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Influence of culture on pain comorbidity in women with and without temporomandibular disorder-pain

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SUMMARY **Evidence on cultural differences in prevalence and impact of common chronic pain conditions, comparing individuals with temporomandibular disorders (TMD) versus individuals without TMD, is limited. The aim was to assess cross-cultural comorbid pain conditions in women with chronic TMD pain. Consecutive women patients (n = 122) with the index condition of chronic TMD pain diagnosed per the research diagnostic criteria for TMD and TMD-free controls (n = 121) matched for age were recruited in Saudi Arabia, Italy and Sweden. Self-report questionnaires assessed back, chest, stomach and head pain for prevalence, pain intensity and interference with daily activities. Logistic regression was used for binary variables, and ANCOVA was used for parametric data analysis, adjusting for age and education. Back pain was the only comorbid condition with a different prevalence across cultures; Swedes reported a lower prevalence compared to Saudis (P < 0·01). Saudis reported higher prevalence of work reduced >50% due to back pain compared to Italians or Swedes (P < 0·01). Headache was the most common comorbid condition in all three cultures. The total number of comorbid conditions did not differ cross-culturally but were reported more by TMD-pain cases than TMD-free controls (P < 0·01). For both back and head pain, higher average pain intensities (P < 0·01) and interference with daily activities (P < 0·01) were reported by TMD-pain cases, compared to TMD-free controls. Among TMD-pain cases, Italians reported the highest pain-related disability (P < 0·01). Culture influences the associated comorbidity of common pain conditions. The cultural influence on pain expression is reflected in different patterns of physical representation.**

KEYWORDS: **pain, chronic, comorbid conditions, low back pain, headache, disability, cross-cultural comparison**

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Background

Temporomandibular disorders (TMD) encompass a group of musculoskeletal disorders that involve temporomandibular joints, masticatory muscles and associated tissues, with US prevalence of approximately 10% (1) and similar prevalence elsewhere (2). While TMD is typically considered a primarily localised disorder of the jaw, a large overlap occurs in the prevalence of facial, back, chest and abdomen pain conditions within individuals (3). Moreover, current data indicate that TMD is a complex disorder that must be viewed from a biopsychosocial illness model, further emphasising that painful TMD should not be regarded solely as a localised oro-facial pain condition (4). Among US samples, 69%–76% of oro-facial pain

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patients report pain extending beyond the head and face (5), and among individuals with TMD that is chronic, the most common comorbid chronic pain conditions are back pain, neck pain and headaches, reported by adults as well as adolescents in both United States (6, 7) and Sweden (8).

The presence of one pain condition appears to strongly predispose to having another (9). For example, a case–control study that examined comorbidity between back and TMD pain in a Swedish sample concluded that patients with TMD pain have a higher probability of reporting back pain than persons without TMD pain (8). While TMD may be defined by the specific local structures putatively responsible for the pain complaint, high prevalence of comorbidity appears to be facilitated by both the persistence of pain and other factors (6). Such comorbidity affects prognosis and whether condition-specific treatment will be of value (10).

Culture, defined as a set of values, beliefs, experiences of living, attitudes and learned patterns of behaviours shared by the members of a particular society (11, 12), is an overarching construct that acts in a top-down manner just as genes act in a bottom-up manner for shaping the neurobiology of the individual. While culture is often regarded as a context, within which culture-specific beliefs and behaviours occur (13), context also refers to local circumstances within the culture affecting the particular behavioural expression that occurs within these simultaneous top-down and bottom-up processes.

