Prevalence and Predicting Factors of Chronic Pain among Workers of Petrochemical and Petroleum Refinery Plants

Maryam Shaygan[1], Maryam Yazdanpanah[2]

[1]Community Based Psychiatric Care Research Center, Faculty of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran

[2]Faculty of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran

Abstract

Background: Taking into account the differences in job requirements and conditions, it is expected that workers in some occupations are more susceptible to pain than others.

Objective: To examine the prevalence of chronic pain among workers of several petrochemical and petroleum refinery plants. We also examined the predictive role of psycho-familial variables (depression, work-family conflict and job stress) in causing chronic pain when controlling for demographic and occupational factors.

Methods: This cross-sectional study was carried out among 674 workers. Those with chronic pain were identified by affirmative answers to screening questions based on the ICD-11 criteria.

Results: There were 162 (24.0%; 95% CI 20.8% to 27.3%) workers meeting the ICD-11 criteria for chronic pain. Headache was the most frequently reported pain (29.9%). We found a significantly (p=0.03) higher prevalence of pain among the middle age than in other age groups. Chronic pain more frequently affected divorced/widowed workers (p<0.001), and those with more work experience (p=0.04). Workers with chronic pain reported significantly higher levels of depression (p<0.001), job stress (p=0.007), and work-family conflict (p<0.001). After controlling for demographic and occupational factors, depression (p<0.001) and work-family conflict (p=0.003) were found to be independent predictors of chronic pain among studied workers.

Conclusion: Workers who experience higher levels of depression, work-family conflict and job stress might be more prone to chronic pain. The majority of these factors are modifiable, and the problem may thus be solved by establishing appropriate screening programs, and availability of proper services and education.

Keywords: Chronic pain; Prevalence; Workers; Depression; Occupational stress; Family; Work place

Introduction

Chronic pain is a major health care problem in most societies. It is common all over the world. Several studies have demonstrated that approximately 3.9% to 64% of the general population suffer from various types of chronic pain.[1-3] Pain has a major effect on how well a worker is able to perform his/her job, as
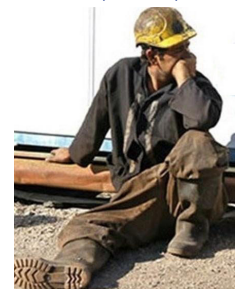
Correspondence to
Maryam Shaygan, PhD, Faculty of Nursing and Midwifery, Shiraz University of Medical Sciences, PO Box 71345-1359, Shiraz, Iran
E-mail: m2620.shaygan@gmail.com

well as his/her ability to be productive.

Taking into consideration the differences in job requirements and conditions, it is expected that workers in some occupations would be more susceptible to some types of pain than others. For example, although upper extremity musculoskeletal disorders are highly prevalent in manual-intensive occupations, such as clerical works,[4] back and lower limb disorders are reported to occur disproportionately among nurses, operators of cranes and other large vehicles.[5]

Consistent with biopsychosocial model of chronic pain, a number of previous studies have provided evidence that not only physical factors, but also psychosocial and familial factors, such as depression,[6] job stress,[7,8] and work-family conflict[9] are associated with the reporting of pain in workers. However, the magnitude or intensity of various factors may vary across cultures or work environments. For example, the impact of job stressors on health may vary across occupational groups.[10] In some studies, psychosocial characteristic of workers were even more strongly predictive of pain and its progression than occupational characteristics.[11]

In petrochemical and petroleum refinery industries in Iran, particularly in Asalooyeh region, Bushehr province, southern Iran, almost all workers are young males seeking promotions in their first years on the job. The majority of these workers are migrant workers, who work away from home and have to spend a long time far away from their families. Long time of work in hot and noisy workplaces, working in an environment polluted by hazardous air pollutants, and highly dynamic repetitive activities are also very common among these workers.[12,13] Therefore, a high rate of chronic pain is expected among these workers due to various physical (*eg*, polluted environment, repetitive activities) and psychological (*eg*, work-family conflict

