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All Fatigue is *not* Created Equal: The Association of Fatigue and its Subtypes on Pain Interference in Orofacial Pain

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Abstract

Objectives—Fatigue is known to be a pathway through which depression, psychological distress, pain intensity, and sleep disturbance influence pain interference, but the independent effects of fatigue on pain interference after controlling for these variables remains unknown. Additionally, no study to date has tested whether fatigue subtypes of general fatigue, mental fatigue, emotional fatigue, physical fatigue, or vigor differentially predict pain interference.

Methods—The current study tested these associations using archival medical data of 2,133 chronic orofacial pain patients who complete a battery of psychological questionnaires at the time of their first appointment at an orofacial pain clinic.

Results—Hierarchical linear regression analysis revealed that after controlling for depression, psychological distress, sleep disturbance, pain intensity, and demographic variables, fatigue predicted higher pain interference (B = 0.70, SE = 0.17, p<001, η^2 = .01). Physical fatigue (B = 1.70, SE = 0.48, p<001, η^2 = .01) and vigor (B = −3.24, SE = 0.47, p<001, η^2 = .03) were independently associated with pain interference after controlling for the aforementioned variables.

Discussion—The findings suggest that fatigue is an important independent predictor of pain interference and not merely a mediator. These findings also suggest that not all fatigue is created equal. Interventions aimed at reducing pain interference should target specific fatigue symptoms of physical fatigue and vigor. Future research investigating the independent associations of fatigue subtypes on pain outcomes may help clarify the nature of the interrelationships between pain and fatigue.

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Conflicts of Interest
The authors report no conflict of interests.

Keywords

depression; fatigue; orofacial pain; vigor; WHYMPI

Introduction

Fatigue is a common symptom in chronic pain disorders, and there is high comorbidity between chronic pain disorders and chronic fatigue syndrome [1-3]. There are strong positive correlations between fatigue levels and pain intensity [4-5]. Not only is fatigue associated with the experience of pain, but it may also predict how well people maintain activity in the face of pain. Few studies, however, have investigated the role of fatigue in predicting how disruptive pain is, and those that have done so primarily examined the associations between fatigue and physical functioning [6-11]. Yet, pain disrupts more than just physical functioning [12]. One broad indicator of the disruptiveness of pain is pain interference, defined as the degree to which pain interferes with social, recreational, and work-related activities [13]. Little is known about the associations of fatigue with pain interference. An exploration of the relationship between fatigue and pain interference is important, as it may highlight how fatigue influences- and possibly disrupts- the daily lives of chronic pain patients.

One previous study found that women with high pain interference reported more fatigue than women with low pain interference [14]. In orofacial pain patients, fatigue partially mediated the relationship of psychological distress on pain interference [5]. Similarly, in non-cancer chronic pain, fatigue partially mediated the associations of pain intensity, sleep disturbance, and depression on pain interference [6]. Additionally, strong positive correlations have been found between pain interference and fatigue ($r = .48$) [15]. These studies cumulatively suggest that fatigue may be an important mediator through which psychosocial variables influence pain interference, and that fatigue may be an interventional target for helping chronic pain patients reduce pain interference in daily life.

The literature on the relationship between fatigue and pain interference has two major weaknesses. First, although fatigue has been tested as a mediator, it is unknown if it predicts pain interference after removing the effects of pain intensity, sleep disturbance, depression, and psychological distress. Second, there are at least five different types of fatigue, including general fatigue (general feelings of feeling worn-down or sluggish), mental fatigue (feeling mentally tired, confused, and unable to concentrate), emotional fatigue (feeling sad, depressed, or upset), physical fatigue (feeling physically tired, weak, or heavy), and vigor (feeling lively, energetic, or cheerful) [16]. Only one study has investigated the associations of fatigue subtypes on pain interference [5]; as such, little is known about which types of fatigue are most strongly associated with pain interference.

What are the direct effects of fatigue on pain interference, and is all fatigue created equal or are some subtypes more predictive of pain interference than others? The current study tested these questions in a large sample of chronic orofacial pain patients. An orofacial pain sample was used because (1) orofacial pain symptoms arise from diverse structures, including muscles, joints, and nerves [17], (2) extant research has tested the relationship between fatigue and pain interference in orofacial pain samples, providing theoretical scaffolding for the current study [4-6], and (3) chronic orofacial pains are prevalent, expensive to treat, and understudied relative to other chronic pain disorders [17-18]. Based on the literature, it was hypothesized that fatigue would significantly predict pain interference even after controlling for pain intensity, sleep disturbance, depression, and psychological distress. It was further hypothesizes that general fatigue, mental fatigue, emotional fatigue, physical fatigue, and vigor would each predict unique variance in pain interference.

Methods

Patient Selection

The study presents archival medical data from 2,133 patients who came in to an initial consultation at a university-affiliated orofacial pain clinic between the years of 1997 and 2013. To be included in the study, patients had to: (1) report pain duration of at least three months, (2) receive an orofacial pain diagnosis, (3) complete the questionnaires of interest, and (4) consent to their data being used for research. Data from all eligible patients were extracted. The study was approved by the Institutional Review Board of the Office of Research Integrity.

