Osmangazi Journal of Med, 2025;47(5):816-827
DOI: 10.20515/otd.1637221

Research Article
Araştırma Makalesi

Osmangazi Journal of Medicine
e-ISSN: 2587-1579

Predictors of Severe Nicotine Dependence in Patients with Chronic Pain

Kronik Ağrı Hastalarında Şiddetli Nikotin Bağımlılığının Öngördürücüleri

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Ethics Committee Approval: The study was approved by Eskisehir Osmangazi University Noninterventional Clinical Research Ethical Committee (Decision no: 29 Date: 30.03.2021

Informed Consent: The authors declared that it was not considered necessary to get consent from the patients because the study was a retrospective data analysis.

Authorship Contributions: Conceptualization: İGYK, GG, MSG,Methodology: İGYK, GG, MSG,Data curation: EG, HK, HU,Formal analysis: İGYK,Writing – original draft: HU, EG, HK, Writing – review & editing: HU, İGYK,Supervision: İGYK, GG, MSG

Copyright Transfer Form: Copyright Transfer Formwas signed by all authors.

Conflict of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Financial Disclosure: The authors received no financial support for the research, authorship, and/or publication of this article.

Received : 11.02.2025

Accepted : 08.08.2025

Published :18.08..2025

Abstract: The combined presence of chronic pain and nicotine dependence has been shown to elevate the risk of both physical and mental illnesses. Consequently, understanding the interconnected relationship between chronic pain, smoking, and nicotine dependence is crucial for developing effective interventions and improving patient outcomes. The present study aimed to reveal if pain intensity, symptoms of anxiety and depression, anxiety sensitivity, and distress tolerance serve as predictive factors of severe nicotine dependence risk among patients with chronic pain. Seventy-six smokers with chronic pain were recruited (mean age = 50.28±12.37, 63.2% female). The study utilized self-reported measures to assess pain intensity, distress tolerance, anxiety sensitivity, nicotine dependence, and symptoms of anxiety and depression. Univariate binary logistic regression was performed to find the predictors of severe nicotine dependence risk. Among the patients, 34.2% reported anxiety (n=26), and 56.6% reported depression (n=43). The anxiety subscale scores of the HADS (odds ratio = 1.125 [1.016–1.245]) and the total scores of the ASI-3 (odds ratio = 1.038 [1.005–1.073]) significantly predicted severe nicotine dependence risk (p = 0.023 and p = 0.025, respectively), as well as pain intensity over the past week (odds ratio = 1.331[1.030–1.720]; p = 0.029). This study highlights the need to address smoking behavior and mental health in patients with chronic pain and emphasizes the importance of pain management, anxiety symptoms, and anxiety sensitivity as potential targets for intervention in smoking cessation efforts within this population.
Keywords: Anxiety sensitivity; Nicotine Dependence; Chronic Pain; Smoking; Tobacco.