Because culture plays an important role in the experience and expression of pain (14, 15), cross-cultural differences might be expected regarding patterns of comorbidity among these common pain conditions. Cross-cultural differences in prevalence, pain intensity and pain-related disability have been observed in several chronic pain conditions such as back pain, neck pain, headache and TMD (16, 17). A population study of these multiple pains found, across four different cultural groups, a predominance of women in each condition as well as variations in the prevalence of each condition (18). Evidence on cultural differences in prevalence and impact of common chronic pain conditions, comparing individuals with TMD pain as the index condition versus individuals without TMD, however, is limited. The hypotheses of this study were that prevalence, pain intensity and pain-related disability associated with common comorbid pain conditions (back, chest, stomach and head pain) differ across cultures and are greater among individuals with chronic painful TMD, as compared to TMD-free controls. Therefore, the aim of this study was to assess prevalence, pain intensity and pain-related disability of comorbid pain conditions by testing for the interaction between three different cultures and case status.

Methods

Subjects

Consecutive women patients ($n = 122$) with chronic TMD pain (39 Saudis, 41 Swedes, and 42 Italians) diagnosed per the research diagnostic criteria for TMD (RDC/TMD) (19) participated in this case–control study. The women patients were age gender-matched with 121 TMD-free controls (39 Saudis, 40 Swedes and 42 Italians). The study was restricted to women due to their preponderance at each study site.

The project followed the Declaration of Helsinki guidelines, and the regional ethics review board in Lund approved the study (daybook no. (20) 366/2008). This study was part of an extensive investigation of the influence of culture on TMD pain, where the overall study was powered for pain sensitivity-related hypotheses; such data were presented elsewhere (21).

Setting and recruitment

Four study sites were involved (i) Department of Orofacial pain and Jaw Function, Faculty of Odontology, Malmö University, Malmö, Sweden, (ii) the Department of Orthodontics and Temporomandibular Disorders, University of Naples Federico II, Naples, Italy, (iii) Specialist Dental Center, Al-Noor Specialist Hospital in Makkah, Saudi Arabia, and (iv) Dental Center, King Fahd General Hospital, Jeddah, Saudi Arabia. Participants from the latter two study sites were combined for data analysis. Subjects were recruited from new patients in the indicated clinics. In Naples, non-TMD controls were selected from among persons accompanying patients undergoing orthodontic treatment. At the other three centres, controls were recruited via advertisement in clinical and community settings. All participants provided signed informed consent before enrolment.

Selection criteria

Inclusion criteria for both cases and controls were (i) woman, (ii) aged 18–75 years, (iii) sufficient spoken and written language skills in the host language, (iv) able to complete questionnaires (instruments) , and (v) identification with the culture in which the study site was based. Cultural identification was assigned to a participant on the basis of all of (a) the participant and at least one parent were born in the culture, (b) the participant spoke the host language at home while growing up, and (c) the participant reported self-identity as a member of that culture.

Additional inclusion criteria for cases were (i) report of pain in the face, jaw, temple, in front of the ear, or in the ear in the last month and persisting for at least the prior 3 months, and (ii) presence of at least one pain diagnosis per the RDC/TMD (19). The complementary inclusion criteria for controls were as follows: (i) pain-free in the TMJ and masticatory muscles for the prior month, (ii) not using medication or treatment for oro-facial pain, as a confirmatory check for being pain-free in the masticatory region, and (iii) matched one case in age (±2 years) at the respective study site.

Exclusion criteria for both cases and controls were presence of any of dental pain, oro-facial neuropathic pain conditions, burning mouth syndrome, autoimmune diseases or significant mental impairment that would prevent compliance with study instructions.

Measures

Participant and pain characteristics. All participants were asked to complete a questionnaire regarding education and marital status. The individuals with TMD also reported pain duration and, from the Graded Chronic Pain Scale (GCPS) (22), intensity of current pain, worst pain and average pain over the prior 6-month time period using an 11-point numeric rating scale (0 = no pain and 10 = pain as bad as it could be). Characteristic pain intensity (CPI) was calculated as the mean of the three ratings, multiplied by 10; this measurement has acceptable reliability and validity (23). In addition, pain-related disability was assessed using three measures of activity interference due to pain (daily activities; recreational, social and family activities; ability to work) and days lost from usual activities measure in the GCPS. The three activity interference measures used an 11-point numeric rating scale (0 = no interference and 10 = unable to carry on any activities); scoring was performed in the same manner as for CPI. The grade of chronic pain was calculated for TMD cases only and ranges from 0 (no pain) to IV (severe dysfunction), reflecting the severity and impact of TMD pain on function.