Procedures

Patients came for an initial consultation at the orofacial pain clinic where the study was conducted. During that consultation, they completed a battery of questionnaires assessing pain symptoms and psychological functioning (described below). They also underwent a thorough clinical evaluation by a licensed dentist doing a residency in orofacial pain. Following this evaluation, the dental resident conferred with an experienced dentist to determine diagnoses. Diagnoses were based on the criteria described in the Guidelines for the Assessment, Management, and Treatment of Orofacial Pain, 4th Edition [17]. Psychological data were scored by psychology residents working at the pain clinic and results were incorporated into the patient's medical files. Deidentified psychological and pain data of patients who met inclusion criteria and provided consent were extracted from their medical records. Only the questionnaires described below were examined for the current study.

Materials

Demographics and Pain Duration—Patients self-reported their age, sex, employment status, marital status, and pain duration.

Fatigue—The Multidimensional Fatigue Symptom Inventory-Short Form (MFSI-SF) assessed general, mental, emotional, and physical fatigue as well as vigor [16]. Patients rated the degree to which they experienced 30 different symptoms over the past week using a scale from 0 "Not at all" to 4 "Extremely." The five subscale scores were computed by averaging all items of that scale, producing subscale scores ranging from 0 to 4. Scores on items were averaged instead of summed so that missing data would not bias the range of possible scores. A total fatigue score where vigor was subtracted from the sum of general, mental, emotional, and physical fatigue was also computed. Higher scores indicated higher levels of the measured construct. The MFSI-SF has been validated in patients with chronic illnesses generally and orofacial pain specifically [4-5, 19-20]. Reliability was adequate for the total score (α = .91) and for all subscales, ranging from α = .88 for physical fatigue to α = .95 for general fatigue.

Pain Interference—The pain interference subscale of the West-Haven Yale Multidimensional Pain Inventory (WHYMPI) was used to assess the degree to which pain disrupted social, recreational, and work-related activities [13]. It consisted of nine items which patients responded to using a scale from 0 to 6. The responses to the nine items were entered into a computer-based scoring system provided by the test developers which used Rasch-based algorithms to produce a scaled score ranging from 0 to 100. Higher scores represented higher pain interference. The WHYMPI pain interference scale has been well-validated in chronic pain samples [5, 12, 13, 19, 21]. The dataset used for the current study contained only scale scores and not individual items; as such, Cronbach's alpha could not be computed. However, previous research has found that the pain interference subscale has good reliability (α = .90) [13].

Pain Intensity—Pain intensity was measured using a visual analog scale. Patients rated their average level of pain over the past month by placing a mark on a 100 mm line with anchors of "No pain at all" and "The most intense pain that you can imagine." The location of the mark was quantified using a 100 mm ruler by a psychology resident working at the pain clinic. Higher scores indicated greater pain intensity.

Sleep Disturbance—Sleep disturbance was assessed by a single-item question from the Pittsburg Sleep Quality Inventory (PSQI) [22]. The item asked patients to report "During the past month, how would you rate your sleep quality overall" using response options ranging from 0 "Very good" to 3 "Very bad." This subjective, single-item measure was chosen over the full PSQI score because previous research suggests that sleep quality is a better predictor of health outcomes and is only moderately related to sleep quantity [23]; this may especially be the case with chronic pain patients who often report irregular sleep schedules [24-25].

Depression and Psychological Distress—Depression and psychological distress were measured using the Depression subscale and the Global Severity Index (GSI) composite scale of the Symptom Check List – 90 – Revised (SCL-90-R) [26]. The SCL-90-R had patients report the frequency of 90 different somatic and psychological symptoms over the course of the past seven days. Patients responded to each item using a scale ranging from 0 "Not at all" to 4 "Extremely." Responses were inputted into a computer-based scoring program provided by the test developers which gave a t-score for each of nine scales ranging from 0 to 81. Higher scores represented worse psychological functioning. The depression subscale consisted of 13 items and the GSI consisted of all 90 items. Previous research has validated these scales for use in chronic orofacial pain populations and have found them to have good reliability [5, 26].

Data Analysis Plan

Prior to data analyses, all variables were checked for outliers using a criteria of +/− 4 standard deviations. Missing data was treated using listwise deletion. Means, standard deviations, and ranges were computed for all study variables. For these descriptive analyses, patients were categorized into one of the following six groups based on primary diagnosis: muscle pain (myofascial pain, local and centrally mediated myalgia, and dystonia); temporomandibular joint-associate pain (osteoarthritis, capsulitis/synovitis, tendonitis, subluxation, disc adhesions, and disc displacements); neuropathic pain (episodic and continuous neuropathic pain); headache pain (tension-type headache, migraine, and other headaches), dento-alveolar pain (pulpitis/periodontitis), and other (orthopedic instability, otologic disorder, etc.).

The primary aim of the study was to test if fatigue predicted pain interference after controlling for pain intensity, sleep disturbance, depression, and psychological distress. To do so, five models in hierarchical linear regression were conducted. In Model 1, total fatigue was entered as a unitary predictor of pain interference. In Model 2, pain intensity was added. In Model 3, sleep disturbance was added. In Model 4, depression and psychological distress were added. Finally, in Model 5, demographic characteristics of age, sex, and pain duration were added. The unstandardized beta estimates of the fatigue predictor in Model 5 was the primary outcome of interest as it represented the estimated unit change in pain interference for each unit change in fatigue after controlling for pain intensity, sleep disturbance, depression, psychological distress, and demographic factors.

