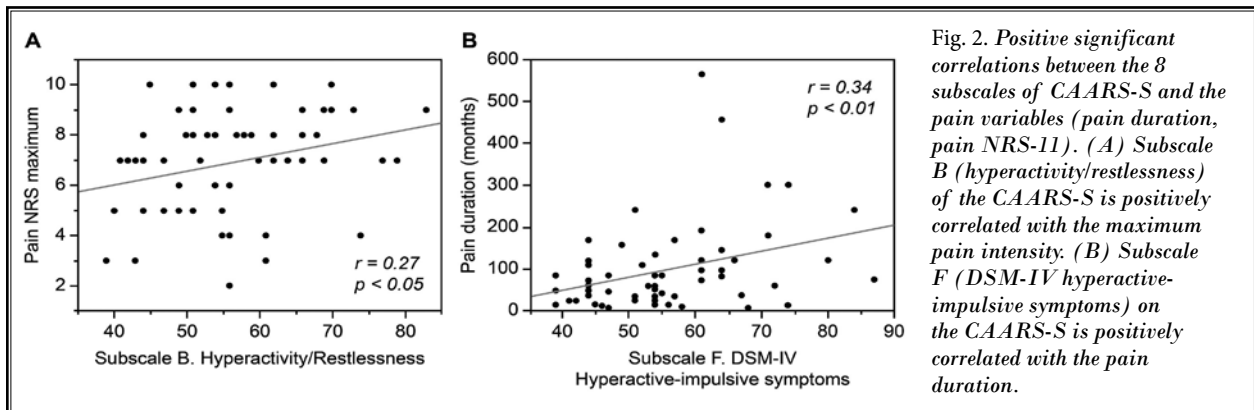


Fig. 2. Positive significant correlations between the 8 subscales of CAARS-S and the pain variables (pain duration, pain NRS-11). (A) Subscale B (hyperactivity/restlessness) of the CAARS-S is positively correlated with the maximum pain intensity. (B) Subscale F (DSM-IV hyperactive-impulsive symptoms) on the CAARS-S is positively correlated with the pain duration.

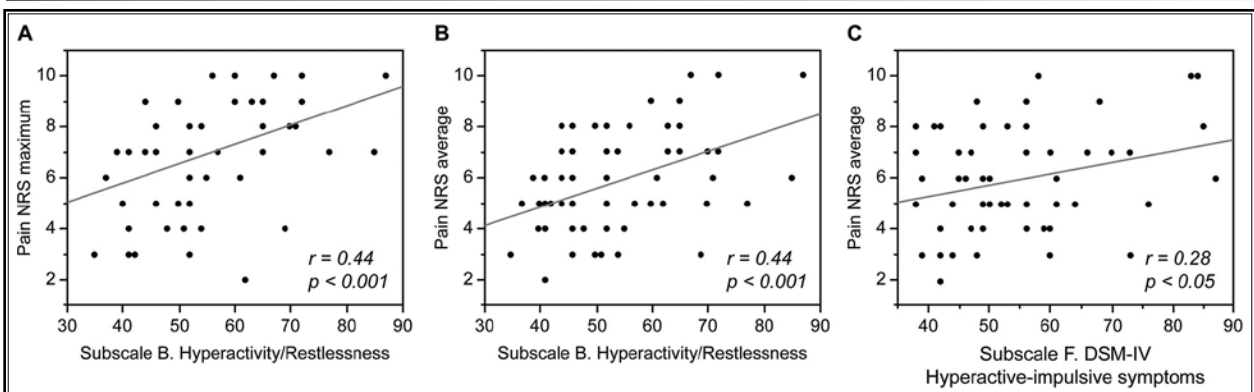


Fig. 3. Significant positive correlations between the 8 CAARS-O subscale scores and the pain variables (pain duration, pain NRS-11). (A) Subscale B (hyperactivity/restlessness) on the CAARS-O scale is positively correlated with the maximum pain intensity. (B) Subscale B (hyperactivity/restlessness) on the CAARS-O scale is positively correlated with the average pain intensity. (C) Subscale F (DSM-IV hyperactive-impulsive symptoms) on the CAARS-O is positively correlated with the average pain intensity.



