Original Article

Effects of chronic pain on sleep quality and depression

A cross-sectional study

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ABSTRACT

الأهداف: كشف أثر الألم المزمن على أبعاد كل من الاكتئاب وجودة النوم وكذلك دراسة دور النوم كوسيط في شرح العلاقة بين الألم المزمن والاكتئاب.

المنهجية: في الفترة ما بين مارس 2019 وفبراير 2020، تم أجراء دراسة مقطعية على 233 مريض ألم مزمن في مستشفيين في الرياض، المملكة العربية السعودية

النتائج: من بين 233 مريض ألم مزمن، 36% يعانون من الاكتئاب، بينما كان 66.1% يعانون من ضعف جودة النوم. أظهرت أيضاً الدراسة أن شدة الألم والإعاقة من الألم قد فسرت 10.9% من التباين في تأثير الاكتئاب، و4.9% من التباين في انعدام التلذذ، و17.3% من التباين في الشكوى الجسدية، و4.5% من التباين في صعوبة التعامل مع الأخرين، و7.4٪ من التباين في كفاءة النوم، و15% من التباين في جودة النوم. أظهرت الدراسة أيضًا تأثيرًا إيجابيًا ومباشرًا للألم المزمن على سوء جودة النوم، والذي بدوره كان له تأثير إيجابي ومباشر على الاكتئاب. ولكن الألم المزمن له تأثير فقط غير مباشر على الاكتئاب عن طريق النوم.

الخلاصة: المعدلات العالية للاكتئاب وضعف جودة النوم بين مرضى الألم المزمن تتطلب اهتمامًا خاصًا. شدة الألم المزمن والإعاقة المتعلقة بالألم المزمن تؤثر على أبعاد الاكتئاب وجودة النوم بطرق مختلفة. وتؤكد النتائج الحاجة إلى إدارة وعلاج سوء جودة النوم لمعالجة الاكتئاب بين مرضى الألم المزمن

Objectives: To examined the impacts of chronic pain on depression and poor sleep quality dimensions as well as the mediating function of poor sleep quality in the pathway between chronic pain and depression.

Methods: Between March 2019 and February 2020, we conducted a cross-sectional study on 233 chronic pain patients in 2 tertiary hospitals in Riyadh, Saudi Arabia.

Results: Of the 233 patients, 36% had depression, while 66.1% had poor sleep quality. Chronic pain intensity and pain disability significantly explained 10.9% of depressed affect variance, 4.9% of anhedonia variance, 17.3% of somatic complaint variance, 4.5% of interpersonal difficulty variance, 7.4% of sleep efficiency variance, and 15% of perceived sleep quality variance. The result also showed a positive, direct effect of chronic pain on poor sleep quality, which in turn positively and directly affect depression. However, chronic pain had only indirect effect on depression.

Conclusions: Among chronic pain patients, the high rates of poor sleep quality and depression requires a special attention. Chronic pain intensity and disability predict depression and sleep quality dimensions differently. The result underlines the need of managing poor sleep quality to address depression in the context of chronic pain.

Keywords: chronic pain, depression, poor sleep quality, chronic pain patients, structural equation modeling

Saudi Med J 2021; Vol. 42 (3): 315-323
doi: 10.15537/smj.42.3.20200768

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Received 29th November 2020. Accepted 9th February 2021.

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Chronic pain is persistent pain that lasts more than 3 months[1] and more than the expected healing period.[2] It has deleterious effects on patients' health, daily activities, and workplace productivity.[3] Its tenacious nature contributes to the co-occurrence of depression and poor sleep quality.[4] Of all patients with chronic pain, 22.9%-60.8% meet the criteria for depression.[3,5,6] Chronic pain explains the variance in depression,[7] which might occur as a result of the shared neuroplasticity alterations and underlying processes between chronic pain and depression.[8] There is still uncertainty related to the question of whether