The second aim of the study was to test whether the five fatigue subtypes differentially predicted pain interference. To do this, three hierarchical linear regression models were computed. In Model 1, pain interference was predicted from each of the five fatigue subtypes simultaneously. Model 2 tested if adding depression, psychological distress, pain intensity, and sleep disturbance changed the findings of Model 1. Model 3 added demographic variables of age, sex, and pain duration to Model 2 to examine if the fatigue subtypes predicted interference above and beyond clinical and demographic variables.

Because of the large sample size, *p*-values were not useful in determining significance, as even very small differences were statistically significant. Thus, adjusted *R*-squared values were computed for each model to represent the total amount of variance in pain interference explained by all predictors in the model. Additionally, partial eta squared (η^2) was computed as a measure of effect size for all predictors. Partial eta square measured the unique variance in the outcome (i.e., pain interference) that was accounted for by a predictor after the effects of all other predictors were partialled out. Further, 95% confidence intervals were computed for all effects. Analyses were conducted using SPSS version 22 software.

Results

Missing Data

Data from 2,133 eligible patients were extracted for the study. After removing outliers and implausible values due to data entry errors (for example, a score of greater than 10 on a 1-10 scale), there were a total of 2,133 people with valid fatigue data (no missing data), 2,091 people with valid pain intensity data (n = 42 missing), 2,112 with valid depression and psychological distress data (n = 21 missing), and 2,104 with valid sleep disturbance data (n =29 missing).

Descriptive Statistics and Bivariate Correlations among Study Variables

Table 1 reveals that the most common diagnoses were muscle-related, followed by joint and nerve-related pain. As a whole, the sample was largely female (85.9%), married (61.2%), and employed (58.5%). Average age of the sample was 41.06 years (SD = 14.24). Average pain duration at the time of the initial consultation was 67.35 months (SD = 89.97). The sample reported mild to moderate levels of fatigue and sleep disturbances and moderate levels of pain intensity, depression, and psychological distress. Table 2 reveals that fatigue, pain intensity, and measures of psychological illbeing were moderately to strongly positively correlated with each other.

Associations among Fatigue and Pain Interference

Fatigue has been independently shown to mediate the relationships between pain intensity, sleep disturbance, depression, and psychological distress on pain interference, but it is unknown if fatigue predicts pain interference above and beyond these relationships. Table 3 reveals that as a unitary predictor, fatigue accounted for 22% of variance in pain interference (Model 1). After accounting for pain intensity, fatigue still accounted for 12% of variance in pain interference (Model 2). After additionally accounting for sleep disturbance, fatigue accounted for 9% of variance in pain interference (Model 3). Finally, after accounting for the aforementioned variables as well as depression, psychological distress, and demographic variables, fatigue accounted for a small but significant 1% of unique variance in pain interference (Models 4 and 5). Betas (B) indicate the unadjusted amount of change in pain interference for each unit change in the predictor. In Model 5, a one unit increase in total fatigue was associated with a .70 unit increase in pain interference.

Associations of Fatigue Subtypes on Pain Interference

A secondary aim of the project was to test whether fatigue subtypes were differentially associated with pain interference. Table 4 reveals that emotional fatigue, physical fatigue, and vigor each explained unique variance in pain interference (Model 1). For example, each unit increase in vigor was associated with a 5.05 point decrease in pain interference. After controlling for depression, psychological distress, sleep disturbance, and pain intensity, only physical fatigue and vigor remained significant predictors of pain interference (Model 2). After additionally controlling for demographic factors, physical fatigue was significantly associated with higher pain interference and vigor with lower pain interference (Model 3).

Discussion

The current study found that fatigue significantly predicted variance in pain interference that was not accounted for by pain intensity, sleep disturbance, depression, psychological distress, age, sex, or pain duration. Similarly, the fatigue subtypes of vigor and physical fatigue significantly predicted variance in pain interference after controlling for the aforementioned psychological and demographic variables.

These findings replicate and extend those in the literature. Fatigue positively correlated with pain intensity in the current study (*r* =.38), replicating previously reported correlations between fatigue and pain intensity in orofacial pain samples(*r*'s = .23-.42) [4-5]. These correlations suggest that dealing with chronic pain requires energy. Routine daily activities like getting out of bed, cleaning the house, or scheduling social activities may feel burdensome when one is in pain [27-28], and these tasks may become more fatiguing as pain becomes more intense [21]. Despite the interrelationships between fatigue and pain intensity, this study adds to the literature by showing that they each uniquely predict pain interference. In the current study, pain intensity explained 20% of variance in pain interference that was not accounted for by fatigue, and fatigue explained 12% of variance in pain interference that was not accounted for by pain intensity. Together, they explained 38% of variance in pain interference. Adding other psychological and demographic variables did little in explaining pain interference, as evidenced by the fact that Model 5 (with all psychological and demographic variables) explained 40% of the variance in pain interference - only 2% more than fatigue and pain intensity alone.