Özet: Kronik ağrı ve nikotin bağımlılığı birlikteliği, fiziksel ve ruhsal hastalıkların riskini arttırmaktadır. Bu nedenle kronik ağrı, sigara kullanımı ve nikotin bağımlılığı arasındaki ilişkinin anlaşılması, etkili müdahaleler geliştirmek için kritik öneme sahiptir. Bu çalışma, kronik ağrısı olan hastalarda şiddetli nikotin bağımlılığı riskinin öngördürücüleri olarak ağrı şiddeti, anksiyete ve depresyon semptomları, anksiyete duyarlılığı ve sıkıntıya dayanma düzeylerini ortaya koymayı amaçlamıştır. Çalışmaya, kronik ağrısı olan, ağrı yönetimi için tedavi gören ve sigara içen 76 kişi katılmıştır (ortalama yaş = 50.28 ± 12.37, %63.2 kadın). Çalışmada; ağrı şiddeti, anksiyete ve depresyon semptomları, anksiyete duyarlılığı ve sıkıntıya dayanma düzeyleri ile nikotin bağımlılığı riskini değerlendirmek için öz-bildirim ölçekleri kullanılmıştır. Şiddetli nikotin bağımlılığı riskinin belirleyicilerini saptamak amacıyla tek değişkenli lojistik regresyon analizi yapılmıştır. Hastane Anksiyete ve Depresyon Ölçeği (HADÖ) kesme değerlerine göre, hastaların %34.2'si anksiyete (n=26) ve %56.6'sı depresyon (n=43) bildirmiştir. HADÖ'nün anksiyete alt ölçek puanları (odds oranı = 1.125 [1.016–1.245]), Anksiyete Duyarlılığı Ölçeği-3 toplam puanları (odds oranı = 1.038 [1.005–1.073]) ve ağrı şiddeti (odds oranı = 1.331[1.030–1.720]) şiddetli nikotin bağımlılığı riskini anlamlı şekilde öngörmüştür (sırasıyla p=0.023, p=0.025, p=0.029). Bu çalışma, kronik ağrı hastalarında sigara kullanımı ve ruh sağlığının ele alınmasının gerekliliğine dikkat çekmekte ve bu hasta grubunda sigara bırakma sürecinde potansiyel müdahale alanları olarak ağrı yönetimi, anksiyete semptomları ve anksiyete duyarlılığının önemini vurgulamaktadır.
Anahtar Kelimeler: Anksiyete Duyarlılığı; Nikotin Bağımlılığı; Kronik Ağrı; Sigara Kullanımı; Tütün.

How to cite/ Atıf için: Ulusoy H, Yilmaz Karaman İG, Gökçeoğlu E, Kocabacak H, Güleç G, Güleç MS, Predictors of Severe Nicotine Dependence in Patients with Chronic Pain, Osmangazi Journal of Medicine, 2025;47(5):816-827

1. Introduction

Addiction is a chronic medical condition involving complex interactions among biological systems, genetics, and environmental factors. It is characterized by the compulsive use of substances despite their mental, physical, and social consequences. Tobacco use, as a form of addiction, is one of the most significant public health challenges, contributing to over 8 million tobacco-related deaths annually (1). According to World Health Organization statistics, 22.3% of the global population used tobacco in 2020, including 7.8% of women and 36.7% of men (2). Tobacco use is linked to numerous health issues affecting almost every organ system, including cancer (3). While nicotine itself does not directly cause cancer, tobacco smoke contains at least 69 carcinogenic chemicals (3).

People with certain medical conditions, such as mental disorders, substance use disorders, and chronic obstructive pulmonary disease, are known to smoke at higher rates (4,5). From this perspective, there are studies investigating the relationship between smoking and chronic medical conditions such as chronic pain. Chronic pain refers to pain that persists or recurs for more than three months. It is associated with low quality of life, disability, and mental symptoms like depressed mood or anxiety (6). Chronic pain and tobacco use are both highly prevalent and often co-occur (3). Research indicates that individuals with chronic pain are more likely to smoke than the general population (7), with these patients being twice as likely to smoke compared to those without chronic pain (8). Chronic pain is associated not only with current smoking status but also with nicotine dependence, smoking severity, and challenges in the quitting process (9). Additionally, smokers with chronic pain report higher pain intensity, greater functional impairment, and an increased need for analgesics compared to non-smokers (10). In terms of nicotine dependence, it is known that higher nicotine dependence is related to an increased risk of persistent smoking (11). The combined presence of chronic pain and nicotine dependence has been shown to elevate the risk of both physical and mental illnesses (12). Consequently, understanding the interconnected relationship between chronic pain, smoking, and nicotine dependence is crucial for developing effective interventions and improving patient outcomes.

Chronic pain is related to mental disorders. Patients suffering from chronic pain report high rates of depression and anxiety symptoms (13). Regarding the relationship between depression, anxiety, and smoking, past studies have documented that smoking is more prevalent among individuals with depression and anxiety disorders (14, 15). Since both chronic pain and symptoms of anxiety and depression are associated with increased cigarette use, chronic pain patients with anxiety and depression may be at an elevated risk for smoking.