Comorbid Pain Conditions Questionnaire. The Comorbid Pain Conditions Questionnaire was based on prior research (3). For each of back, chest, stomach and head pains, a filter question inquired into the presence of each pain condition in the previous 6 months; a positive response to a condition leads to the following pain-condition-specific questions: (i) average pain intensity in the previous 6 months using the same 11-point numeric rating scale as for the CPI scales, (ii) number of days work was reduced >50% (hereafter, days of work reduction) and (iii) activity interference due to pain, measured with the same three scales as for TMD pain. Even though individual measures within the CPI have lower reliability (23), only average pain intensity (rather than the typical 3 measures comprising the CPI) was assessed for the comorbid conditions to reduce subject burden, a method used elsewhere (3).

Translation of instruments

All instruments were translated, back-translated and culturally adapted into the language of each culture to maximise cultural application of the original instruments. This methodology has been compiled by Ohrbach and colleagues (available at www.rdc-tmdinternational.org).

Data reduction and analysis

Education was dichotomised to less than high school graduation versus graduation and beyond. Marital status was dichotomised to married versus not. Living together without being married was also a response option for participants in Sweden and Italy, and this option was also considered as married for data reduction. Because cohabitating without marriage does not exist in the Saudi Arabian/Muslim culture, it was not included in the Arabic questionnaire, and for Saudi Arabia, married status was solely 'marriage'. 'Not married' included married spouse not living in

household, widowed, divorced and separated in all three cultures. Days of work reduction was dichotomised to none versus any, due to the highly skewed truncated distribution. A comorbid pain index was defined as number of pain sites by creating a variable ranging from 0 to 4 (i.e. count of back, chest, stomach, head) in each subject (5), to compare total number of pain sites outside the masticatory system.

Missing data were of two forms. A small number of individuals did not answer all questions such as for demographic or TMD pain attributes, and these discrepancies are noted in Table 1. The other form of missing is related to the filter questions for each comorbid pain condition; only individuals with the condition provided responses to the subsequent questions, and Tables 2 and 3 provide those sample sizes.

Continuous variables (e.g. age, pain intensity) were analysed with ANOVA while dichotomous variables (e.g. marital status, back pain presence) were analysed with multiple logistic regression; independent variables included culture (Saudi, Sweden, Italy), case status (TMD-pain cases, non-TMD controls) and the interaction term. Among the three demographic variables, age and education differed according to the cultures and case status, respectively, and the planned models for all other variables were modified by including age and education as adjustment variables. For testing the primary study hypothesis, a two-way ANCOVA (culture, case status and interaction term)

Table 1. Descriptive statistics for TMD-pain cases and TMD-free controls

				P-values		
Characteristics	Saudis	Swedes	Italians	Culture	Case status	Interaction
N						
Cases	39	41	42			
Controls	39	40	42			
Age (years): mean (SD)						
Cases	32 (10)	34 (15)	40 (12)	<0·01**,***	0·58	0·68
Controls	30 (12)	35 (14)	39 (8)			
Education (≥12 years): *N* (%)						
Cases	23 (59)	34 (83)	26 (62)	0. 01**,***	<0·01	0·03
Controls	36 (92)	37 (92)	31 (74)			
Marital status (married): *N* (%)						
Cases	10 (26)	20 (50)	25 (60)	<0·01**	0·22	0·91
Controls	15 (38)	23 (58)	29 (69)			
TMD-pain Cases Only						
Pain duration (months): mean (SD)	30 (28)	77 (79)	52 (72)	<0·01*	N/A****	N/A
CPI: mean (SD)	55 (24)	55 (21)	64 (20)	0·11	N/A	N/A
Activity interference: mean (SD)	24 (27)	21 (25)	52 (33)	<0·01**,***	N/A	N/A
Graded chronic pain:						
Grade I-II : *N* (%)	34 (87)	32 (86)	24 (57)	<0·01 **,***	N/A	N/A
Grade III-IV: *N* (%)	5 (13)	5 (14)	18 (43)			

*Significant difference between Saudis and Swedes.