Chronic pain disorders are often comorbid with sleep disorders [29-30]. In fact, poor sleep is one of the most common symptoms reported by chronic pain patients [31-33]. The current study found that poor self-reported sleep had a moderate positive correlation with fatigue (r=.47). However, fatigue predicted pain interference above and beyond self-reported sleep quality. The extent to which sleep contributes to feelings of fatigue remains an open question, and one that should be explored in future research. In some conditions like chronic fatigue syndrome, sleep has little effect on feelings of fatigue [34]. Other studies have found that sleep improvements improve pain outcomes in chronic pain populations [35], but it may be that such interventions would have a stronger effect if they not only improved sleep, but also if they reduced fatigue or increased vigor.

The associations between depression and chronic pain are well-established [36]. Fatigue can be one of the clinical symptoms of depression, and serves as a mediator through which depression and psychological distress influence pain interference [5-6]. The fact that fatigue remained a significant predictor of pain interference after controlling for physiological (pain intensity), biological (sleep), and psychological (depression, psychological distress) variables highlights the multidimensional nature of fatigue. Earlier beliefs that humans are akin to batteries which become depleted with use and recharged with rest are giving way to a more nuanced understanding of what fatigue is and how it functions [37]. Fatigue is not entirely a biological phenomenon that occurs when a particular biological substrate is depleted, nor is it entirely a psychological effect of reduced motivation. Instead, fatigue may be a biopsychosocial phenomenon similar to an emotion that is influenced by a multitude of biological and psychological substrates [38].

An exploration of the nuanced, multidimensional understanding of fatigue was the second aim of the study. General, emotional, physical, and mental fatigue, as well as vigor predicted pain interference to different degrees, suggesting that not all fatigue is created equal. Only physical fatigue and vigor remained significant after controlling for all other variables in the model. The fact that physical fatigue remained a potent predictor of pain interference suggests that people who endorsed feeling “weak” or “heavy” were less likely to report partaking in social, recreational, or occupational activities in the face of pain. In contrast, vigor- or feeling lively and full of energy- was associated with less pain interference. Vigor is not mutually exclusive with fatigue. A runner at the home stretch of a marathon may simultaneously feel fatigue and vigor, for example. Future work should expand on the theoretical distinctions between physical fatigue and vigor. Multi-faceted interventions that not only reduce physical fatigue but also increase vigor may prove to be most effective for managing pain interference.

Other types of fatigue aside from those examined in the current study have also been posited. In psychology, much attention is paid to self-regulatory fatigue, defined as fatigue in the ability to override dominant responses [39]. Self-regulatory fatigue explains why dieters give in to eating unhealthy foods, or why recovering drug addicts sometimes relapse in the presence of an addictive substance, along with a multitude of other behaviors [40]. In the context of pain, the dominant response is to try and make the pain go away, be it by resting in a dark room, canceling social appointments, or calling in sick from work. Adaptively maintaining functioning in the face of pain draws on self-regulatory ability, and over time, results in self-regulatory fatigue [41]. Compelling research shows that chronic pain patients are in a state of constant self-regulatory fatigue [42]. How self-regulatory fatigue interacts with the other subtypes of fatigue represents an important area of future research, and one that remains critically understudied.

The findings from the current study have important clinical implications. For one, they highlight the value of assessing for fatigue in chronic orofacial pain populations. If a patient states that they constantly feel tired, it may be important to distinguish physical fatigue from emotional or other types of fatigue. This can be accomplished by asking the patient to complete the MFSI-SF or other fatigue inventories that assess specific fatigue subtypes. If a patient reports mental fatigue, positive activities that increase feelings of mental rejuvenation like reading a book or watching a movie may be merited; on the contrary, if a patient reports physical fatigue, other interventions might be more applicable. For instance, there are good psychological interventions that have empirical support for improving physical fatigue symptoms [43]. If fatigue presents as a significant problem, patients can be referred to a psychologist specializing in these interventions, or to a physical therapist with expertise in establishing exercise regiments for chronic pain patients [44].

The current study is not without limitations. The major limitation of the study is that data were cross-sectional. As such, causal claims cannot be made. Alternate theoretical models from the ones postulated are possible. For example, pain interference may be the cause instead of the consequence of fatigue. Longitudinal data are needed to clarify the temporal and causal associations among variables. Another limitation is that data were collected during the first appointment at a pain clinic, and patients may have over-reported symptoms to ensure that the dentists adequately appreciated their distress. Third is that the data were all from self-report measures. However, pain and fatigue are inherently subjective; they are real only to the extent that patients perceive them to be real. Finally, the study is limited by the fact that the sample was largely female and may not generalize to males; it may also not generalize to pain conditions aside from chronic orofacial pain.