The concept of anxiety sensitivity (AS) was introduced by Reiss and McNally in 1985 as part of their expectancy model of fear. It was defined as the fear of bodily sensations associated with anxiety (16). AS reflects the fear that anxiety symptoms may lead to harmful physical, mental, or social consequences. AS has three dimensions: physical, cognitive, and social. The physical dimension involves fear of physical symptoms of anxiety, such as palpitations. The cognitive dimension pertains to the fear of losing control, while the social dimension involves the fear of others noticing one's anxiety symptoms. AS is considered a risk factor for anxiety disorders, and it is typically elevated in individuals with panic disorder and other anxiety disorders (17). Regarding the relationship between smoking and AS, a study found patterns similar to those observed in chronic pain studies. AS was significantly related to the severity of tobacco dependence, perceived barriers to quitting, and problems during quit attempts (18).

The relationship between AS, chronic pain, and smoking is a relatively new and emerging area of research. A review of the literature reveals notable findings. In a study involving participants who used electronic cigarettes, Zvolensky et al. (2019b) reported that the interaction between AS and pain severity was significantly associated with increased e-cigarette dependence (19). Similarly, Rauven et al. (2021) found that among adult smokers experiencing homelessness, participants with higher AS demonstrated heavier smoking (based on the Heaviness of Smoking Index) (20) as past month pain increased (21).

Distress tolerance (DT) refers to an individual's perceived capacity to endure negative emotional and physical states, such as pain, as well as the behavioral effort to resist distressing internal experiences triggered by stressors (22). Evidence suggests that low DT is associated with an increased vulnerability to various addictions and poorer treatment outcomes (22, 23). While earlier research primarily focused on alcohol and substance use (24,

25), smoking has also emerged as an area of interest. Recent studies have placed greater emphasis on how DT relates to smoking persistence, motives for smoking, and early lapses during cessation attempts (26, 27). Redmond et al. (2024) highlighted that DT is associated with smoking motives related to addiction, alleviation of negative emotions, and stimulation-seeking (27). Moreover, DT has been shown to indirectly influence nicotine dependence through smoking motives, such as tension reduction and habitual smoking (28). In terms of chronic pain, Trepanier et al. (2022) stated that DT may influence the pain experience of patients suffering from chronic pain (29).

The present study aimed to reveal if symptoms of anxiety and depression, anxiety sensitivity, and distress tolerance were predictive factors of severe nicotine dependence risk among smoking patients with chronic pain.

2. Materials and Method

The present study has a cross-sectional design.

Inclusion criteria included being between 18 and 65 years old, experiencing pain for at least 3 months, currently smoking at least one cigarette per day, volunteering to participate in the study, and being literate enough to complete the forms independently. Exclusion criteria included having psychosis or severe depression, cognitive impairment or intellectual disability, and substance abuse or severe alcoholism. The study criteria were monitored and managed by trained psychiatry residents during patient recruitment.

2.1. Procedure

The study recruited patients with chronic pain from the Algology Unit of the Eskişehir Osmangazi University Hospital. The patients were either inpatients or outpatients. Data recruitment took place between April 1, 2021, and March 1, 2022.

2.2. Measurements

Sociodemographic and clinical data form: The form included age, sex, marital status, employment status, educational level, and the clinical characteristics of the pain.

Visual Analog Scale (VAS): The patients' pain intensity over the last week and the discomfort associated with it were evaluated using the VAS. Having a single-item measurement with VAS is commonly used in healthcare settings. The VAS scores range from 0 to 10 (30). Regarding pain intensity, 0 indicated no pain, and 10 represented the worst possible pain. For discomfort, 0 indicated no discomfort, and 10 referred to the highest level of discomfort.

Hospital Anxiety and Depression Scale (HAD): It is a self-assessment scale designed to assess the risk of anxiety and depression, as well as to measure the severity and changes in these conditions in patients with physical illnesses and those seeking primary care (31). It was translated into Turkish, and a validity and reliability study was conducted (32). There are subscales for anxiety (HAD-A) and depression (HAD-D). It contains a total of 14 questions. Seven of them (odd numbers) measure anxiety, and the other seven (even numbers) measure depression. Provides a four-point measurement using the Likert scale. The cut-off score for the anxiety subscale was 10/11 and for the depression subscale 7/8 among the Turkish population (32). The lowest score that patients can achieve on both subscales is 0, the highest 21. Considering that our study included patients hospitalized due to pain, the HAD was preferred because it does not contain any items related to physical symptoms, which helped us obtain more accurate results (33). Since the present study evaluated anxiety and depression using self-report measures, the variables are referred to as probable anxiety and probable depression.