## DISCUSSION

In this study of 60 (29 male, 31 female) patients with continuous persistent CNLBP, 46 (76.7%) (25 male, 21 female) were found to have positive scores on either the CAARS-S or CAARS-O questionnaires, whereas only 19 (31.7%) (8 male, 11 female) had positive scores on both CAARS-S/O questionnaires. CAARS scores exceeding 65 indicate that the score is over the 95th percentile for the general population. Patients with CAARS scores exceeding 65 were deemed to have clinically significant ADHD. Furthermore, severe ADHD symptoms were observed in 36 out of 46 patients (78.3%) whose CAARS scores exceeded 70 points. Overall, we found that the scores on an ADHD scale were considerably high among patients with persistent CNLBP; therefore screening for ADHD should be considered as part of the standard treatment plan for patients with persistent CNLBP.

A recent meta-analysis reported that the global prevalence of adult patients with ADHD is 2.5% (28). In Japan, the prevalence of adults with ADHD is reported to be 1.65% (29). In the current study, approximately 31.7% of patients had positive scores on both the CAARS-S and CAARS-O scales, which is close to the prevalence rate of ADHD among patients with FM in previous studies conducted by Derksen et al (20) (25%) and Yilmaz and Tamam (15) (29.5%). Further, the number of patients with positive CAARS-S or CAARS-O scores in this study (76.7%) was close to the prevalence of ADHD at an FM clinic (80%), as reported by Young and Redmond (16). Furthermore, there is decreased dopaminergic neuron function in both FM and ADHD (30,31). CNLBP has also been reported to reduce the function of dopaminergic neurons (32), which may explain why patients with persistent CNLBP also displayed high scores on the ADHD scale in this study.

Previous studies on ADHD among patients with FM used the ASRS or the Wender Utah Rating Scale, for which only the patients are expected to respond to the scales. In contrast, the CAARS scale employed in the present study requires both patients and their family members to respond. The positive CAARS percentages differed (31.7% vs. 76.7%) when the T-scores of both CAARS-S and CAARS-O exceeded 65, or when either the CAARS-S or CAARS-O scales had T-scores greater than 65 (Fig. 1). In future studies on the prevalence of ADHD coexisting with chronic LBP or FM, determining how to define ADHD-positive patients using ADHD self-report scales will be important. We believe that the CAARS scale will be suitable because it is composed of 2 scales for patients and their families, making it possible to de-

fine ADHD positivity when both scales indicate T-scores greater than 65, thus providing a strict definition for the diagnosis of ADHD.

Among the 8 CAARS subscales, subscale G assesses whether a patient's ADHD symptoms meet the DSM-IV diagnostic criteria, and subscale H estimates the necessity of treatment for ADHD. The male patients with persistent CNLBP in this study had significantly higher subscale G scores on both CAARS-S/O tests than the standardized sample, whereas the female patients had significantly higher subscale G scores on the CAARS-S than did the standardized sample. With respect to the H subscale scores, both male and female patients had significantly higher scores on both CAARS-S/O tests than the standardized sample. These findings suggest that the patients with persistent CNLBP in the present study almost met the DSM-IV diagnostic criteria for ADHD and required treatment; however, the criteria were not fully fulfilled.

A CAARS T-score greater than 60 corresponds to the 86th percentile of a standard population and is considered above average. In this study, male patients were found to have T-scores greater than 60 on both subscale D (problems with self-concept [ $60.9 \pm 12.0$ ]) and subscale H (ADHD index [ $62.1 \pm 14.6$ ]) of the CAARS-O questionnaire. This indicates that the severity of "problems with self-concept" and the severity of treatment requirement for ADHD symptoms in male patients in this study were higher than average, according to the assessments made by the patients' family members.

Furthermore, both male and female patients with persistent CNLBP scored significantly higher than the standardized sample on subscales A, D, and E for both CAARS-S/O tests. Subscales A and E are items related to inattention, and subscale D reflects a lack of self-confidence or low self-esteem. Inattention and a lack of self-confidence are speculated to be difficult to acknowledge by a brief observation during a regular medical examination. Therefore it is recommended to confirm the existence of inattention and a lack of self-confidence using an ADHD assessment scale such as the CAARS.