Despite these weaknesses, the current study has several strengths. It is the largest study to date to examine the associations between fatigue, pain intensity, and pain interference in chronic orofacial pain patients. It is also one of the few studies to examine fatigue subtypes as they pertain to pain interference. The sample contained a wide array of disorders, including muscle, joint, neuropathic, and neurovascular conditions, allowing results to generalize to multiple orofacial pain conditions. The strength of the study is also in that it highlights avenues for future research in fatigue and chronic orofacial pain. Specifically, future research should examine whether fatigue subtypes can be used clinically to personalize treatment. Future research should also examine if the associations of fatigue and pain interference remain consistent over time and throughout the course of the pain disorder. Finally, the findings from the current study underscore that different types of fatigue have different associations with pain interference; that is, not all fatigue is created equal.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Clauw DJ, Chrousos GP. Chronic pain and fatigue syndromes: overlapping clinical and neuroendocrine features and potential pathogenic mechanisms. Neuroimmunomodulat. 1997; 1997:134–153. doi: 10.1159/000097332.
2. Aaron LA, Burke MM, Buchwald D. Overlapping conditions among patients with chronic fatigue syndrome, fibromyalgia, and temporomandibular disorder. Arch Intern Med. 2000; 2000:221–227. doi: 10.1001/archinte.160.2.221.
3. White K, Speechley M, Harth M, Òstbye T. Co-existence of chronic fatigue syndrome with fibromyalgia syndrome in the general population: a controlled study. Scand J Rheumatol. 2000; 29:44–51. doi: 10.1080/030097400750001798. [PubMed: 10722257]
4. de Leeuw R, Studts JL, Carlson CR. Fatigue and fatigue-related symptoms in an orofacial pain population. Oral Surg Oral Med O. 2005; 99:168–174. doi: 10.1016/j.tripleo.2004.03.001.
5. Boggero IA, Kniffin TC, de Leeuw R, Carlson CR. Fatigue mediates the relationship between pain interference and distress in patients with persistent orofacial pain. J Oral Facial Pain Headache. 2014; 28:38–45. doi: 10.11607/jop.1204. [PubMed: 24482786]
6. Sturgeon JA, Darnall BD, Kao MCJ, Mackey SC. Physical and psychological correlates of fatigue and physical function: a collaborative health outcomes information registry (CHOIR) study. J Pain. 2015; 16:291–298. doi: 10.1016/j.jpain.2014.12.004. [PubMed: 25536536]
7. Bombardier CH, Buchwald D. Chronic fatigue, chronic fatigue syndrome, and fibromyalgia: disability and healthcare use. Med Care. 1996; 34:924–930. [PubMed: 8792781]
8. Pollard L, Choy E, Gonzalez J, Khoshaba B, Scott D. Fatigue in rheumatoid arthritis reflects pain, not disease activity. Rheumatol. 2006; 45:885–889. doi: 10.1093/rheumatology/kel021.
9. Feuerstein M, Carter RL, Papciak AS. A prospective analysis of stress and fatigue in recurrent low back pain. Pain. 1987; 3:333–344. doi: 10.1016/0304-3959(87)90162-X.
10. Kop WJ, Lyden A, Berlin AA, Ambrose K, Olsen C, Gracely RH, Williams DA, Clauw DJ. Ambulatory monitoring of physical activity and symptoms in fibromyalgia and chronic fatigue syndrome. Arthritis Rheum. 2005; 52:296–303. doi: 10.1002/art.20779. [PubMed: 15641057]

11. Murphy SL, Smith DM, Clauw DJ, Alexander NB. The impact of momentary pain and fatigue on physical activity in women with osteoarthritis. Arthritis Care Res. 2008; 59:849–856. doi: 10.1002/art.23710.

12. Boggero IA, Carlson CR. Somatosensory and affective contributions to emotional, social, and daily functioning in chronic pain patients. Pain Med. 2015; 16:341–347. doi:10.1111/pme.12598. [PubMed: 25351790]

13. Kerns RD, Turk DC, Rudy TE. The west haven-yale multidimensional pain inventory (WHYMPI). Pain. 1985; 23:345–356. doi: 10.1016/0304-3959(85)90004-1. [PubMed: 4088697]

14. Kushang VP, Cochrane BB, Turk DC, Bastian LA, Haskell SG, Woods NF, Zaslavsky O, Wallace RB, Kerns RD. Association of pain with physical function, depressive symptoms, fatigue, and sleep quality among veteran and non-veteran postmenopausal women. The Gerontologist. 2016; 56:S91–S101. doi: 10.1093/geront/gnv670. [PubMed: 26768395]

15. Amtmann D, Cook KF, Jensen MP, Chen WH, Choi S, Revicki D, Lai JS. Development of a PROMIS item bank to measure pain interference. Pain. 2010; 150:173–182. doi: 10.1016/j.pain.2010.04.025. [PubMed: 20554116]

16. Stein KD, Jacobsen PB, Blanchard CM, Thors C. Further validation of the multidimensional fatigue symptom inventory-short form. J Pain Symptom Manag. 2004; 27:14–23. doi: 10.1016/j.jpainsymman.2003.06.003.

17. de Leeuw, R. Orofacial pain: guidelines for assessment, diagnosis, and management. 4th. Quintessence; Chicago: 2008.

18. Sessle, BJ., Dostrovsky, JO. Encyclopedia of pain. Springer; Berlin: 2013. Orofacial pain.

19. Boggero IA, Rojas-Ramirez MV, de Leeuw R, Carlson CR. Satisfaction with life in orofacial pain disorders: associations and theoretical implications. J Oral Facial Pain Headache. 2016:30. doi: 10.11607/ofph.1526.