The Anxiety Sensitivity Index-3 (ASI-3): It is the most commonly used scale for assessing anxiety sensitivity, developed by Reiss et al. in 1986 (34). The scale consists of three subscales (physical, cognitive, and social) and a total of 16 items. The physical subscale measures the “fear of physical symptoms” caused by anxiety, such as fear of palpitations or shortness of breath. The cognitive subscale measures the "fear of losing cognitive control" dimension, which assesses situations such as the fear of not being able to concentrate on a topic or the fear of feeling strange or empty. The social subscale assesses situations defined as "fear of one's anxiety symptoms being noticed" by others in society, like being noticed that one is shaking. After several revisions, ASI-3 was developed (35). ASI-3 consisted of 18 items and three subscales (physical, cognitive and social). The Turkish validity and reliability study was conducted (36).

The Fagerström Nicotine Dependence Test (FNDT): It is a six-question questionnaire created by revising the Fagerström Tolerance Questionnaire (FTQ) (37). The FNDT is a short, practical test for smoking dependence. The Turkish version of the test is valid and reliable (38). In the FNDT scoring system, a score of 0–2 indicates very low

dependence, 3–4 indicates low dependence, 5 indicates moderate dependence, 6–7 indicates high dependence, and 8–10 indicates very high dependence. FNDT scores ≥6 reflect severe nicotine dependence (39). The study evaluated severe nicotine dependence psychometrically; thus, the variable used was probable severe nicotine dependence, defined based on an FNDT score of 6 or higher.

Distress Tolerance Scale (DTS): The DTS, developed by Simons and Gaher (2005), is a self-assessment scale consisting of 16 items (40). The items are rated on a Likert scale ranging from 1 to 5. The scale options range from (5) 'strongly disagree' to (1) 'strongly agree,' with higher scores reflecting a greater ability to tolerate stress. The DTS comprises four subscales designed to measure the ability to tolerate emotional stress: 1) Tolerance to emotional stress (Tolerance), 2) Subjective appraisal of stress (Appraisal), 3) Distraction from distressing emotions (Attention Distraction), and 4) Regulatory efforts to reduce stress (Regulation). The DTS was valid and reliable among the Turkish population (41).

2.3. Ethics

The study was approved by the Non-invasive Clinical Studies Ethics Committee of Eskişehir Osmangazi University on 30.03.2021 with decision number 29. Written informed consent was obtained from all partipants. The study adheres to the principles outlined in the Declaration of Helsinki.

2.4. Statistical Analysis

SPSS version 25 was utilized for the statistical analysis. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as means and standard deviations, or medians and interquartile ranges. The normality of the data was evaluated based on skewness and kurtosis values. The associations between continuous variables were tested by utilizing the Pearson correlation test. Binary logistical regression analysis was performed to identify predictors of severe nicotine dependence. A statistically significant p-value was set at 0.05.

A post-hoc power analysis was conducted for the Pearson correlation test of FNDT and ASI-3 ($r = 0.297$, $p = 0.009$, $n = 76$), yielding an estimated statistical power of 72.4% ($\alpha = 0.05$, two-tailed). That indicates a moderate probability of correctly detecting the observed effect size.

3. Results

Among the participants, 63.2% were female (n=48), and 36.8% were male (n=28). The mean age of the participants was 50.28 ± 12.37 years. Most participants were married (80.3%, n=61). Regarding employment status, 23.7% were retired, 36.8% were employed full-time, and 28.9% were unpaid domestic workers, also known as homemakers. The sociodemographic characteristics of the participants are presented in Table 1.