depression occurs before the onset of chronic pain or due to the persistent and enduring pain.[9] The diathesis-stress framework posits that chronic pain might lead to unpleasant sensory and troubling emotional feelings, which, in turn, create a sense of helplessness and hopelessness and result in the development of depression symptoms.[10] The criteria for depression include sleep difficulties.[11] An overlap between depression and sleep disturbance has been found,[12] which occurs as a result of changes in the dopamine system[13] and the serotonin and proinflammatory cytokine levels.[14] Chronic pain also disturbs the patient's sleep quality because he/she struggles to fall or stay asleep.[9] Sleep quality refers to the extent of night-wakefulness, which is due to sleep latency, efficiency, arousal, and/or the number of awakenings Chronic pain patients suffer from more sleep.[15] disturbances;[16] 40.7%-86% of patients with chronic pain have sleep disturbances.[17,18] Chronic pain and sleep share the same neurophysiological mechanisms.[19] In addition, chronic pain has a stronger effect on sleep disturbance than sleep on chronic pain.[20]

There are still inconsistencies related to the relationship of chronic pain with both depression and sleep quality, which might be due to measurement issues. Some studies only measured the total pain intensity using various scales, such as the McGill pain questionnaire,[21] brief pain inventory,[3] visual analog scale,[22] or only a single question on whether the patient has chronic pain.[23] These measurements assess current pain or pain during the last week and have an inadequate comprehensive and multidimensional viewpoint related to chronic pain that lasts for more than three months.[10] With regard to depression, using the categorical or overall total score is inappropriate, because it does not capture the heterogeneousness of the underlying dimensions of depression symptomology.[24] There is a need to better understand how chronic pain affects the symptoms of depression.[25] A diagnosis of depression is based on the manifestation of depressive symptoms.[11] Thus, identifying the effect of chronic pain on these depressive symptom dimensions is crucial for a comprehensive assessment, diagnosis, and management, as well as for developing interventions for the management of chronic pain. Similarly, sleep quality is a multidimensional, complex construct;[26] therefore, to understand its nature, a special consideration of the underlying dimensions is needed.

A limited body of literature has examined the mechanisms by which chronic pain, poor sleep quality, and depression are related. Three different mechanisms have been investigated. Some studies have reported that sleep affects chronic pain intensity through depression,[17] while others have shown that chronic pain leads to sleep disturbance[27] and is mediated by mood issues, including depression, and still, others have reported that chronic pain affects depression through sleep disturbance.[28,29]

The majority of existing evidence originates in Western countries, which limits its generalizability to other contexts. Pain is a subjective experience that is shaped by the patient's physiological and psychological aspects, in addition to sociocultural and environmental circumstances.[2] Ethnicity and cultural background differences also affect chronic pain and related outcomes.[30] The sequels of chronic pain must be studied in different sociocultural contexts to fill the gap in the existing body of evidence related to the influences of chronic pain.[31] In Saudi Arabia, chronic pain and its high impact are evident among the adult population (46.4% and 4%, respectively).[32] However, the pathway through which chronic pain is related to depression and sleep quality has not been examined in Saudi patients. Thus, among chronic pain patients in Saudi Arabia, this study assessed the extent of depression and poor sleep quality, examined the effect of chronic pain on depression and sleep quality dimensions, and investigated the pathway by which chronic pain affects depression. Based on the diathesis-stress framework and existing evidence,[10] we hypothesized that chronic pain positively affects depression directly and indirectly through the mediating function of poor sleep quality.

Methods. We conducted a cross-sectional study involving 233 patients with chronic pain from the specialty pain clinics of 2 main tertiary hospitals in Riyadh, Saudi Arabia between March 2019 and February 2020. The patients were screened for eligibility to participate in the study while they were waiting for regular appointments. The inclusion criteria were chronic pain diagnosis, Saudi citizenship, adults, and willingness to provide consent. Ethical permission was granted by the institutional review boards of King Saud University (E-19-3719) and the Saudi Ministry of Health (19-146E). Before collecting the data, informed consent was provided and explained to each participant.