due to prolonged absences from home) risk factors. Choobineh, *et al*, demonstrated a high frequency of musculoskeletal symptoms among petrochemical workers.[13] However, to the best of our knowledge, no previous study has evaluated the prevalence of various types of chronic pain among this group of workers. The focus on musculoskeletal disorders may cause us to overlook other types of pain among these workers. No studies have broadly examined the prevalence of chronic pain, and demographic, occupational and psycho-familial factors associated with it among petrochemical and petroleum refinery workers. The present study was therefore undertaken to determine the prevalence of chronic pain among workers of several petrochemical and petroleum refinery plants; compare demographic, occupational and psycho-familial variables between workers with chronic pain and healthy workers; and examine the predictive role of psycho-familial variables (depression, work-family conflict, and job stress) in chronic pain when controlling for demographic and occupational factors.

Materials and Methods

Participants and Sampling

This cross-sectional study was carried out from December 2017 to April 2018 on 700 workers of several petrochemical and petroleum refinery plants in Asalooyeh, southern Iran. Using G-Power software, the sample size of 700 was adequate to perform the analysis with a statistical power of 95%.[14]

A clustering sampling method was used to select a representative sample of workers in the studied plants. First, all petrochemicals and refineries were identified. Then, we drew a cluster sample of six randomly selected petrochemicals and six randomly selected petroleum refineries.

About 58 workers were randomly selected from the list of all workers included in each of the plants. Totally, 700 workers were randomly selected from all 12 plants identified. The inclusion criteria were working at least three months in petrochemical and petroleum refinery industries and the ability to comprehend Persian language. Workers were excluded from the study if they experienced any types of chronic pain before joining the industry, and if they reported a history of chronic physical diseases not related to pain, or mental chronic disorders. Workers not meeting the criteria were replaced by other randomly selected workers.

The workers received a letter with information about the study, self-report instruments and consent forms to sign. The self-report instruments and consent forms were completed by workers and returned to the researcher. The data were collected anonymously without name lists. The study was approved by the Ethics Committee of Shiraz University of Medical Sciences.

Measurements

Chronic Pain Assessment Tool

Individuals with chronic pain were identified by affirmative answers to three screening questions developed based on the ICD-11 criteria:[15] (a) "Are you currently troubled by pain or discomfort, either all the time or on and off?" (b) "Have you had this pain or discomfort for more than three months?" (c) "Does it affect your life and activities?" Respondents with long-lasting pain lasting for at least three months continued with the questions. In the next part of the assessment, participants were asked to determine if they experienced pain after joining the industry? Respondents answered "yes" were asked if they experienced pain during the last three months in each of head, chest, back, abdomen, neck and shoulder, hand, knee, and leg. Those indicating more than one region were asked to specify the region of main concern—the region with the worst pain experienced and the main reason for seeking medical attention. Participants were also asked if they had been diagnosed with any common causes of pain (*eg*, herniated/deteriorating intervertebral discs, arthritis, migraine headache, vascular damage, undergoing a surgical operation more than three months before, and sustaining injury). The assessment tool contained a numerical rating scale ranging from '0' (no pain) to '10' (worst imaginable pain) to assess the average intensity of pain during the last two weeks. The workers also answered about the frequency (answer categories: permanent, one or more attack per day, one or more attack per week, and one or more attack per month) and history of their pain (the number of months since they experienced pain).

Evaluation of qualitative face validity was based on the opinions of 13 experts to find any vague or irrelevant questions, or any difficulty with understanding of the questions. Ninety-two percent of the experts found the questions clear and understandable. To determine the quantitative face validity of each item, the item impact score was calculated. All the questions had an impact score ≥1.5. Therefore, in terms of face validity all the items were approved. Content validity was also evaluated qualitatively and quantitatively. The content validity index (CVI) for items was between 0.89 and 1.0 that was above the acceptable level. The content validity ratio (CVR) was >0.84, and thus approved. To examine test-retest reliability, the first 100 respondents answered the same questions for a second time, two weeks later. All questions had correlation coefficients ≥0.72.