Although 31.7% of the patients in this study had positive ADHD scale scores for both CAARS-S and CAARS-O questionnaires, none had previously been diagnosed with ADHD. This raises the question as to why ADHD was overlooked, considering that patients with persistent CNLBP frequently exhibit higher ADHD scale scores. The prevalence of ADHD in the general population is estimated to range from 2.5% to 5% (28,33),

but ADHD is reportedly underdiagnosed in more than 80% of cases, even by clinical psychiatric practitioners (34). This is partly attributable to the fact that adult persons with ADHD frequently appear to function normally because they expend excessive energy in striving to overcome their impairments. In addition, it is speculated that numerous patients with ADHD are underdiagnosed because orthopedic or pain clinicians, who treat most patients with persistent CNLBP, are unfamiliar with the diagnosis and management of ADHD.

The present study demonstrates that among patients with persistent CNLBP, ADHD scale scores (subscale B: hyperactivity/restlessness and subscale F: DSM-IV hyperactive-impulsive symptoms) are associated with the degree of subjective pain and pain duration. Subscales B and F both indicate the level of hyperactivity of ADHD. In the current chronic pain literature, "overactivity," "action-proneness," and "ergomania" have been described as general behavioral patterns in patients with chronic pain (35,36). It has also been reported that more "overactivity" demonstrates more pain (37). Based on the results of this study, we believe that "overactivity" reflects the ADHD symptoms of hyperactivity. A previous study described the interference of ADHD symptoms and pain with work (12). However, to the best of our knowledge, the present study is the first to examine the association between ADHD scale scores and the extent of LBP in patients with persistent CNLBP.

Moreover, in a previous study, pain symptoms in patients with chronic pain, including those with persistent CNLBP, were improved with standard ADHD treatment medications. In this study, it was found that the pain and ADHD symptoms of patients with chronic pain and comorbid ADHD tend to improve with ADHD treatment (38). In detail, our results showed that 35 of 110 patients (31.8%) with chronic pain at various sites, who were referred to a psychiatrist at a pain clinic, were ultimately diagnosed with ADHD. Of these 35 patients, 21 received adjusted ADHD medications (methylphenidate and/or atomoxetine). Twenty of

the 21 medicated patients (95.5%) experienced an improvement in their ADHD symptoms, and 14 of 21 patients (66.7%) experienced a simultaneous improvement in their pain symptoms, as evaluated using the NRS-11. The NRS-11 pain scores of the 14 patients decreased by  $4.6 \pm 2.6$  points ( $64.7\% \pm 30.1\%$ ). In addition, considering that there were only 7 patients with persistent CNLBP (among the 21 patients with chronic pain at various sites) who received adjusted medication, 7 of 7 (100%) experienced reduced pain symptoms, as measured using the NRS-11 ( $4.3 \pm 2.6$  points,  $65.3\% \pm 28.2\%$ ).

The present study has some limitations. In this study, ADHD tendency was evaluated using only a self-report questionnaire. The positivity rate was 31.7% when both CAARS-S and CAARS-O questionnaires were positive, and 76.7% when either test was positive, which reflects a difference of 45%. According to the CAARS manual, if the results of the CAARS-S and CAARS-O questionnaires do not match, either the patient or his/her family is not aware of the patient's symptoms (23). In other words, 45% of patients who have a difference in CAARS positivity may actually have clinical-level ADHD symptoms, which were not noticed by themselves or their family members, thus leading to a discrepancy in scores. Hence in the future, accurate and precise assessments of ADHD symptoms using structured clinical interviews conducted by ADHD experts are warranted. Additionally, the present study only included patients with persistent CNLBP. Therefore in the future, it will be valuable to investigate ADHD scale scores (e.g., CAARS) among patients with CNLBP and NLBP with larger sample sizes.

## CONCLUSIONS

The ADHD scale scores were considerably high among patients with persistent CNLBP. Our clinical experience indicates that persistent CNLBP can be substantially relieved by administering ADHD medications; thus ADHD screening is warranted in the treatment of persistent CNLBP.

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