Table 1. Sociodemographic characteristics of the participants (n=76)

		Mean	Standard deviation
Age		50.28	12.37
		Frequency (n)	Percentage (%)
Sex	Female	48	63.2
	Male	28	36.8
Civil status	Single	15	19.7
	Married	61	80.3
Employment	Full-time	28	36.8
	Part-time	1	1.3
	Retired	18	23.7
	Unpaid domestic worker	22	28.9
	Unemployed	7	9.2
Education	Primary school	45	44.1
	Secondary school	11	10.8
	High school	23	22.5
	Graduate or post-graduate	23	22.5

3.1. Smoking Characteristics

The daily cigarette consumption was as follows: 42.1% smoked 10 or fewer cigarettes per day (n=32), 46.1% smoked 11 to 20 cigarettes (n=35), 10.5% smoked 21 to 30 cigarettes (n=8), and 1.3% smoked more than 30 cigarettes (n=1). The mean duration of smoking was 24.65 ± 13.09 years. Table 2 summarizes the severity of the nicotine dependence. Based on the FNDT scores, ≥6 points reflecting severe nicotine dependence; 25% of the participants (n = 19) met the criteria for severe dependence (See Table 2).

Table 2. Nicotine dependence levels of the participants based on FNDT scores

	Frequency (n)	**Percent (%)**
Very low dependence	32	42.1
Low dependence	16	21.1
Moderate dependence	9	11.8
High dependence	11	14.5
Very high dependence	8	10.5

3.2. Pain Characteristics

Table 3 demonstrates the pain characteristics of the patients.

Table 3. Pain characteristics of the patients (n=76)

		Frequency (n)	Percentage (%)
Pain localization*	Lumbar	42	55.26
	Extremities	8	10.53
	Hip	8	10.53
	Other	8	10.53
	Shoulder	7	9.21
	Neck	7	9.21
	Head	4	5.26
Treatment*	Surgical	51	67.1
	Medical	43	56.6
		Median	Q1-Q3
Pain duration (months)		60	24- 120
		Mean	Standard deviation
Pain intensity over the past week		7.18	± 2.73
Discomfort due to pain		7.82	± 2.25

**: Some patients had more than one.*

3.3. Evaluation of Measurements

Based on the HADS cut-off scores, 34.2% of patients reported anxiety (n=26), and 56.6% reported depression (n=43). Among the participants, 25% (n=19) had Fagerström Nicotine Dependence Test (FNDT) scores ≥6, indicating severe dependency (39). The mean values and standard deviations are presented in Table 3.

Table 4. Mean values and standard deviations of the scales utilized (n=76)

		Mean	Standard deviation
Hospital Anxiety Depression Scale	Anxiety	8.57	5.34
	Depression	8.17	3.87
Anxiety Sensitivity Index-3	Total	19.71	15.80
Distress Tolerance Scale	Total	47.83	12.65
Fagerström Nicotine Dependence Test		3.63	2.85

Spearman correlation analysis was used to examine the relationships between variables. There was a significant positive correlation between FNDT scores and ASI-3 total scores (r=0.297, *p=0.009*), indicating that higher anxiety sensitivity is associated with greater nicotine dependence. FNDT scores were also positively and significantly correlated with both HADS-Anxiety (r=0.284, *p=0.013*) and HADS-Depression scores (r=0.262, *p*=0.022), indicating that higher levels of anxiety and depression symptoms are associated with increased nicotine dependence scores. Additionally, a positive correlation was found between FNDT scores and pain intensity over the past week (r=0.287, *p*=0.012), suggesting that increased pain severity is related to higher nicotine dependence. Relevant results are presented in Table 5.

Table 5. Correlation analysis of the study variables

Measures	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FNDT (1)	-					
DTS (2)	-.191	-				
ASI-3 (3)	.297**	-.636**	-			
HADS-Anxiety (4)	.284*	-.388**	.552**	-		
HADS-Depression (5)	.262*	-.288*	.484**	.543**	-	
Pain intensity over the past week (6)	.287*	-.264*	.341**	.399**	.419**	-

***: Correlation is significant at the 0.01 level (2-tailed)*

**: Correlation is significant at the 0.05 level (2-tailed)*

FNDT: Fagerström Nicotine Dependence Test

DTS: Distress Tolerance Scale

ASI-3: Anxiety Sensitivity Index-3

HADS: Hospital Anxiety Depression Scale

3.4. Predictors of Severe Nicotine Dependence

Univariate binary logistic regression was performed to find the predictors of severe nicotine dependence (See Table 6). Age and sex did not show a statistically significant prediction.