Patient Health Questionnaire (PHQ)

Depressive symptoms were assessed by

Table 1: Sample characteristics (n=674)	
Parameter	n (%)
Age group (yrs)	
18–30	235 (34.9)
31–50	371 (55.0)
>50	68 (10.1)
Sex	
Male	612 (90.8)
Female	62 (9.2)
Marital status	
Single	189 (28.0)
Married	477 (70.8)
Divorced/Widowed	8 (1.2)
Education	
High school or less	50 (7.5)
Diploma	148 (22.0)
Bachelor	342 (50.7)
MSc	117 (17.3)
PhD	17 (2.5)

the Patient Health Questionnaire for depression.[16] Each item of the questionnaire evaluates the presence of one of the nine DSM-V (American Psychiatric Association) criteria for major depression. The nine items are answered on a 4-point rating scale ranging from "not at all = 0" to "nearly every day = 3." The PHQ-9 score can range from 0 to 27. In a study by Khamseh, *et al*, the reliability (Cronbach's α 0.87) of the Persian version of the instrument was confirmed.[17] The Persian version of PHQ-9 has a high sensitivity (73.8%) and specificity (76.2%) for the diagnosis of depressive disorders.[17] Therefore, the criterion validity of the questionnaire was approved.

Work-family Conflict Scale

Work-family conflict was measured using the work-family conflict scale.[18] This Scale consists of 10 items—five items assessing work-to-family conflict and five assessing family-to-work conflict. The items are answered on a 7-point scale ranging from '1' (strongly disagree) to '7' (strongly agree). The Persian version of the scale demonstrated good internal consistency (Cronbach's α 0.91 for work-to-family conflict, and 0.88 for family-to-work conflict).[19] The construct validity of the Persian version of the scale was confirmed by correlating its total score with those of other questionnaires such as World Health Organization Quality of Life Brief Questionnaire (r -0.47), Job Descriptive index (r -0.22), Subjective Vitality Scale (r -0.21), Organizational Commitment Questionnaire (r -0.37) and General Health Questionnaire (r -0.19).[19-21]

Industrial Unit Job Stressor Inventory (IUJSI)

The job stress was assessed using the Industrial Unit Job Stressor Inventory.[22] It is a self-administered questionnaire to assess the extent of the job stress due to management problems and employee welfare problems. The IUJSI consists of 34 items answered on a 4-point scale ranging from 0 (never) to 3 (often). The instrument has been shown to have adequate-to-excellent internal consistency (Cronbach's α 0.91–0.97).[22-24] The construct validity of the Persian version of the scale was confirmed by correlating its total score with those of other questionnaires such as Job Descriptive Index (r -0.46), Psychological Hardiness (r -0.49), Role Overload Scale (r 0.41), Physical Complaints Scale (r 0.28) and Anxiety Questionnaire (r 0.34).[22-24]

Statistical Analysis

Descriptive statistics were used to assess the demographic and occupational char-

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acteristics of the sample and the presence and characteristics of pain (intensity, frequency, history, location and self-reported cause of pain). *Student's t* test for independent samples and χ^2 test were used to compare differences in demographic, occupational and psycho-familial variables between workers with chronic pain and healthy workers. Binary logistic regression analysis was used to determine the association of psycho-familial variables (independent variables) with chronic pain (dependent variable) after adjusting for demographic and occupational factors. A p value <0.05 was considered statistically significant. The analyses were conducted with SPSS® for Windows® ver 22.0 (SPSS Inc, Chicago, IL, USA).

Results

A total of 700 workers were recruited from 12 studied petrochemical and petroleum refinery plants. Of the 700 workers invited, 26 (3.71%) did not return their questionnaires or consent forms, leaving 674 workers—an overall response rate of 96.3%. The study workers were mostly migrant (93%) and young, and had a mean age of 34.3 (SD 6.4) years. The majority of workers were male (90.8%), married (70.8%); 50.7% had Bachelor degree (Table 1).