20. Donovan KA, Stein KD, Lee M, Leach CR, Ilozumba O, Jacobsen PB. Systematic review of the multidimensional fatigue symptom inventory-short form. Support Care Cancer. 2015; 23(1):191–212. doi: 10.1007/s00520-014-2389-7. [PubMed: 25142703]

21. Boggero IA, Geiger PJ, Segerstrom SC, Carlson CR. Pain intensity moderates the relationship between age and pain interference in chronic orofacial pain patients. Exp Aging Res. 2015; 41:463–474. doi: 10.1080/0361073X.2015.1053770. [PubMed: 26214102]

22. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiat Res. 1989; 28:193–213. doi: 10.1016/0165-1781(89)90047-4.

23. Pilcher JJ, Ginter DR, Sadowsky B. Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. J Psychosom Res. 1997; 42:583–596. doi:10.1016/S0022-3999(97)00004-4. [PubMed: 9226606]

24. Riley JL, Benson MB, Gremillion HA, Myers CD, Robinson ME, Smith CL Jr, Waxenberg LB. Sleep disturbance in orofacial pain patients: pain-related or emotional distress? Cranio. 2001; 19:106–113. [PubMed: 11842861]

25. Osorio CD, Gallinaro AL, Lorenzi-Filho G, Lage LV. Sleep quality in patients with fibromyalgia using the Pittsburgh Sleep Quality Index. J Rheumatol. 2006; 33:1863–1865. [PubMed: 16924687]

26. Derogatis, LR. SCL-90-R. Clinical Psychometric Research Incorporated; Washington DC: 1992.

27. Breivik H, Collett B, Ventafridda V, Cohen R, Gallacher D. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. Eur J Pain. 2006; 10:287–287. doi: 10.1016/j.ejpain.2005.06.009. [PubMed: 16095934]

28. Bush FM, Harkins SW. Pain-related limitation in activities of daily living in patients with chronic orofacial pain: psychometric properties of a disability index. J Orofac Pain. 1994; 9:57–63.

29. Koffel E, Kroenke K, Bair MJ, Leverty D, Polusny MA, Krebs EE. The bidirectional relationship between sleep complaints and pain: analysis of data from a randomized trial. Health Psychol. 2015 doi: 10.1037/hea0000245.

30. Sivertsen B, Lallukka T, Petrie KJ, Steingrímsdóttir ÓA, Stubhaug A, Nielsen CS. Sleep and pain sensitivity in adults. Pain. 2015; 156:1433–1439. doi: 10.1097/j.pain.0000000000000131. [PubMed: 25915149]

31. Kelly GA, Blake C, Power CK, O'Keeffe D, Fullen BM. The association between chronic low back pain and sleep: a systematic review. Clin J Pain. 2011; 27:169–181. doi: 10.1097/AJP.0b013e3181f3bdd5. [PubMed: 20842008]
32. Siu YF, Chan S, Wong KM, Wong WS. The comorbidity of chronic pain and sleep disturbances in a community adolescent sample: prevalence and association with sociodemographic and psychosocial factors. Pain Med. 2012; 13:1292–1303. doi: 10.1111/j.1526-4637.2012.01473.x. [PubMed: 22925527]
33. Finan PH, Smith MT. The comorbidity of insomnia, chronic pain, and depression: dopamine as a putative mechanism. Sleep Med Rev. 2013; 17:173–183. doi:10.1016/j.smrv.2012.03.003. [PubMed: 22748562]
34. Afari N, Buchwald D. Chronic fatigue syndrome: a review. Am J Psychiat. 2004; 160:221–236. doi: 10.1176/appi.ajp.160.2.221.
35. Vitiello MV, McCurry SM, Shortreed SM, Baker LD, Rybarczyk BD, Keefe FJ, Von Korff M. Short-term improvement in insomnia symptoms predicts long-term improvements in sleep, pain, and fatigue in older adults with comorbid osteoarthritis and insomnia. Pain. 2014; 155:1547–1554. doi:10.1016/j.pain.2014.04.032. [PubMed: 24793909]
36. Kroenke K, Wu J, Bair MJ, Krebs EE, Damush TM, Tu W. Reciprocal relationship between pain and depression: a 12-month longitudinal analysis in primary care. J Pain. 2011; 12:964–973. doi: 10.1016/j.jpain.2011.03.003. [PubMed: 21680251]
37. Ackerman, PL. Cognitive fatigue: multidisciplinary perspectives on current research and future applications. APA; Washington DC: 2011. doi: 10.1037/12343-000
38. Evans DR, Boggero IA, Segerstrom SC. The nature of self-regulatory fatigue and “ego depletion” lessons from physical fatigue. Pers Soc Psychol. 2015 doi: 10.1177/1088868315597841.
39. Muraven M, Baumeister RF. Self-regulation and depletion of limited resources: does self-control resemble a muscle. Psychol Bull. 2000; 126:247–259. doi: 10.1037/0033-2909.126.2.247. [PubMed: 10748642]
40. de Ridder DT, Lensvelt-Mulders G, Finkenauer C, Stok FM, Baumeister RF. Taking stock of self-control: a meta-analysis of how trait self-control relates to a wide range of behaviors. Pers Soc Psychol Rev. 2012; 16:76–99. doi: 10.1177/1088868311418749. [PubMed: 21878607]
41. Solberg-Nes L, Roach AR, Segerstrom SC. Executive functions, self-regulation, and chronic pain: a review. Ann Behav Med. 2009; 37:173–183. doi: 10.1007/s12160-009-9096-5. [PubMed: 19357933]
42. Solberg-Nes L, Carlson CR, Crofford LJ, De Leeuw R, Segerstrom SC. Self-regulatory deficits in fibromyalgia and temporomandibular disorder. Pain. 2010; 151:37–44. doi:10.1016/j.pain.2010.05.009. [PubMed: 20561749]
43. Malouff JM, Thorsteinsson EB, Rooke SE, Bhullar N, Schutte NS. Efficacy of cognitive behavioral therapy for chronic fatigue syndrome: a meta-analysis. Clin Psych Rev. 2008; 28:736–745. doi: 10.1016/j.cpr.2007.10.004.
44. Dimeo FC, Thomas F, Raabe-Menssen C, Pröpper F, Mathias M. Effect of aerobic exercise and relaxation training on fatigue and physical performance of cancer patients after surgery. A randomised controlled trial. Support Care Cancer. 2004; 12:774–779. doi: 10.1007/s00520-004-0676-4. [PubMed: 15338385]