The anxiety subscale scores of the HADS (B=0.118, p=0.023) significantly predicted severe nicotine dependence. According to the univariate binary logistic regression analysis, a 1-point increase in the anxiety subscale increased the probability of severe nicotine dependence 1.125 times. Anxiety sensitivity was one of the predictors; the total scores of the ASI-3 (B=0.038, p=0.025) significantly predicted severe nicotine dependence. Lastly, pain intensity over the past week (B=0.286, p=0.029) was associated with an increased probability of severe nicotine dependence. Specifically, each 1-point increase in VAS was related to a 1.331 times higher probability of severe nicotine dependence.

Table 6. Predictors of Severe Nicotine Dependence (n=76)

Predictor	B	p	Exp(B)	95% CI	
				Lower	Upper
Anxiety- HADS	0.118	0.023*	1.125	1.016	1.245
Depression- HADS	0.122	0.082	1.130	0.984	1.298
Anxiety Sensitivity Index	0.038	0.025*	1.038	1.005	1.073
VAS- Last week	0.286	0.029*	1.331	1.030	1.720

**Statistically significant predictor of severe nicotine dependence ($p<0.05$)*

4. Discussion

The present study focused on patients with chronic pain to identify mental health-related predictive factors of severe nicotine dependence (FNDT scores ≥6). One key finding was high psychological distress among the participants: 34.2% reported anxiety, and 56.6% reported depression, based on psychometric assessments. Anxiety symptoms, anxiety sensitivity, and the pain intensity reported over the past week were found to predict severe nicotine dependence risk among patients with chronic pain.

The predominance of women in the sample and the mean age being over 50 are consistent with the literature, indicating that the prevalence of chronic pain is higher among women and older age groups (42).

It is widely recognized that the rate of comorbid chronic conditions, both mental and physical, is elevated in patients with chronic pain (43). As previously mentioned, anxiety disorders and depression, in particular, are more prevalent among adults suffering from chronic pain (44). In our study, 34.2% of participants reported anxiety, and 56.6% reported depression, based on the scales administered to participants. The relationship between depression, anxiety, and chronic pain is clinically significant, as these mental health conditions are associated with worse outcomes in individuals with chronic pain (45).

The strong association between depression and chronic pain is well established, yet the exact prevalence of this comorbidity remains unclear. Epidemiological studies on chronic pain and depression report that depression affects 20–50% of individuals with chronic pain (43, 46). Recent findings further support this link, with 42.4% of individuals with chronic pain reporting mild, moderate, or severe depressive symptoms (44). In the present study, 56.6% of participants reported depression, consistent with previous findings. Given the common overlap between chronic pain and depression, as well as the adverse effects of depression on pain-related disability (47), it is important to emphasize the need to treat depression in this population.

The link between smoking and depression is also well-documented, with estimates indicating that 50–60% of individuals with major depression experience nicotine dependence, compared to approximately 25% in the general population (48). As previously noted, individuals with chronic pain report higher rates of both depressive symptoms and smoking compared to the general population. This overlap suggests a potential relationship between depression and smoking within this group. In this context, depression may serve as a predictor of nicotine dependence in chronic pain patients who smoke. However, a review of the literature reveals that data on this relationship remain limited. In our study, depressive symptoms did not predict severe nicotine dependence risk in patients with chronic pain. This finding may be attributed to certain limitations of the study, including its single-center design, small sample size, and the fact that depression was self-reported rather than assessed through clinical interviews with a physician.

In the context of chronic pain and anxiety comorbidity, numerous studies have demonstrated that individuals with chronic low back pain exhibit a higher prevalence of anxiety disorders compared to the general population, with rates ranging from 19% to 31% (49, 50). In a recent nationally representative study in the United States, 43.6% of respondents with chronic pain reported elevated levels of anxiety (44). In our study, symptoms of anxiety were reported by 34.2% of participants.

