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Original Reports

Subjective Sleep Quality Deteriorates Before Development of Painful Temporomandibular Disorder

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Abstract: **There is good evidence that poor sleep quality increases risk of painful temporomandibular disorder (TMD). However, little is known about the course of sleep quality in the months preceding TMD onset, and whether the relationship is mediated by heightened sensitivity to pain. The Pittsburgh Sleep Quality Index was administered at enrollment into the Orofacial Pain: Prospective Evaluation and Risk Assessment (OPPERA) prospective cohort study. Thereafter the Sleep Quality Numeric Rating Scale was administered every 3 months to 2,453 participants. Sensitivity to experimental pressure pain and pinprick pain stimuli was measured at baseline and repeated during follow-up of incident TMD cases (n = 220) and matched TMD-free controls (n = 193). Subjective sleep quality deteriorated progressively, but only in those who subsequently developed TMD. A Cox proportional hazards model showed that risk of TMD was greater among participants whose sleep quality worsened during follow-up (adjusted hazard ratio = 1.73, 95% confidence limits = 1.29, 2.32). This association was independent of baseline measures of sleep quality, psychological stress, somatic awareness, comorbid conditions, nonpain facial symptoms, and demographic characteristics. Poor baseline sleep quality was not significantly associated with baseline pain sensitivity or with subsequent change in pain sensitivity. Furthermore the relationship between sleep quality and TMD incidence was not mediated via baseline pain sensitivity or change in pain sensitivity.**

Perspective: ***Subjective sleep quality deteriorates progressively before the onset of painful TMD, but sensitivity to experimental pain does not mediate this relationship. Furthermore, the relationship is independent of potential confounders such as psychological stress, somatic awareness, comorbid conditions, nonpain facial symptoms, and various demographic factors.***

Key words: *Epidemiology, musculoskeletal pain, pain perception, psychological stress, sleep quality.*

Adults with chronic pain report a sleep debt of 42 minutes per night, exceeding the 14-minute sleep debt of adults with acute pain and the absence of sleep debt in adults with no pain.[27] In addition, only 37% of adults with chronic pain rate their sleep quality as good or very good, compared with 65% of

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adults with no pain.[27] These nationally representative findings of the 2015 Sleep in America poll add a population insight to experimental and clinical evidence that pain worsens sleep, likely via cortical arousal, which interferes with sleep onset and sleep maintenance.[6,22]

Just as pain disturbs sleep, sleep disturbance increases sensitivity to experimental pain,[10,19,26,29,38] revealing the bidirectional nature of this relationship. In fact, napping[14] or extending sleep time[33] can reverse elevated sensitivity to pain induced by sleep deprivation. Determining the predominant direction of the sleep and pain relationship was the focus of 3 comprehensive reviews. These reviews examined longitudinal studies published before 2005,[39] experimental studies published before 2007,[21] and longitudinal and experimental studies published from 2006 to 2012.[16] It is now clear from the more nuanced temporal analyses that sleep disturbances are stronger, more reliable predictors of pain development than are pain complaints predictors of sleep disturbance.[16]

An association between sleep disturbance and painful temporomandibular disorder (TMD) is well established. Sleep fragmentation, respiratory effort-related arousals,[11] insomnia,[31,40] and poor sleep quality[36] are each more common in people with TMD than in pain-free control subjects. The limitation of all but one[31] of these studies was reliance on cross-sectional data. One contribution of the Orofacial Pain: Prospective Evaluation and Risk Assessment (OPPERA) prospective cohort study was to show that baseline assessments of obstructive sleep apnea symptoms[34] and poor subjective sleep quality[35] predicted development of first-onset painful TMD among adults with no lifetime history of TMD.

Most cross-sectional analyses of variability in pain thresholds show that chronic TMD patients have lower pain thresholds than pain-free control subjects for a wide range of experimentally evoked noxious pain stimuli, in the orofacial region and also in extracranial sites.[18,23,24,40] Hence, it is reasonable to expect that individuals with poor sleep quality may have lower pain thresholds and that this effect may mediate the relationship between poor sleep quality and risk of developing TMD.

What has yet to be characterized is the longitudinal trajectory of sleep quality before development of painful TMD. It is not clear whether sleep quality is stable, fluctuating, or worsening in the months before first-onset TMD. Consequently, our study had 2 aims. First we examined the temporal dynamics of sleep quality in a cohort of initially TMD-free adults followed over time, comparing sleep quality trajectories of patients with incident TMD with those of matched TMD-free control subjects in the cohort. We evaluated the contribution of sleep quality trajectories to risk of developing first-onset TMD. Second we estimated the potential mediation of heightened sensitivity to experimental pain in the pathway between poor sleep quality and TMD development. We hypothesized that poor sleep quality has a hyperalgesic effect which, in turn, increases risk of developing TMD.

Methods

Institutional review boards at each study site approved the study procedures, and signed, informed consent was obtained from each participant. This article complies with recommendations made for the Strengthening the Reporting of Observational Studies in Epidemiology.[42]

Study Design

This study used 2 studies designs, both of which drew on the OPPERA study. Essentially OPPERA is a series of community-based epidemiologic studies designed to characterize the etiology and persistence of painful TMD. This analysis draws upon 2 of OPPERA's studies. These are the prospective cohort study and its nested case control study. The advantage of the nested case control study is that it combines the efficiency and comparison group of a conventional case control study with the strengths of a prospective cohort study. Meanwhile, the strength of the prospective cohort study is its longitudinal design in which exposure is ascertained before TMD onset.

Setting, Study Participants, and Enrollment

OPPERA recruited community-based volunteers into its prospective cohort between May 2006 and November 2008. Its 4 study sites are located at Baltimore, Maryland; Buffalo, New York; Chapel Hill, North Carolina; and Gainesville, Florida. Initially, potential participants were screened for eligibility. Those who were aged between 18 and 44 years, with no significant history of TMD symptoms, no significant medical illnesses or recent history of facial injury or surgery, not pregnant or nursing, $\leq$4 headaches per month within the preceding 3 months, not receiving orthodontic treatment, never diagnosed with TMD, and no use of a night guard occlusal splint were invited to come to a clinic appointment. There they were clinically examined using Research Diagnostic Criteria for TMD.[12] A total of 3,263 were confirmed as TMD-free were enrolled and followed for up to 5.2 years (median follow-up = 2.8 years).

Baseline Assessment of Subjective Sleep Quality and Experimental Pain Sensitivity

At enrollment, OPPERA participants completed standardized questionnaires with well established psychometric properties. Habitual sleep quality and sleep disturbance in the past month was assessed using the 19-item Pittsburgh Sleep Quality Index (PSQI).[7] The PSQI has 7 subscales that assess subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each subscale is weighted equally, scored from 0 to 3, summing to a global score (range, 0–21). Higher scores denote worse sleep quality and a global score >5 has diagnostic sensitivity of 89.6% and specificity of 86.5% in distinguishing poor from good sleep.[7] In people who have TMD, the PSQI is a unidimensional construct.[32] Hence, in this analysis we used the PSQI single global score.

Methods for quantitative sensory testing (QST) of thermal pain, pressure pain, and mechanical pain in OPPERA have been described in detail.[18] In OPPERA, QST was used to assess pressure pain, mechanical cutaneous (pricking)