**Significant difference between Saudis and Italians.

***Significant difference between Swedes and Italians.

****Not applicable analysis due to cases only.

The first row depicts the nominal sample size for each of cases and controls, within each culture. This sample size remained constant for Saudis and Italians for all other analyses in this table, whereas missing data among the Swedes resulted in a sample size as small as 37 cases and 40 controls. ANOVA was used for continuous variables of age, pain duration, CPI, and interference with daily activities, while logistic regression was used for education, marital status and graded chronic pain.

Table 2. Back and head pain conditions in the last 6 months

				P-values		
	Saudis	Swedes	Italians	Culture	Case status	Interaction
Back pain						
Prevalence: % (*N*)						
Cases	71·8 (28)	60·0 (24)	66·7 (28)	<0·01*,**	0·38	0·24
Controls	59·5 (22)	32·5 (13)	38·6 (12)			
Average intensity: mean (SD)						
Cases	68 (25)	48 (20)	57 (22)	0·08	<0·01	0·72
Controls	46 (15)	40 (21)	42 (22)			
Days of work reduction: % = Yes						
Cases	37·5	45·5	42·9	<0·01*,**,***	0·04	<0·01
Controls	63·6	10·0	0·0			
Activity interference: mean (SD)						
Cases	41 (28)	30 (28)	40 (33)	0·11	0·01	0·49
Controls	31 (29)	12 (20)	17 (29)			
Head pain						
Prevalence: % (*N*)						
Cases	71·8 (28)	80·5 (32)	88·1 (37)	0·38	0·21	0·19
Controls	54·1 (20)	65·0 (26)	52·4 (22)			
Average intensity: mean (SD)						
Cases	67 (24)	60 (19)	64 (23)	0·03*	<0·01	0·25
Controls	47 (25)	35 (22)	47 (21)			
Days of work reduction: % = Yes						
Cases	32·1	67·7	29·7	0·42	0·25	0·08
Controls	50·0	39·1	22·7			
Activity interference: mean (SD)						
Cases	42 (30)	36 (28)	42 (34)	0·64	<0·01	0·58
Controls	33 (34)	17 (25)	15 (26)			

*Significant difference between Saudis and Swedes.

**Significant difference between Saudis and Italians.

***Significant differences were found among controls only.

Cases refer to cases with TMD pain, while controls refer to individuals without TMD pain. Prevalence refers to the available sample, with the reported *N* as exact. Logistic regression was used for prevalence and work reduced >50%; ANCOVA was used for the remaining variables. Results were adjusted for age and education.

compared mean values for each continuous dependent variable (average intensity, interference with daily activities) for each of the four pain conditions (back, chest, stomach, head). And, a similar logistic regression model was used for the dichotomous variables. When the ANCOVA revealed a statistical difference among the three cultures, Tukey's HSD (honest statistical difference) was used for multiple comparisons. A significance level of 0·05 was used in all tests, although marginally significant results are also identified due to the repeating pattern observed across the comorbid pain conditions. Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 21.0 for Windows.

Results

Subject characteristics and, for the cases, TMD pain characteristics are displayed in Table 1. The Italians were older than the Saudis and Swedes ($P < 0·01$). Education years received did not differ across cultures, but fewer cases had received at least 12 years of education compared to TMD-free controls ($P < 0·01$). More Italians reported being married compared to Saudis ($P < 0·01$).