Individuals with anxiety disorders tend to smoke at higher rates, consume more cigarettes per smoker, and quit smoking at lower rates compared to those without anxiety disorders (51). While smoking prevalence is elevated among individuals with anxiety disorders, the evidence regarding nicotine

dependence remains inconsistent. In a systematic review of population-based epidemiological studies, Moylan et al. (2012) found that certain baseline anxiety disorders serve as risk factors for the initiation of smoking and nicotine dependence (52). However, the literature provides more substantial evidence for the relationship between anxiety and smoking rather than nicotine dependence.

When examining the role of anxiety in smoking dependence among chronic pain patients, Ditre et al. (2014) highlighted the influence of pain-related anxiety (53). They suggested that smokers with comorbid chronic pain may be at heightened risk of sustaining or worsening their nicotine dependence, possibly due to individual variations in pain-related anxiety. Another study involving electronic cigarette users found that pain intensity was positively associated with past failed cessations and negative abstinence expectancies among participants with high levels of pain-related anxiety, but not among those with moderate or low levels (54). Although pain-related anxiety was not measured in our study, this concept may be particularly relevant for patients hospitalized for pain management. In this regard, specifying anxiety symptoms in a domain-specific manner among patients hospitalized due to pain may be important for future research. In the present study, symptoms of anxiety were identified as a predictor of severe nicotine dependence risk in patients with chronic pain. This finding highlights the potential role of emotional distress in maintaining or exacerbating nicotine use in this population. Individuals with heightened anxiety levels may engage in smoking as a maladaptive coping strategy to reduce psychological discomfort (55).

As mentioned earlier, anxiety sensitivity is simply the fear of anxiety symptoms (16). AS has been linked to smoking dependence and persistence (18, 56). In this regard, Zvolensky et al. (2019a) reported that, based on their study using the Fagerström Nicotine Dependence Test, AS was significantly related to the severity of nicotine dependence among Latinx smokers and that the physical dimension of AS also showed a significant association with cigarette dependence (18). A recent study showed that anxiety was associated with tobacco dependence in individuals highly anxiety sensitive, but not in those with lower levels of anxiety sensitivity (57). This outcome indicates that the interconnection between anxiety and anxiety sensitivity is important for a better understanding of tobacco dependence. In terms of cessation, smokers with high levels of AS tend to experience more difficulties during the quitting process (18). The literature also notes more intense withdrawal symptoms in these individuals during the early phases of quitting (58). This finding, when considered alongside the study of Zvolensky et al. (2019a), which emphasized the impact of the physical subdimension of AS on dependence, may help explain the underlying mechanism (18).

Research examining the relationship between AS and nicotine dependence among chronic pain patients is limited. One important study by Zvolensky et al. (2020) examined the role of anxiety sensitivity concerning pain intensity among chronic pain patients who smoke (12). They stated that the ASI-3 total score was significantly positively associated with smoking problems (measured by the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) tobacco problems score) among chronic pain patients. Another important finding was the significant indirect effect of pain intensity on smoking problems through AS. This finding suggests that individuals with higher pain intensity may develop smoking-related problems more strongly if they also have high AS. From this point of view, targeting AS could help in reducing the impact of pain on smoking behaviors. In the present study, AS and higher pain intensity over the past week positively predicted severe nicotine dependence risk in patients with chronic pain. In this respect, our findings are consistent with the existing literature. Furthermore, understanding the interconnected relationship between anxiety sensitivity, pain intensity, and severe nicotine dependence seems important in order to better support this patient group.

Distress tolerance (DT) is simply the capacity to endure distress, as previously noted. Individuals with low levels of DT are thought to be more prone to addictive behavior, such as smoking. Previous research has demonstrated that low DT is linked to a higher risk of smoking maintenance, greater nicotine dependence, and complications of cessation (59, 60). More recently, Niezabitowska et al. (2022) also emphasized that individuals with low DT are especially likely to develop nicotine dependence (28). Schlam et al. (2020) stated that higher DT was associated with higher quitting success and predicted abstinence over a year after quitting (61). Contrary to the findings mentioned above, a systematic review by Veilleux (2019) reported inconsistent evidence on the relationship between distress tolerance and smoking (62). The review also noted

that lower DT does not appear to be associated with higher smoking frequency or longer smoking duration. Furthermore, treatments targeting DT show promise; however, additional research is needed to gain a better understanding of this relationship.