Disclosure. Authors have no conflict of interests, and the work was not supported or funded by any drug company. This research project was supported by a grant from the Research Center of the Female Scientific and Medical Colleges, Deanship of Scientific Research, King Saud University.

Structured interviews were conducted with 233 patients to collect data. Since the minimum required sample size for structural equation modeling (SEM) is 200 participants,[33] the current study sample was considered appropriate.

The survey questions were assessed the patients' background, including age, gender, education, income, hours of exercise, and smoking status.

Chronic pain. The Chronic Pain Grade (CPG) scale,[34] which has 7 items, was used. It evaluates chronic pain during the last 6 months with 2 subscales: pain intensity and pain related disability. First, the pain intensity has 3 items that assessed present, worst, and mean pain intensity based on 10 points Likert scale. Second, the pain disability assesses the hindrance of pain in performing everyday activities and the change in the capacity to take part in activities and work based on 10 points Likert scale. One item asks about the number of days during the last 6 months when routine activities (for example, work or housework) could not be performed owing to the pain. The CPG scale can also be categorized into 4 grades based on pain intensity and disability points. The CPG scale has been validated in different languages.[35] In the present study, we utilized the Arabic version of the CPG scale,[36] which is also reliable, with a Cronbach's alpha value of 0.916 for pain intensity and 0.815 for pain disability.

Depression. We used the Center for Epidemiologic Studies-Depression (CESD) scale,[37,38] which quantifies the symptoms of depression. Using 20 items, the participants rated how frequent they suffer from depressive symptoms based on 4 points Likert scale throughout the last week. The total score ranges from 0 to 60, with a higher score reflecting higher depression and a score of 16 or more indicating depression, which is in alignment with depression criteria from the Diagnostic and Statistical Manual of Mental Disorders, fourth edition. The CESD has 4 subscales: depressed affect, anhedonia (lack of positive affect), somatic complaints, and interpersonal difficulties. It is reliable and valid in different populations,[39] including patients with chronic pain.[40] The structure of the CESD scale's factors is also applicable to patients with chronic pain.[41] In the present study, the CESD Arabic scale[42] was used, and it has also an evidence of reliability, with a Cronbach's alpha value of 0.867.

Poor sleep quality. The Pittsburgh Sleep Quality Index (PSQI)[43] was used to evaluate poor sleep quality. The PSQI has 18 items that assess a patient's overall sleep quality by measuring 7 components: usage of sleep medications, sleep duration, sleep quality, sleep latency, sleep efficiency, sleep disturbance, and daytime dysfunction. The total score ranges from 0 to 21, with a higher score indicating poor sleep quality, and a score of more than 5 reflecting sleep problems. The PSQI is reliable and valid in different populations,[44] including patients with chronic pain.[45] Among patients with chronic pain, sleep efficiency and perceived sleep quality are supported as scale subscales.[46] In this study, we used the Arabic version of the PSQI,[47] which has a reliability score of 0.752.

Data analysis. Data were analyzed using SPSS Statistics version 26 (IBM Corporation, Armonk, NY, USA). The extent of missing data for the study's variables ranged from 0% to 3.9%. Little's test was not significant, indicating that data were missing completely at random (MCAR). Thus, missing values were imputed by using expectation maximization. We performed descriptive statistics to analyze the patients' background characteristics and study variables. Normality of the distributions was assessed based on skewness and kurtosis indices. Data were considered non-normal for a skewness index >3 and kurtosis index >10.[33] At the item level, the skewness index ranged from 0.13 to 4.0, while the kurtosis index ranged from 0.08 to 16.32, indicating that univariate normality was not met; therefore, the multivariate normality was deviated. Correlational analyses were performed to assess the relationship between the study variables and patient characteristics.