There were 162 (24.0%; 95% CI 20.8% to 27.3%) workers meeting the ICD-11 criteria of chronic pain. The mean pain intensity over the two weeks was 5.44 (SD 1.92) on an 11-point numeric rating scale. They had history of pain for mean of 6.56 (SD 0.71) months; approximately one-third of patients had one or more pain attacks per day. Headache was the most frequently reported pain, representing approximately one-third of those with chronic pain. Other commonly reported body locations included the back, leg, knee, and neck and shoulder (Fig 1). Migraine headache, injury, and herniated or deteriorating intervertebral
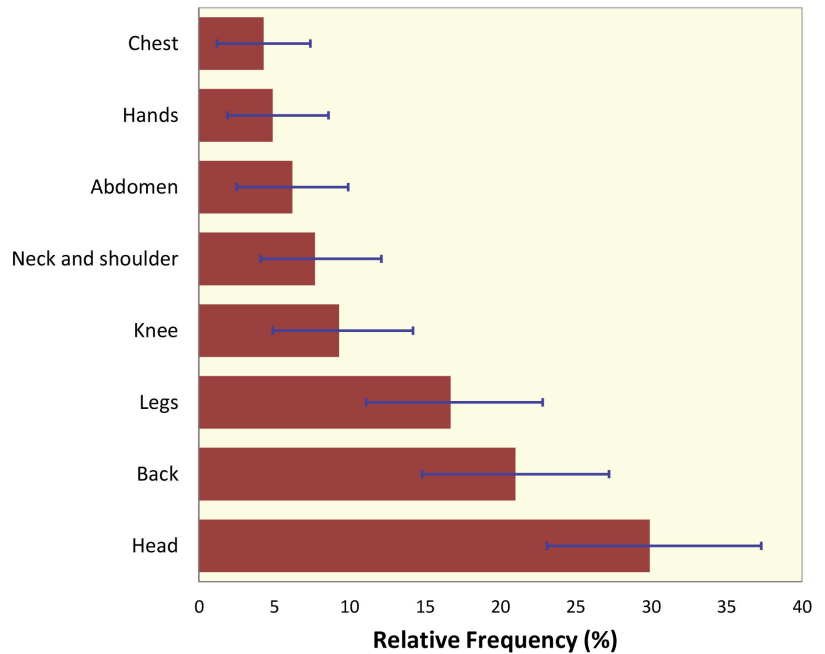

Figure 1: Self-expressed sites of pain (n=162). Error bars represent 95% confidence interval.

discs were the causes most frequently reported by the study participants and accounted for about two-thirds of individuals reporting chronic pain (Fig 2).
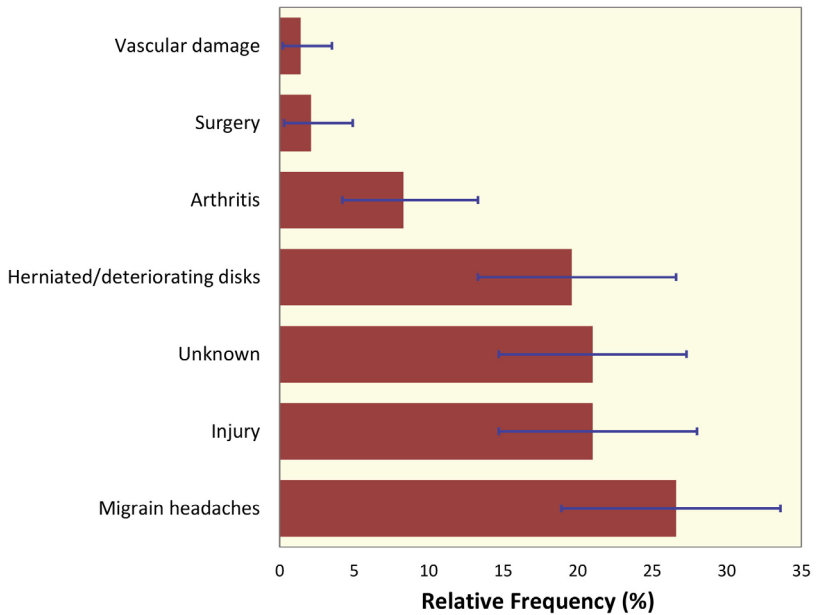

Figure 2: Self-expressed causes of pain (n=162). Error bars represent 95% confidence interval.