Table 1

Primary Diagnoses and Descriptive Statistics of the Sample.

	Total Sample	Muscle Pain	TMJ Pain	Neuropathic Pain	Headache Pain	Dento-Al. Pain	Other Pain
	Mean *(SD)*	**Mean *(SD)***	**Mean *(SD)***	**Mean *(SD)***	**Mean *(SD)***	**Mean *(SD)***	**Mean *(SD)***
n	2,133	1,072	743	119	66	24	109
% Female	85.9%	87.6%	86.7%	74.8%	84.8%	87.5%	76.1%
% Employed	58.5%	57.7%	64.7%	36.4%	59.4%	54.5%	49.5%
% Married	61.2%	62.9%	61.0%	68.6%	65.6%	52.2%	70.5%
Age	41.06 (14.24)	41.23 (13.61)	38.98 (14.99)	49.99 (13.10)	38.09 (11.23)	43.63 (11.09)	44.96 (13.91)
Pain Duration (months)	67.35 (89.97)	72.43 (91.64)	60.27 (85.46)	54.50 (72.10)	94.87 (105.25)	59.39 (102.28)	69.59 (105.29)
Pain Intensity	51.12 (25.14)	53.31 (23.16)	45.90 (24.35)	61.21 (25.19)	58.92 (21.73)	54.08 (21.68)	48.93 (25.38)
Sleep Disturbance	1.56 (0.88)	1.66 (0.88)	1.42 (0.85)	1.61 (0.93)	1.82 (0.86)	1.38 (0.92)	1.49 (0.81)
Depression	57.47 (11.14)	58.57 (11.05)	55.03 (10.52)	59.08 (11.63)	62.97 (9.45)	56.75 (11.45)	58.15 (13.08)
Psychological Distress	58.40 (11.29)	59.86 (11.07)	55.62 (10.72)	59.29 (11.54)	64.03 (9.44)	56.17 (13.84)	58.95 (13.26)
Pain Interference	36.98 (17.69)	38.95 (17.15)	30.87 (16.66)	45.20 (15.82)	51.02 (14.18)	37.11 (18.25)	41.52 (19.36)
Total Fatigue	3.77 (4.07)	4.43 (4.14)	2.60 (3.61)	4.04 (4.21)	5.67 (4.02)	3.68 (3.32)	3.76 (4.43)
General Fatigue	1.92 (1.21)	2.07 (1.20)	1.68 (1.17)	1.87 (1.25)	2.40 (1.08)	2.06 (1.26)	1.89 (1.22)
Mental Fatigue	1.06 (0.97)	1.17 (1.01)	0.87 (0.84)	1.12 (1.04)	1.41 (1.04)	0.95 (0.73)	1.11 (1.10)
Emotional Fatigue	1.22 (1.01)	1.35 (1.04)	0.96 (0.88)	1.33 (1.08)	1.63 (1.11)	1.29 (1.09)	1.26 (1.10)
Physical Fatigue	1.15 (0.99)	1.33 (1.03)	0.88 (0.88)	1.10 (1.01)	1.41 (0.97)	0.87 (0.96)	1.07 (0.94)
Vigor	1.58 (0.87)	1.48 (0.85)	1.79 (0.87)	1.39 (0.83)	1.18 (0.71)	1.49 (0.86)	1.57 (0.88)

Notes: TMJ = temporomandibular joint; Dento-Al. = dento-alveolar

Table 2

Bivariate Correlations among Study Variables.

	1	2	3	4	5	6	7	8	9	10	11
1. Depression	1	.91**	.38**	.30**	.79**	.64**	.63**	.77**	.56**	−.57**	.43**
2. Psychological Distress		1	.44**	.36**	.81**	.64**	.68**	.76**	.64**	−.54**	.44**
3. Sleep Disturbance			1	.36**	.47**	.44**	.32**	.36**	.38**	−.40**	.32**
4. Pain Intensity				1	.38**	.31**	.26**	.31**	.36**	−.29**	.55**
5. Total Fatigue					1	.85**	.80**	.84**	.82**	−.69**	.47**
6. General Fatigue						1	.58**	.60**	.66**	−.52**	.37**
7. Mental Fatigue							1	.65**	.60**	−.40**	.36**
8. Emotional Fatigue								1	.60**	−.53**	.39**
9. Physical Fatigue									1	−.40**	.41**
10. Vigor										1	−.40**
11. Pain Interference											1

NOTE:

** = $p < .01$

Table 3

Hierarchical Linear Regression Predicting Pain Interference from Total Fatigue.