Mplus version 8 was used to conduct confirmatory factor analysis to test the uni-dimensionality of depression and sleep quality, and then the supported underlying dimensions.[41,46] Subsequently, multiple linear regression analyses were conducted with chronic pain intensity and pain disability as independent variables to predict depression and sleep quality dimensions. Kruskal-Wallis analysis of variance was conducted to assess how depression and sleep quality symptoms differed based on the four chronic pain categories. Using Mplus, we performed SEM to test our hypothesis using the robust maximum likelihood method to correct for non-normality. The fit indices, chi-square (χ^2), comparative fit index (CFI), Tucker-Lewis Index (TLI), root-mean-square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR), were used for examining the model fit with the data. For adequate fit, the index values were as follows: CFI and TLI ≥0.90, RMSEA <0.08, and SRMR <0.08.

Results. **Table 1** lists the patients' background characteristics. Their mean age was 51.32 years (standard deviation [SD] = 14.344; range = 18-87 years). Of the 233 patients, 67% were women, and only 32.2% were

Table 1 - Background characteristics of study participants (N=233).

Characteristics	n	(%)
Gender		
Female	156	(67.0)
Male	77	(33.0)
Employment		
Employed	75	(32.2)
Not employed	93	(39.9)
Retired	65	(27.9)
Personal income per month		
0-2000	80	(34.3)
2000-5000	35	(15.1)
5000-10,000	59	(25.3)
10,000-15,000	27	(11.6)
Education		
Unable to read and write	36	(15.5)
Primary education	63	(27.0)
Secondary Education	53	(22.7)
Diploma	12	(5.2)
University/college degree	67	(28.7)
Smoking		
Smoker	49	(21.0)
Non-smoker	183	(78.9)
Body mass index		
Underweight	4	(1.7)
Normal	47	(20.2)
Overweight	57	(24.5)
Obese	120	(51.5)
Pain site		
Head	2	(0.9)
Facial	1	(0.4)
Neck	24	(10.3
Shoulder	16	(6.9)
Hand/arm	7	(3.0)
Chest	1	(0.4)
Back	103	(44.2)
Pelvis	5	(2.1)
Knee	20	(8.6)
Leg	9	(3.9)
Foot	11	(4.7)
Joint	9	(3.9)
Muscle	1	(0.4)
Others	24	(10.3)
Pain Grade		
Grade I (low pain intensity-low disability)	18	(7.7)
Grade II (high pain intensity-low disability)	74	(31.8)
Grade III (moderately limiting pain- high disability)	138	(59.2)
Grade IV (severely limiting pain-high disability)	3	(1.3)
Characteristics (mean±SD)		
Number of cigarettes/day	3.25 ± 8.73	
Number of exercise minutes/day	26.52 ± 45.07	

Missing data for background characteristics range between 0.1% to 13.7%

employed. Their education level varied: 15.5% were unable to read or write and 28.7% had a university or college degree. In addition, their personal income varied from 34.3% earning up to SR2000, whereas 11.6% earning SR10001-15000. The pain was located at different sites, but most of the patients (44.2%) suffered from back pain. On the CPG scale, 7.7% of the patients had Grade I (namely, low pain disability with low pain intensity), 31.3% had Grade II (namely, low pain disability with high pain intensity), 58.8% had Grade III (namely, high pain disability with moderately limiting pain), and 0.9% had Grade IV (namely, high pain disability with severely limiting pain). The mean number of exercise minutes/day was 26.52 (SD=45.07; range: 0-240). On an average, patients smoked 3.25 cigarettes/day (SD=8.73; range: 0-80).

Descriptive results for study variables. The descriptive results are presented on **Table 2**. The mean pain intensity score was 73.45 (SD=21.21; range: 10-100), and the mean pain disability score was 68.56 (SD=23.91; range: 10-100). The mean depression score was 15.78 (SD=9.11; range: 0-53), and the mean score of poor sleep quality was 7.68 (SD=3.68; range: 1-18.81). Of the 233 patients, 36% had depression, while 66.1% had poor sleep quality.