TMD pain duration was shorter in Saudis compared with the Swedes (Table 1; $P < 0·01$). Pain intensity (CPI) associated with TMD pain did not differ cross-culturally. Average TMD pain intensity, as a

Table 3. Chest and stomach pain conditions in the last 6 months

				P-values		
	Saudis	Swedes	Italians	Culture	Case status	Interaction
Chest pain						
Prevalence: % (*N*)						
Cases	30·8 (12)	17·5 (7)	33·3 (14)	0·06	0·17	0·49
Controls	16·2 (6)	2·5 (1)	14·3 (6)			
Average intensity: mean (SD)						
Cases	54 (17)	20 (22)	51 (27)	0·04*	0·23	0·85
Controls	48 (28)	50 (0)	35 (23)			
Days of work reduction: % = Yes						
Cases	16·7	14·3	21·4	0·05*,**	0·24	0·07
Controls	50·0	0·0	0·0			
Activity interference: mean (SD)						
Cases	37 (21)	17 (37)	31 (30)	0·07	0·04	0·45
Controls	15 (21)	0 (0)	4 (10)			
Stomach pain						
Prevalence: % (*N*)						
Cases	51·3 (20)	41·5 (17)	57·1 (24)	0·39	0·09	0·26
Controls	27·8 (10)	22·5 (9)	16·7 (7)			
Average intensity: mean (SD)						
Cases	64 (28)	51 (28)	61 (23)	0·87	0·84	0·28
Controls	51 (29)	36 (14)	57 (24)			
Days of work reduction: % = Yes						
Cases	35·0	57·1	33·3	0·13	0·18	0·06
Controls	60·0	22·2	14·3			
Activity interference: mean (SD)						
Cases	34 (33)	27 (27)	34 (33)	0·77	0·67	0·84
Controls	41 (28)	16 (22)	30 (37)			

*Significant difference between Saudis and Swedes.

**Significant difference between Saudis and Italians.

Cases refer to cases with TMD pain, while controls refer to individuals without TMD pain. Prevalence refers to the available sample, with the reported *N* as exact. Logistic regression was used for prevalence and work reduced >50%; ANCOVA was used for the remaining variables. Results were adjusted for age and education.

component of CPI and serving as a comparison for the other pain conditions, showed no cross-cultural differences. Disability days ranged 0–30 for each of Saudi and Sweden, and from 0 to 180 for Italy, without cross-culture differences. Italians reported greater activity interference due to TMD pain ($P < 0{\cdot}01$), compared to Swedes and Saudis. Similarly, Italian TMD-pain cases represented a higher proportion of pain-related disability grades of III-IV (moderate and severe) ($P < 0{\cdot}01$) compared to the other two cultures which were similar.

Back pain prevalence was higher among the Saudis (Table 2; $P < 0{\cdot}01$), particularly and unexpectedly among the Saudi non-TMD controls, in comparison with the controls in the other cultures. We removed the Saudis from the analysis, resulting in a higher prevalence of back pain in both Swede and Italian TMD-pain cases ($P < 0{\cdot}02$), compared to the respective controls. Average back pain intensity was marginally higher in the Saudis ($P = 0{\cdot}08$), consistent with the higher prevalence in that setting; pain intensity was also higher among cases, compared to controls ($P < 0{\cdot}01$). More Saudis reported days of work reduction, compared to Italians and Swedes ($P < 0{\cdot}01$); days of work reduction were reported by more Saudi controls and by both Swede and Italian cases ($P < 0{\cdot}01$). Activity interference did not differ between cultures but was higher among cases ($P = 0{\cdot}01$). Overall, TMD-pain cases reported higher average pain intensity ($P < 0{\cdot}01$) and activity interference ($P < 0{\cdot}01$) associated with the back, compared to TMD-free controls.