Table 2: Differences in demographic, occupational and psycho-familial variables according to pain in the previous three months (n=674). Values are either n (%) or mean [SD].

Variables		Chronic pain		
Demographic variables		**Yes (n=162)**	**No (n=512)**	**p value**
Age group (yrs)	18–30	43 (6.3)	192 (28.4)	0.03
	31–50	121 (18.0)	250 (37.1)	
	>50	2 (0.4)	66 (9.8)	
Sex	Male	152 (22.6)	460 (68.2)	0.33
	Female	12 (1.8)	50 (7.4)	
Marital status	Single	13 (2.0)	146 (21.7)	< 0.001
	Married	50 (8.0)	360 (53.5)	
	Divorced/Widowed	99 (14.0)	6 (0.8)	
Education	High school or less	6 (0.9)	44 (6.6)	0.09
	Diploma	42 (6.3)	106 (15.7)	
	Bachelor	84 (12.4)	258 (38.3)	
	MSc/PhD	30 (4.4)	104 (15.4)	
Occupational variables				
Type of industry	Petrochemical	99 (14.7)	303 (45.0)	0.81
	Petroleum refinery	63 (9.3)	209 (31.0)	
Type of job	White collar	34 (5.1)	125 (18.8)	0.77
	Gray collar	228 (4.3)	71 (10.7)	
	Blue collar	54 (8.1)	152 22.9)	
Daily work (hrs/day)	8 hours	12 (1.8)	41 (6.1)	0.58
	10 hours	36 (5.3)	124 (18.4)	
	≥12 hours	114 (16.9)	347 (51.5)	
Absence from work (hrs/month)		0.3 [0.9]	1.5 [2.1]	0.08
Work experience (yrs)		7.5 [4.1]	4.3 [6.7]	0.04
Scores of psycho-familial variables				
Depression		9.6 [5.4]	7.5 [5.2]	<0.001
Work-family conflict		37.4 [12.7]	32.4 [14.4]	<0.001
Job stress		61.9 [20.0]	56.9 [21.8]	0.007

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There were significant differences between participants with or without chronic pain in terms of age group and marital status. The middle age group had a significantly higher frequency of chronic pain (18%, p=0.03) compared with other age groups. The most frequent marital status in workers with chronic pain was divorced/widowed (14%, p<0.001). There was no significant difference between participants with and without chronic pain in terms of other demographic variables. No significant difference was found between the two groups in terms of type of industry (p=0.81), type of job (p=0.77), daily work (p=0.58), and absence from work (p=0.08). Participants with chronic pain had a significantly higher work experience (p=0.04) and reported higher levels of depression (p<0.001), work-family conflict (p<0.001), and job stress (p=0.007) (Table 2).

The Predictive Role of Psycho-familial Variables in Chronic Pain

Binary logistic regression revealed that depression (p<0.001), work-family conflict (p<0.001) and job stress (p=0.01) were significant predictors of chronic pain in workers. After controlling for demographic and occupational factors, depression and work-family conflict were found to be independent predictors of chronic pain; job stress was not (Table 3).

Discussion

We found that a considerable proportion of workers of the petrochemical and petroleum refinery industries suffered from various types of chronic pain. We found a higher prevalence of chronic pain in the middle age compared with other age groups. Chronic pain significantly affected more frequently divorced or widowed workers and those with a higher work experience. After controlling for demograph-

Table 3: Logistic regression analysis. The association of psycho-familial variables with chronic pain (n=674)

Independent variables	Crude OR (95% CI)	Adj OR* (95% CI)
Depression	1.07 (1.03 to 1.10)	1.08 (1.04 to 1.13)
Job stress	1.01 (1.00 to 1.02)	1.00 (0.99 to 1.01)
Work-family conflict	1.02 (1.01 to 1.03)	1.02 (1.00 to 1.03)

*Adjusted for demographic (age, sex, marital status, education) and occupational (type of industry, type of job, daily work, work experience) variables.

ic and occupational factors, we found that depression and work-family conflict were independent predictors of chronic pain in workers.