Kruskal-Wallis non-parametric analysis of variance showed significant between-group differences in the symptoms of depression (χ^2 [3] = 5.878; p=0.001) and sleep quality (χ^2 [3] = 7.183; p=0.000); here, the Grade IV group exhibited the worst symptoms of depression and the poorest sleep quality. The relationship of chronic pain intensity and pain disability with background characteristics showed a non-significant relationship; however, we found significant relationships between the number of smokes and chronic pain intensity (r=0.196; p=0.003) and pain disability (r=0.153; p=0.020). An independent t-test showed significant differences between smokers and non-smokers in chronic pain intensity (t [230] = 3.48; p=0.001) and pain disability (t [230] = 2.46; p=0.014).

Confirmatory factor analysis. For the CESD scale, the unidimensional model (1-factor) had poor fit with the data; the goodness-of-fit indices were as follows: χ^2 (170, N=233) = 936.29, CFI=0.708, TLI=0.673, RMSEA=0.139 (90% confidence interval [CI]: 0.130-0.148), and SRMR=0.113. For the 4-factor model, the goodness-of-fit indices showed that the underlying depression dimensions (depressed affect, anhedonia, somatic complaints, and interpersonal difficulties) adequately fit the data, allowing item 3 from depressed affect to co-vary with item 19 from

Table 2 - Descriptive statistics for study variables (N=233).

Measure	Mean	SD	Range	Skewness	Kurtosis
Pain intensity	73.54	21.21	10-100	-1.15	1.50
Pain-related disability	68.56	23.91	10-100	-0.70	0.08
Overall depression	15.78	9.11	0-53.0	1.08	1.67
Depression subscales					
Depressed affect	3.30	5.25	0-21	1.66	1.83
Anhedonia	4.59	4.46	0-12	0.32	–1.40
Somatic complaints	5.18	0-19	0-19	0.84	–0.47
Interpersonal difficulties	0.42	1.10	0-6	3.10	9.98
Overall poor sleep quality	7.68	3.68	1-18.8	0.71	0.07
Poor sleep quality subscales					
Sleep efficiency	2.10	1.84	0-6	0.58	–0.75
Perceived sleep quality	5.80	2.91	1-14	0.77	0.04

Table 3 - Effects of chronic pain on depression and sleep quality dimensions (regression analyses).

Predictors	Depressed affect		Anhedonia		Somatic complaints		Interpersonal difficulties		Sleep efficiency		Perceived sleep quality	
	B	β	B	β	B	β	B	β	B	β	B	β
Pain intensity	0.024	0.097	0.048*	0.228*	0.045*	0.193*	0.002	0.043	–0.032*	–0.370*	0.025	0.181
Pain disability	0.055*	0.250*	0.001	0.008	0.052*	0.251*	0.011*	0.242*	0.012	0.159	–0.028*	–0.232*
R^2 (explained variance)	10.9%		4.9%		17.3%		4.5%		7.4%		15%	
F	14.0*		5.96*		24.06*		5.42*		9.21*		20.27*	

β: unstandardized regression coefficient, B: standardized regression coefficient, F: test for linear regression, *P<0.05

interpersonal difficulties. The goodness-of-fit indices were as follows: χ^2 (163, N=233) = 356.392, CFI=0.926, TLI=0.914, RMSEA=0.070 (90% CI: 0.060-0.080), and SRMR=0.046. The standardized factor loading for the subscales were significant, ranged from 0.50-0.89.

For the PSQI, the unidimensional model had poor fit with the data; the goodness-of-fit indices were as follows: χ^2 (14, N=233) = 59.48, CFI=0.782, TLI=0.673, RMSEA=0.118 (90% CI: 0.088-0.150), and SRMR=0.066. An excellent fit of the data, with the following goodness-of-fit indices: χ^2 (13, N=233) = 18.97, CFI=0.971, TLI=0.954, RMSEA=0.044 (90% CI: 0.00-0.085), and SRMR=0.038, was found to support the 2-factor model (sleep efficiency and perceived sleep quality). The standardized factor loading for the subscales were significant, ranged from 0.41-0.85.