Head pain prevalence did not differ cross-culturally, whereas cases uniformly reported higher prevalence of headache pain compared to controls, though not significantly (Table 2). Average head pain intensity was lower among Swedes compared to Saudis ($P = 0{\cdot}03$), and the Italians more closely resembled the Saudis. Consistent with the prevalence between cases and controls, TMD-pain cases reported greater average pain intensity ($P < 0{\cdot}01$) and activity interference ($P < 0{\cdot}01$) associated with the head, compared to TMD-free controls. More Saudi controls and Swede cases reported days of work reduction, compared to all others, due to head pain, although this was marginal ($P = 0{\cdot}08$).

Chest pain prevalence differed marginally cross-culturally, with fewer Swedes reporting this pain (Table 3). For this condition, other estimated effects were based on small samples and only major findings are summarised here. Swedes reported lower average chest pain intensity compared to Saudis ($P = 0{\cdot}04$). Overall, TMD-pain cases reported higher activity interference ($P = 0{\cdot}04$) associated with the chest, compared to TMD-free controls. More Saudi controls and no Swede or Italian controls reported days of work reduction due to chest pain, although this was marginally significant ($P = 0{\cdot}07$).

None of the variables associated with stomach pain differed between cultures or case status, although cases uniformly reported higher prevalence of stomach pain compared to controls, though not significantly ($P = 0{\cdot}09$) (Table 3). More Saudi controls and Swede cases marginally reported days of work reduction due to stomach pain ($P = 0{\cdot}06$).

The number of comorbid pain conditions (Fig. 1) was higher among cases ($P < 0{\cdot}01$) with a larger contrast within the Italians ($P = 0{\cdot}05$) but did not differ across cultures.

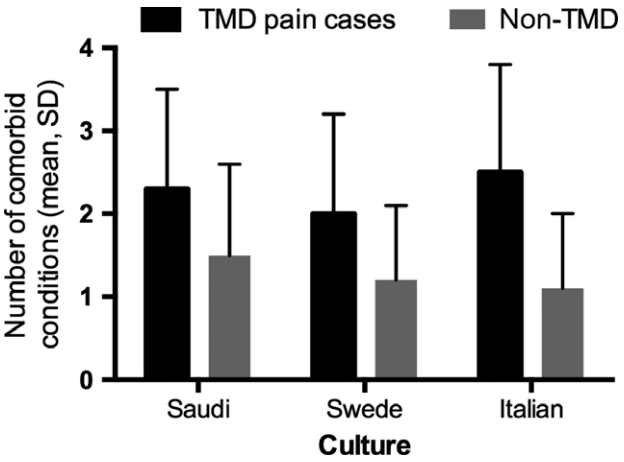

Fig. 1. Number of comorbid pain conditions (range: 0-4, consisting of back, headache, abdominal and chest pains) stratified by case versus non-case. Cases report more comorbid conditions than non-cases ($P < 0{\cdot}01$).

Discussion

The main findings of this study are as follows: the prevalence of back pain and, marginally, chest pain differed across cultures; pain intensity was higher for head pain and back pain in cases and differed across cultures for chest pain, head pain and, marginally, back pain; and pain-related disability exhibited a complex pattern depending on pain condition and measure of either days of work reduction or activity interference. The cases in this study are similar (i.e. age, years education, pain intensity, pain duration, graded pain status) to the cases previously reported for the respective countries at each study site (24–26) and US settings (3, 6, 17), suggesting sufficient generalisability of findings to the population of clinic cases within the respective cultures. In each setting, cases were seeking medical care, and generalising to individuals with TMD pain but not seeking care would be inappropriate. In addition, the method of finding controls was not population-based but rather reflects a convenience sample of unknown characteristics beyond not having TMD pain. All measures were adjusted for age and education years to control for baseline differences; these are convenience samples, and consequently, any demographic differences are more likely intrinsic to the setting.