Predictors	B	*SE*	95% C.I.	η^2	*p*	*F*	Adj. R^2
Model 1:					<.001	506.40	.22
Total Fatigue	2.01	0.09	[1.83, 2.18]	.22	<.001		
Model 2:					<.001	562.61	.38
Pain Intensity	0.32	0.01	[0.29, 0.34]	.20	<.001		
Total Fatigue	1.23	0.09	[1.12, 1.46]	.12	<.001		
Model 3:					<.001	377.88	.38
Sleep Disturbance	1.00	0.42	[0.17, 1.83]	.002	.02		
Pain Intensity	0.31	0.02	[0.28, 0.34]	.19	<.001		
Total Fatigue	1.21	0.09	[1.02, 1.39]	.09	<.001		
Model 4:					<.001	234.83	.39
Depression	0.21	0.07	[0.07, 0.35]	.01	.003		
Psychological Distress	0.03	0.07	[−0.12, 0.18]	>.001	.69		
Sleep Disturbance	0.97	0.42	[0.13, 1.80]	.002	.02		
Pain Intensity	0.31	0.02	[0.27, 0.33]	.19	<.001		
Total Fatigue	0.69	0.14	[0.41, 0.97]	.01	<.001		
Model 5:					<.001	151.56	.40
Age	0.11	0.02	[0.06, 0.15]	.01	<.001		
Gender	0.16	0.92	[−1.65, 1.96]	>.001	.87		
Pain Duration	0.00	0.00	[−0.00, 0.01]	.001	.33		
Depression	0.19	0.07	[0.05, 0.33]	.004	.01		
Psychological Distress	0.03	0.07	[−0.11, 0.18]	>.001	.66		
Sleep Disturbance	1.05	0.42	[0.23, 1.88]	.003	.01		
Pain Intensity	0.31	0.02	[0.28, 0.34]	.20	<.001		
Total Fatigue	0.70	0.14	[0.42, 0.98]	.01	<.001		

NOTES: Model 1 df = 1, 1,831; Model 2 df = 2, 1,831; Model 3 df = 3, 1,831; Model 4 df = 5, 1,831, Model 5 df = 8, 1,831

Table 4

Hierarchical Linear Regression Predicting Pain Interference from Fatigue Subtypes.

Predictors	B	*SE*	95% C.I.	η^2	*p*	*F*	Adj. R^2
Model 1:					<.001	115.22	.24
General Fatigue	0.02	0.44	[−0.84, 0.87]	>.001	.97		
Mental Fatigue	0.92	0.53	[−0.13, 1.96]	.004	.08		
Emotional Fatigue	1.58	0.53	[0.55, 2.62]	.003	.003		
Physical Fatigue	3.82	0.52	[2.80, 4.84]	.03	<.001		
Vigor	−5.05	0.51	[−6.05, −4.05]	.05	<.001		
Model 2:					<.001	137.77	.40
Depression	0.24	0.07	[0.09, 0.38]	.01	.001		
Psychological Distress	0.03	0.08	[−0.12, 0.18]	>.001	.65		
Sleep Disturbance	0.75	0.43	[−0.09, 1.59]	.001	.08		
Pain Intensity	0.30	0.02	[0.27, 0.33]	.19	<.001		
General Fatigue	−0.79	0.40	[−1.58, −0.01]	.001	.05		
Mental Fatigue	0.73	0.49	[−0.22, 1.69]	.002	.13		
Emotional Fatigue	−0.62	0.53	[−1.66, 0.43]	.001	.25		
Physical Fatigue	1.96	0.48	[1.02, 2.91]	.01	>.001		
Vigor	−3.18	0.47	[−4.12, −2.25]	.02	>.001		
Model 3:					<.001	106.30	.41
Age	0.10	0.02	[0.06, 0.14]	.01	<.001		
Gender	0.56	0.92	[−1.24, 2.37]	>.001	.54		
Pain Duration	0.00	0.00	[−0.00, 0.01]	.001	.33		
Depression	0.21	0.08	[0.06, 0.35]	.004	.01		
Psychological Distress	0.05	0.08	[−0.10, 0.20]	>.001	.50		
Sleep Disturbance	0.80	0.43	[−0.03, 1.64]	.002	.06		
Pain Intensity	0.30	0.02	[0.27, 0.33]	.19	<.001		
General Fatigue	−0.60	0.41	[−1.40, 0.20]	.001	.14		
Mental Fatigue	0.64	0.49	[−0.31, 1.60]	.001	.19		
Emotional Fatigue	−0.56	0.53	[−1.61, 0.49]	.001	.29		
Physical Fatigue	1.70	0.48	[0.75, 2.65]	.01	<.001		
Vigor	−3.24	0.47	[−4.17, −2.32]	.03	<.001		

NOTES: Model 1 df = 5, 1,831; Model 2 df = 9, 1,831; Model 3 df = 12, 1,831