Effect of chronic pain on both depression and sleep quality dimensions. **Table 3** lists the unstandardized and standardized regression coefficients, as well as the explained variance (R2) and F-statistics values for each regression analysis. For each depression dimension as a dependent variable, the analysis showed that a linear combination of chronic pain intensity and pain disability significantly predicted depressed affect (F [2, 230] = 14.00; *p*=0.000), anhedonia (F [2, 230] = 5.96; *p*=0.003), somatic complaints (F [2, 230] = 24.06; *p*=0.000), and interpersonal difficulty (F [2, 230] = 5.42; *p*=0.005). Looking specifically for chronic pain dimensions, chronic pain intensity did not significantly predict depressed affect (β = 0.097; t [232] = 1.03; *p*=0.302); however, pain disability significantly predicted depressed affect (β = 0.250; t [232] = 2.66; *p*=0.008). Only chronic pain intensity significantly predicted anhedonia (β = 0.228; t [232] = 2.34; *p*=0.02), while pain disability did not significantly predict anhedonia (β = 0.008, t [232] = 0.08; *p*=0.937). Both chronic

pain intensity (β = 0.193, t [232] = 2.13; *p*=0.035) and pain disability (β = 0.251; t [232] = 0.2.773; *p*=0.006) predicted somatic complaints. Chronic pain intensity did not significantly predict interpersonal difficulties (β=0.043; t [232] = 0.437; *p*=0.663), while pain disability significantly predicted interpersonal difficulties (β = 0.242; t [232] = 2.487; *p*=0.014).

A linear combination of chronic pain intensity and pain disability significantly predicted sleep efficiency (F [2, 230] = 9.21; *p*=0.000) and perceived sleep quality (F [2, 230] = 20.27; *p*=0.000). Only chronic pain intensity significantly predicted sleep efficiency (β = 0.370; t [232] = 3.86; *p*=0.00), while pain disability did not significantly predict sleep efficiency (β = 0.159; t [232] = 1.655; P = 0.099). Chronic pain intensity did not significantly predict sleep quality (β = 0.181; t [232] = 1.97; *p*=0.050), while pain disability significantly predicted sleep quality (β = 0.232, t [232] = 2.525; *p*=0.012).

Structural equation modeling. To test our hypothesis, SEM was conducted with chronic pain, poor sleep quality, and depression as latent variables. Our model adequately fit the data: χ^2 (16, N=233) = 36.261, CFI=0.967, TLI=0.942, RMSEA= 0.070 (90% CI: 0.040-0.106), and SRMR=0.055; depressed affect co-varied with interpersonal difficulties. **Figure 1** shows the standardized (B) and unstandardized (β) regression coefficients for each path. For all latent measures, the loadings for factor were significant (0.122-0.991). Chronic pain positively and directly affect poor sleep quality (β = 0.488; B = 0.021; *p*=0.00). Moreover, poor sleep quality positively and directly affect depression (β = 0.501; B = 3.142; *p*=0.00). In contrast, chronic pain did not have a significant direct effect on depression (β = 0.191; B = 0.051; *p*=0.106), but it indirectly affected depression (β = 0.245; B = 0.065; *p*=0.005). This analysis revealed that poor sleep quality has a full mediating function in explaining the association between chronic pain and depression.

Discussion. This study aimed to examine the extent of depression and poor sleep quality, effect of chronic pain on depression and sleep quality dimensions, and pathway by which chronic pain affects depression. Grade IV patients (high pain disability, severely limiting pain) exhibit the worst symptoms of depression and poor sleep quality. Chronic pain (namely, a linear combination of pain intensity and pain disability) predicts depression and sleep quality dimensions; yet, pain intensity and pain disability each independently predict depression and sleep quality dimension in different ways. With regard to the mechanism, chronic pain affects depression indirectly through poor sleep quality.