The prevalence of chronic pain among workers in petrochemical and petroleum refinery industries of Iran was 24%. It was similar to, or even lesser than that reported among general population or other occupational groups (such as health care workers) in Iran.[3,25,26] This could, in principle, be due to one or more of the following reasons: (1) as previously described, the majority of these workers were young males seeking promotions in their first years on the job. Therefore, having a mean experience of <7 years, workers studied in our study expectedly had a lower mean age than those reported in population-based studies. A previous study has found a significant association between pain and work experience.[27] (2) Individuals must be relatively healthy to be employed in petrochemical and petroleum refinery industries in Iran. Unlike general population or most of other occupational groups in Iran, the workers have free access to health care system. They have periodic health assessment visits in a primary care setting and access to free services provided in specialized hospitals, if necessary. This might be the reason for a lower rate of chronic pain among the studied workers compared with general population or other occupational groups in Iran. Finally, (3) although we considered the anonymity of the workers,

they might have under-reported symptoms through fear of losing their jobs.

Headache was the most frequent reported pain in workers. Migraine headache was also commonly reported. Petrochemical and petroleum refinery industries produce various types of pollutants such as hydrogen sulfide (H_2S), heavy metals, and hazardous air pollutants.[28] Several studies have reported headache as a common effect of hydrogen sulfide exposure on oil field workers.[28] Another important factor contributing to chronic headache is stress.[29] Petrochemical and petroleum refinery workers experience unique stressors such as busy and noisy workplaces.[30] Research has suggested a significant association between experiencing stress and the frequency and intensity of tension headache.[31] There is also evidence in favor of association between migraine headache and stress.[32] Our results revealed that the prevalence of headache among petrochemical and petroleum refinery workers was even higher than that of other types of chronic pain that are considered frequent types of pain among general populations and workers (eg, hospital nurses).[3,13,26]

Injury and herniated/deteriorating intervertebral discs were other common causes of chronic pain among petrochemical and petroleum refinery workers. Manual handling of material and taking awkward postures while doing operational activities, moving/lifting and pushing/pulling heavy objects, and overhauls are very common among petrochemical and petroleum refinery workers.[28] Under such circumstances, injuries and herniated/deteriorating discs are not unexpected. Choobineh, et al, report that static and awkward postures and moving/lifting and pushing/pulling heavy objects are significantly associated with musculoskeletal symptoms in various body regions in Iranian petrochemical workers.[12]

The highest frequency of chronic pain was found among the middle-age group. Consistently, some previous studies have observed a higher prevalence of chronic pain in the middle age than in older ages. For example, a large survey of chronic pain in the US shows that the prevalence of pain increases from younger to middle age and then decreases with increasing age.[33] Some researchers have suggested that older people have a higher pain threshold than young people.[34].

Our study found no significant sex difference in the prevalence of chronic pain among workers. Sex difference in pain perception is controversial. While some studies have found a higher prevalence of chronic pain amongst women,[1,3] most studies have found no sex differences.[25,33] Defrin, et al, have discussed that the difference in response to pain is complex and may be affected by culture.[35]

Similar to other published studies,[1,36] the most frequent marital status in workers with chronic pain was divorced/widowed. Mehnert, et al, in a study on patients with prostate cancer have shown that married patients have significantly higher levels of perceived positive support than single, divorced or widowed patients.[37] Positive support has widely been demonstrated to promote mental as well as physical health.[37,38]

We found that chronic pain affected

TAKE-HOME MESSAGE

- One of the most important health problems of workers is chronic pain.

- We found that a considerable proportion of workers of a petrochemical and petroleum refinery industries suffered from various types of chronic pain.

- Chronic pain is more frequent in middle-aged and divorced or widowed workers.