The prevalence of each of the comorbid pain conditions was higher in the TMD-pain cases in each culture, though not significantly higher in any individual pain condition. In contrast, the global count of pain conditions was significantly higher in cases, consistent with one part of the study hypothesis and with two separate US samples, where subjects who developed TMD pain reported previously at enrolment higher prevalence of pain in other body sites such as the head, back and abdomen compared to individuals without TMD pain (7, 9). The absence of the hypothesised significantly higher prevalence of any specific comorbid condition in cases versus controls may of course reflect insufficient statistical power. However, one interpretation of the consistent pattern of each

comorbid condition as more prevalent in cases, coupled with the strong quantitative result when simply counting the number of conditions, pertains to a general risk for pain condition comorbidity given a pre-existing pain disorder. This risk appears to be centrally mediated, which we discuss further in the next paragraph, whereas the particular bodily locus for a comorbid condition may be determined by behavioural and environmental factors which occur across cultures in a generic manner but exert their effects at the individual level. The present data suggest that this contribution by a pre-existing pain disorder appears to be a more substantial factor than the role of culture on pain expression. For example, there were no cultural differences in the extent of pain disorder comorbidity among cases as contrasted to controls which was not consistent with hypothesis.

Culture itself seems to exert its role on pain expression more so through pain-related disability, given any comorbidity; for example, Saudi controls exhibited the highest rate of days of work reduction for three of the four comorbid conditions. But 'pain expression' here is taken in its broadest context to include all of the behaviours associated with pain experience (e.g. meeting clinical criteria for having a disorder because the bodily experience is sufficiently aversive in a given context that the individual classifies the experience as 'pain' versus non-pain; see, for example (27)).

A variety of mechanisms have been proposed to explain comorbidity, such as hormonal or immune systems (28, 29). Based on the present data, we can speculate that central sensitisation as a consequence of an existing chronic pain disorder coupled with condition-specific new exposure to an initiating event for nociception may potentially explain some new disorder onsets and in particular increased risk for chronicity; an initiating event would vary according to the disorder, such as strain from chronic overuse or injury for back pain or TMD pain, or altered motility for irritable bowel syndrome ('stomach pain'). This potential mechanism then implies that interoceptive information signalling existence of an initiating event (30) is interpreted by the individual in culturally invariant ways as far as the simple presence of one or more comorbid disorders.

Headache was the most common comorbid pain disorder, consistent with known TMD pain and headache overlap (31), followed by back, stomach and chest pain. That back pain is, after headache, the next most common comorbid disorder with TMD pain is likely related to shared musculoskeletal pain mechanisms (32, 33), perhaps related as well to a stress diathesis specific to musculoskeletal response patterns (34). In contrast, pain in the regions of the stomach and chest is more likely to be mediated by different mechanisms. Headache comorbid with new-onset TMD-pain appears to be predominately of migraine type compared to tension-type headache (35); one possible reason for this association is because migraine has a substantially higher base rate, compared to tension-type headache, in the general population (36). For example, and in contrast to the dichotomy of visceral versus musculoskeletal pain mechanisms, both TMD pain and headache are subserved by the trigeminal system, and evidence supports a strong role for the trigeminal system as a whole for migraine pathogenesis (37). In addition, headache comorbid with TMD pain likely shares musculoskeletal mechanisms as well, as exemplified by the headache secondary to TMD (38). The latter, however, points to the complex boundary between overlapping (and related conditions) and comorbidity: Is headache, if secondary to TMD pain, a comorbid disorder, an overlapping disorder, or simply an extension of the primary TMD pain? The increasing emphasis on comorbidity within the pain field surely points to the need to grapple with this question. That this pattern of results was the same across cultural settings is consistent with our above discussion regarding comorbidity in general.

Among the other comorbid pain conditions, back pain prevalence exhibited a cross-cultural difference, with Saudis overall reporting more back pain compared to Swedish and Italians, whereas for chest pain, with a marginal cross-cultural difference, Saudis and Italians reported equally higher prevalence compared to the Swedes. Perhaps, more striking is that the Saudi controls reported the highest work reduction for each of the four comorbid conditions, with significant or near significant interactions for each comorbidity. A previous population study reported a back pain prevalence of 63·8% among Saudi teachers in the eastern region and a general increase in the prevalence of back pain in the Saudi population accompanied by their increasingly sedentary nature (39), pointing to a profound cultural shift within the Saudis at this time; these data suggest that the previously reported impact on the Saudis by the cultural shift may be yet broader, occurring across multiple pain conditions.