Our finding that 36% of chronic pain patients have depression aligns with the existing body of literature, which has shown that 22.9%-60.8% of chronic pain patients meet the criteria for depression.[3,5,6] Although

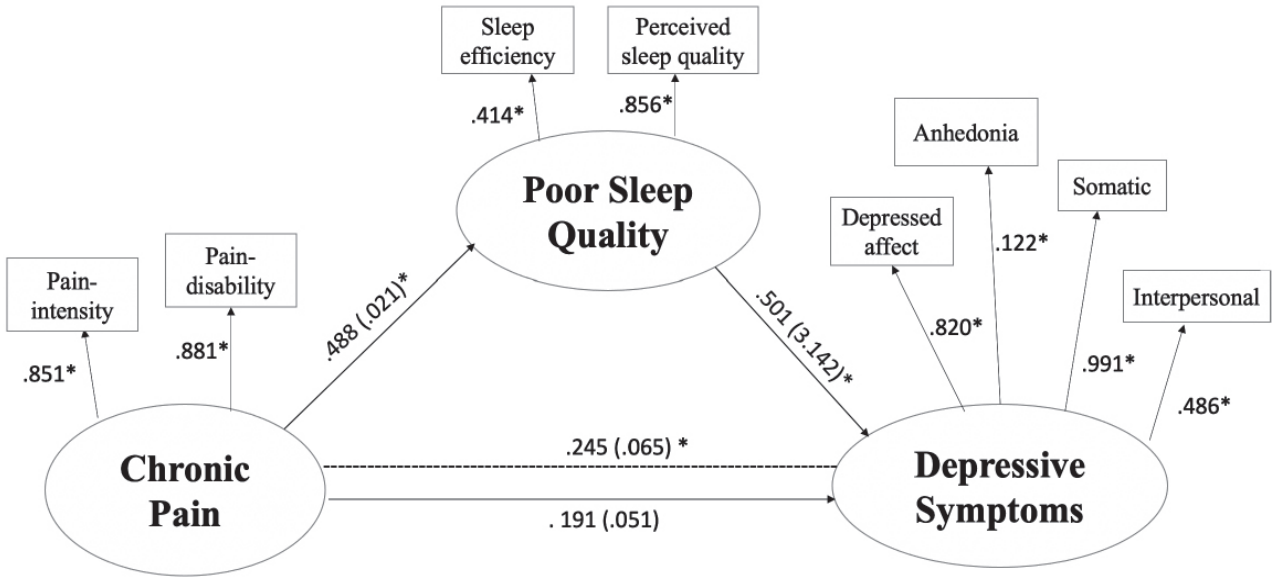

Figure 1 - Structure equation modeling with the standardized (unstandardized regression coefficients.

not every chronic pain patient has depression; patient with a higher level of chronic pain have more severe symptoms of depression. Therefore, chronic pain can be stressful, leading to catastrophizing, rumination, and helplessness[48] because of pain and limited activity levels. Similarly, the existing body of literature has revealed that 40%-86% of chronic pain patients experience poor sleep quality[17,18] which is in agreement with our finding that 66.1% of patients have poor sleep quality.

Although epidemiological studies highlight the association between chronic pain and advanced age, gender, and employment condition,[30] some studies have revealed that age, gender, education, and occupation do not explain any differences in chronic pain.[7,49] Our findings revealed no association between the patient's background characteristics and both chronic pain intensity and pain disability. In terms of lifestyle and behavior, our findings highlighted the relationship between smoking and both chronic pain intensity and pain disability. The present finding is in agreement with the literature that reveals a positive feedback loop between smoking and chronic pain, as smoking is a risk factor for chronic pain, which could have an impact on patients' decision to smoke.[50]