- Workers who experience higher levels of depression, work-family conflict and job stress are more prone to chronic pain.

more frequently workers with more work experience. Although our finding of a higher frequency of chronic pain among middle-age than young workers confirmed a positive association between work experience and pain, the observed lower frequency of chronic pain among old workers contradicted this association. The low percentage of old workers (10%) could probably not affect the association of work experience and pain enough. Although the association of work experience and pain is supported by another study,[27] studies with larger number of workers in different age groups are required to confirm or refute this association.

We found no significant difference between participants with and without chronic pain in terms of educational level, daily work hours, type of industry, and type of job. Johannes, *et al*, did also not observe a consistent correlation between chronic pain and level of education.[1] Choobineh, *et al*, report that the prevalence of musculoskeletal symptoms in office workers does not significantly different from that in operation workers of a petrochemical industry.[13] A recent study shows no significant difference in prevalence of pain symptoms between white-collar and blue-collar workers.[39] The current results indicated that factors other than demographic and occupational factors might be important in developing or maintaining chronic pain. Kim, *et al*, in their recent review have shown that most of the risk factors found for neck pain are related to psychosocial characteristics, rather than physical characteristics.[11] Consistently, our results showed that participants with chronic pain reported significantly higher levels of depression, work-family conflict, and job stress.

Depression and work-family conflict were found to be significantly associated with chronic pain even after we adjusted the model for demographic and occupa-

tional confounders. This finding was consistent with results of various studies.[6,11] The association between depression and chronic pain might be explained in different ways. For example, according to Beck's cognitive theory,[40] some individuals are vulnerable to depression because they have negative attitudes toward their own self, the world, and the future (Beck's cognitive triad). When such individuals are faced with stressors (*eg*, persistent pain), the cognitive triad is activated. Since the cognitive triad accounts for almost all symptoms of depression, it increases the individual's risk for depression. Therefore, the vulnerable individuals may develop depression after developing their pain. Some studies indicate that chronic pain may develop depression through disabling patient for doing personal and social activities.[41] Maladaptive coping strategies, catastrophizing, low spiritual well-being and low self-efficacy may also play mediating roles.[19,42] On the other hand, depressed mood may result in heightened attention toward painful stimuli and thereby predisposing individuals to the development of chronic pain.[42] Although our correlational findings did not shed light on causal relationships, the current results added some evidence to support the association between depression and chronic pain in workers.

Consistent with past research studies, our findings suggested that there was a significant association between work-family conflict and chronic pain.[9,43] As it has already pointed out, prolonged absence from home could cause stress in both worker and family. When workers experience work-family conflict, they may be preoccupied with these conflicts. It might induce stress responses that, in turn, increase physiological stress reactions such as increased muscle tension, which may lead to musculoskeletal pain and tension headache.[44]

In line with other studies,[7,8] we found

that job stress was associated with chronic pain in workers. In industrial settings, stress can be produced by an array of physical stressors such as repetitive work position or movements, as well as psychological stressors, *eg*, low levels of support from coworkers and supervisors, low job control and low decision authority—both categories are associated with subjective well-being in workers.[7,45] When we adjusted for demographic and occupational confounders, this association became non-significant. This finding clearly showed that this association could be wholly explained by demographic and occupational factors.[45] For instance, according to previous studies, female, single and young workers are more likely to have job stress.[46] Screening and appropriate education to workers may reduce the risk of chronic pain among them.

Our study had some limitations. Assessing chronic pain solely based on a self-report questionnaire and not on clinical examination might endanger our findings. However, because pain is a subjective experience, assessments of pain intensity and frequency by self-report are considered acceptable. Furthermore, given the cross-sectional nature of our study, our findings cannot provide causal relationships. Prospective studies with larger samples assessing a wider array of occupational factors are thus needed.

In summary, the present study showed a high prevalence of chronic pain among workers of the petrochemical and petroleum refinery industries. The results suggested that workers who experience higher levels of depression, work-family conflict and job stress might be more prone to chronic pain. Since the majority of these factors are considered modifiable, it is important to optimize screening programs, availability of services, and proper education. Considering the burden of chronic pain, the results have the potential to make a significant impact on health outcomes of industrial workers.

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