The cross-cultural pattern of pain and disability across pain conditions, as summarised above and interpreted in relation to specific findings, is clearly complex, and while overall the findings support the main study hypothesis, the observed pattern does not point to a simple and parsimonious explanation. To further complicate a possible parsimonious interpretation, contextual influences may help explain the present results because depending on the context, some people may act more culturally than others even within the same cultural group (40). Broader possible mechanisms underlying comorbidity, such as sleep disturbance and smoking (9), have been proposed, but we are unable to explore them in this sample. We propose two additional, perhaps intersecting, explanations – environmental exposure and pain processing – for differential comorbidity across cultures. One common form of exposure relevant to pain disorders is physical activity, where non-specific back pain increases with inactivity (41). Physical inactivity appears to be increasing among the Saudis; in contrast, the research settings in both Sweden and Italy are urban with various forms of mass transit, encouraging more activity. This may explain part, but certainly not all, of the observed disability differences related to the pain conditions across cultures. A central feature of all current pain-processing theories is the role of the affective dimension of pain, and stress coping is a central part of some of those theories (42). Emotion, affect and coping are strongly shaped by culture (13). Body map representation, as perhaps influenced by individual differences in interoception and how early development shapes that percept (30), may serve as a locus for symptom expression (43). Taken together and considering the above interpretations, the present data illustrate differences across cultures in comorbid pain profiles suggestive of exposure interacting with perception of the body map and how that influences symptom expression for a given disorder. These interpretations are speculative and require prospective research for further investigation.

This study has several strengths. To our knowledge, it is the first comparing comorbid pain conditions among TMD-pain cases and healthy controls in three well-defined cultural groups selected to avoid acculturation bias. Second, this is the first study that specifically compared chronic TMD-pain cases recruited at specialised units in which we find the individuals with the most severe symptoms, consistent with the real clinical impact of such conditions (25). Third, all instruments and instructions were translated, back-translated and reviewed by experts in each culture according to recommended specifications. This ensured that the constructs were assessed equally in each culture. A final strength is the factoral design and hypothesised interaction, wherein we attempted to identify whether cultural determinants might act as an effect modifier of case status – that is, having an identified pain condition in the context of medical care-seeking – in the reporting of both pain and pain-related interference.

One limitation is that this study focused on women because, as a convenience sample, women predominated in all of the clinics which is common (1). While the assessment of comorbidity was restricted to only women in this study, women compared to men are more likely to have TMD pain-related comorbidity in the form of head, neck, stomach and back pain (5, 18). A second limitation is the time frame (last 6 months) for the disease assessment, which was assessed at only one time-point in this case–control study of the relationship among the different pain disorders; clearly, a prospective study would be more informative in elucidating causal relationships. A third limitation is the relatively small number of participants within several of the comorbid disorders because the present study was powered for pain sensitivity not for pain comorbidity; the effect of the small sample size is particularly important with regards to low statistical power to detect the statistical interactions. In addition, the small sample size results in the relatively large standard deviations for the continuous variables, thereby making increasing our type II error rate. While the statistical outcome of selected variables could change with a larger sample size, the fundamental conclusions regarding the presence of cultural differences affecting pain does not change. A final limitation is that explanatory variables (e.g. pertaining to context for a given symptom) were not measured, thereby not allowing microcultural level of analyses; such variables would lead to better support of some of our interpretations.

Conclusions

In summary, comorbid pain prevalence, intensity and disability differed across cultures in a complex pattern. Collectively, these findings support our major

hypothesis – that culture affects the expression of pain and that, in turn, is reflected in different patterns of physical representation.

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Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

Disclosure

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