Our results do not support the 1-factor model for depression and sleep quality; yet, we found 4 depression and 2 sleep quality dimensions. Depression has 4 dimensions.[37,51] Our findings support the heterogeneousness of depression and how chronic pain affects depression symptoms differently. Some studies have looked to the association between chronic pain and some depressive symptoms, but their findings are almost in alignment with our current findings. For instance, depressed affect is related to distress and feelings of sadness, fearfulness, anger, and chronic pain severity.[52] Anhedonia is the lack of a positive effect (excitement, eagerness, and individual strength).[53] A positive effect was not significantly correlated with chronic pain interference or intensity.[54] Previous research did not specifically analyze the association between chronic pain and somatic complaints as dimensions of depression. Somatic complaints as a dimension of depression are not the same as chronic pain. Identifying how chronic pain affects depression dimensions is crucial for developing interventions related to depression in chronic pain patients. In terms of sleep quality, our present study revealed that sleep efficiency and perceived sleep quality are 2 dimensions of poor sleep quality, which is consistent with previous studies.[46] Chronic pain intensity independently influences sleep efficiency, which is related to total sleep time. Pain disability affects perceived sleep quality, which is related to daytime dysfunction, usage of medications for sleep, subjective sleep quality, sleep latency, and sleep disturbance. Previous studies have shown that patients with chronic pain have lower sleep efficiency, and that high pain intensity predicts lower sleep quality.[55]

Poor sleep quality has a full mediating function in the association between chronic pain and depression because a higher level of chronic pain leads to poorer sleep quality, which, in turn, leads to worse depression symptoms. There are inconsistencies in the literature regarding this pathway. Our findings are similar to those of studies that have shown a partial[29] or complete[28] mediating role of sleep quality on the effect of chronic pain on depression. Although the diathesis-stress framework[10] is used to test the chronic pain effects on depression, this framework does not include sleep quality. Evidence shows that chronic pain affects sleep quality[9] and sleep quality affects depression.[56] Our study underscores the crucial role of poor sleep quality in explaining the link between chronic pain and depression. This means that among patients with chronic pain a higher level of depression can be explained by the poor sleep quality. Clinicians can address depression by managing chronic pain, as well as assessing and treating poor sleep quality using pharmacological and non-pharmacological treatments, such as cognitive behavioral therapy.

Study limitations. First, the use of a cross-sectional design did not allow us to infer the cause-effect relationship and reverse causation. Second, using self-reported measures was not possible because it could have increased the shared method variance. Third, the study sample included a convenience sample of patients with chronic pain who were seeking treatment; therefore, the findings may not be generalized to patients who experience chronic pain but do not seek treatment or seek alternative forms of treatment. Although the sample was recruited from a government hospital to ensure that the sample represents the Saudi population, the majority of the study sample was female with a mean age of 51.32 years, and this could negatively affect the generalizability of the findings. To avoid increasing the structured interview duration, we could not consider some important factors (for example, anxiety, self-efficacy, and pain tolerance). Finally, the mediation analysis did not account for potential confounding factors that could affect the sequential ignorability assumption.

In conclusions, among chronic pain patients in Saudi Arabia, poor sleep quality and depression are prevalent issues, and this requires the assessment and treatment of both conditions. The current findings might underscore

the cluster of symptoms related to chronic pain and address the need to consider the dimensions of these symptoms, not just the total score of both depression and sleep quality. Considering poor sleep quality in the context of chronic pain is highly necessary for managing depression, including its occurrence and progress. This finding can be utilized to tailor evidence-based interventions for patients in chronic pain clinics. Future longitudinal studies with larger sample sizes are needed to confirm the mediating effect of poor sleep quality.

Acknowledgment. *The authors are thankful to the Research Center of the Female Scientific and Medical Colleges, Deanship of Scientific Research for funding this research and to the Deanship of Scientific Research and RSSU at King Saud University, Riyadh, Saudi Arabia for their technical support (such as English language editing).*

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