Studies investigating the relationship between pain, smoking dependence, and DT are limited. An important study on this topic found that smokers who experienced pain in the past month had lower scores on the distress tolerance test compared to those without pain (63). Based on this finding, DT among smokers suffering from pain may be one mechanism by which pain contributes to the continuation of tobacco use. In the present study, DT did not predict severe nicotine dependence among chronic pain patients. When the literature is collectively evaluated, although data on the relationship between DT and nicotine dependence show variability, we would have expected DT to be a predictor of severe nicotine dependence in patients with chronic pain. This outcome may be related to several limitations of the study: a small sample size, its single-center design, and the focus on severe nicotine dependence (FNDT score ≥6) rather than nicotine dependence in general. Nonetheless, our findings may contribute to the diverse literature on this topic.

Chronic pain is associated with nicotine dependence, as mentioned earlier. In the coexistence of chronic pain and nicotine dependence, pain intensity appears to play a significant role as well. Bakhshaie et al. (2016) found that smoking severity variables—such as years of daily smoking, current cigarettes per day, cigarettes per day during the heaviest lifetime smoking period, and current nicotine dependence levels—were significantly linked to higher pain intensity (64). Similarly, in the present study, higher pain intensity reported over the past week was found to predict the risk of severe nicotine dependence. Several mechanisms may underlie this relationship. One possibility is the reinforcement of the conditioned use of nicotine through its acute analgesic, arousing, and mildly euphoric effects (65). Besides increasing pain thresholds and tolerance to painful stimuli, the effects of nicotine have been shown (66). Building on this, nicotine use may serve as a coping strategy for patients with higher pain intensity. However, this behavior may reinforce dependence in the long term and perpetuate the pain-nicotine cycle. From this point of view, pain can be considered not only a physical symptom but also a factor associated with addictive behavior. When the literature is examined from this perspective, Ditre et al. (2011) suggest that nicotine use may be adopted as a coping mechanism for pain, a perspective further supported by Zale et al. (2016) (67, 68). Our current finding supports this assumption. Mechanisms stated below may help explain the increased prevalence of smoking and nicotine dependence among individuals with chronic pain, but evidence suggests a bidirectional interaction. According to that, pain increases smoking, and smoking, in turn, increases pain (10). It is not entirely evident how chronic tobacco use contributes to increased pain. In this manner, a recent study showed that chronic exposure to nicotine can induce hypersensitivity to pain by activating dopaminergic projections to the anterior cingulate cortex (7).

Several limitations of the present study should be acknowledged. First, the cross-sectional design restricts the ability to infer causal relationships between anxiety, anxiety sensitivity, pain intensity, and severe nicotine dependence. As a result, the findings only reflect associations rather than directional effects. To address this limitation, future research should have longitudinal study designs. Second, the study was conducted at a single center, which limits the generalizability of the findings to broader populations. Third, the findings rely on self-reported psychometric scales, and the diagnosis of depression and anxiety was not validated through clinical interviews conducted by a mental health professional. Finally, the analyses were not specified for subgroups of chronic pain but were instead based on the general condition of experiencing any chronic pain.

The strengths of this study include its contribution to the limited literature on this topic and its emphasis on smoking and mental health among patients with chronic pain.

5. Conclusion

The present study focused on patients with chronic pain to identify mental health–related predictors of severe nicotine dependence (FNDT scores ≥6). One key finding was the high level of psychological distress among participants: 34.2% reported anxiety symptoms and 56.6% reported depressive symptoms, based on psychometric assessments. Anxiety symptoms, higher anxiety sensitivity scores, and greater pain intensity experienced in the past week were found to predict the risk of severe nicotine dependence among patients with chronic pain.

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