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The effect of culture on pain sensitivity

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SUMMARY **Cross-cultural differences in pain sensitivity have been identified in pain-free subjects as well as in chronic pain patients. The aim was to assess the impact of culture on psychophysical measures using mechanical and electrical stimuli in patients with temporomandibular disorder (TMD) pain and pain-free matched controls in three cultures. This case–control study compared 122 female cases of chronic TMD pain (39 Saudis, 41 Swedes and 42 Italians) with equal numbers of age- and gender-matched TMD-free controls. Pressure pain threshold (PPT) and tolerance (PPTo) were measured over one hand and two masticatory muscles. Electrical perception threshold and electrical pain threshold (EPT) and tolerance (EPTo) were recorded between the thumb and index fingers. Italian females reported significantly lower PPT in the masseter muscle than other cultures ($P < 0.001$) and in the temporalis muscle than Saudis ($P = 0.003$). Swedes reported significantly higher PPT in the thenar muscle than other cultures ($P = 0.017$). Italians reported significantly lower PPTo in all muscles than Swedes ($P \leq 0.006$) and in the masseter muscle than Saudis ($P < 0.001$). Italians reported significantly lower EPTo than other cultures ($P = 0.01$). Temporomandibular disorder cases, compared to TMD-free controls, reported lower PPT and PPTo in all the three muscles ($P < 0.001$). This study found cultural differences between groups in the PPT, PPTo and EPTo. Overall, Italian females reported the highest sensitivity to both mechanical and electrical stimulation, while Swedes reported the lowest sensitivity. Mechanical pain thresholds differed more across cultures than did electrical pain thresholds. Cultural factors may influence response to type of pain test.**

KEYWORDS: **case–control studies, cross-cultural comparison, pain threshold, temporomandibular disorder, chronic pain**

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Background

Culture is an important factor affecting perception, experience and expression of pain, as early studies demonstrated (1, 2). Cross-cultural studies highlight that the description and perception of pain are culturally specific (3). Race, ethnicity and culture are overlapping terms in the literature, are sometimes used synonymously but represent dissimilar concepts (4, 5) and are defined here for clarity. Race is based on specific genes that identify major groups of people primarily by ancestry and common heritable physical characteristics (6, 7). Ethnicity refers to people within a society who share a common language, religion, culture and experience (6, 8). Culture is defined as a set of values, beliefs, experiences of living, attitudes and learned patterns of behaviours shared by the members of a particular society (3–5). In this study, we will use cultural differences as a synonym for ethnic differences among individuals of three countries residing in their country of birth.

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Cross-cultural differences, wide-ranging across psychophysical method, in pain sensitivity have been found in pain-free subjects as well as in individuals with chronic pain (9–12). Among pain-free subjects, South Indians demonstrate higher capsaicin-induced pain intensity and lower pressure pain thresholds (PPT) than Danish Caucasians (11), whereas South Asians demonstrate lower pain threshold to heat compared to Caucasians (10). Swedish Caucasians exhibit higher tolerance to thermal pain and pressure pain than Middle Eastern Caucasians (9). No cross-cultural difference was found between adults from Japan and the USA in electric pain-induced dental pain (13).

Evidence strongly supports TMD as a musculoskeletal condition characterised by higher sensitivity to a mechanical stimulus (14–16) among TMD cases compared to non-TMD controls. To measure pain sensitivity in the oro-facial region, both mechanical and electrical stimuli have been used (17, 18).

To the best of our knowledge, no studies defined culture as distinct cultural identity and living in the country of origin. This study aimed to compare psychophysical responses to mechanical and electrical stimuli in female TMD patients and TMD-free controls, nested within each of three cultures (Saudi, Italian and Swedish). Sensitivity to both mechanical and electrical stimuli was hypothesised to differ among cultures and between chronic TMD patients and TMD-free subjects.

Methods

Study population

Saudi Arabian (n = 39), Italian (n = 42) and Swedish (n = 41) new consecutive female TMD patients participated in the study. The study sites were as follows: (i) the Specialist Dental Center, Al-Noor Specialist Hospital in Makkah, Saudi Arabia, (ii) the Dental Center, King Fahd General Hospital, Jeddah, Saudi Arabia, (iii) the Department of Orofacial Pain and Jaw Function, Malmö University, Malmö, Sweden and (iv) the TMD/Orofacial Pain Clinic, School of Dentistry, University of Naples Federico II, Naples, Italy. At each centre, an equal number of TMD-free female controls were recruited who were age-matched with TMD patients.

In Naples, TMD-free controls were selected from among persons accompanying patients undergoing orthodontic treatment. At the other three centres, TMD-free controls were recruited via advertisement in clinical and community settings. All participants signed informed consent forms before entering the study. The project followed the Declaration of Helsinki guidelines, and the regional ethics review board in Lund approved the study as a multicentre study ([Dnr] 366/2008). At the end of the study participation, an oro-facial pain specialist at each study site offered treatment to all patients with chronic TMD.

Inclusion criteria

Cases and controls. Participants must fulfil all of the following: (i) Self-identity of the subject was as a member of that culture identify culturally with the host country (ii) At least one parent and the subject were born in that culture, (iii) The subject spoke the host language at home while growing up and (iv) Be able to communicate and complete written questionnaires in the host language.

Cases. Cases must (i) report pain in the face, jaw, temple, in front of the ear or in the ear at the time of recruitment, and the pain must have begun at least 3 months previously to be considered chronic, (ii) have at least one pain diagnosis since the cases and controls were examined since the Research Diagnostic Criteria for TMD (RDC/TMD) (19), (iii) be of female gender and (iv) be age 18–75 years.

Controls. Controls must be females who (i) are free from pain in the TMJ and masticatory muscles in the last 3 months, (ii) not taking medication or receiving treatment for oro-facial pain and (iii) match a case in age.

Exclusion criteria

Subjects were excluded based on the presence of any of the following: dental pain, oro-facial neuropathic pain conditions, burning mouth syndrome, auto-immune diseases or significant mental impairment that would prevent compliance with study instructions.

Measures

Pain characteristics and demographics. All participants were asked to complete a questionnaire regarding

facial pain intensity and pain duration. Characteristic pain intensity (CPI), from the Graded Chronic Pain Scale (20) was measured using three 0–10 numeric rating scales (NRS) assessing (i) current pain, (ii) worst pain and (iii) average pain over the prior 6-month time period (21). For controls, these questions were not applicable, and hence, the CPI was zero. In addition, the questionnaire asked about years of education (0–18+) and marital status.

Pressure pain measurements. Pressure pain measurements were made using a digital pressure algometer* with a constant application rate of 30 kPa s^{-1}. The tip was a rubber probe with a surface area of 1 cm^2, as used in other studies (22, 23). Pressure pain threshold (PPT) was defined as the pressure (kPa) that the subject first perceived to be painful. Pressure pain tolerance (PPTo) was defined as the most painful pressure (kPa) the subject could tolerate (18). Pressure was applied in this order: over (i) the right anterior temporalis muscle, (ii) the central part of the right masseter muscle midway between the upper and lower borders and 1 cm posterior to the anterior border, and (iii) the palm side of the thenar muscle of the right hand on the point connecting the longitudinal axis of the thumb and index finger (24). Three meaurements of PPT with intervals of 30 s and two measurements of PPTo with intervals of 60 s were taken. The examinations were conducted by a calibrated examiner in Sweden and Saudi Arabia (M. Al-Harthy) and one calibrated examiner in Italy (S. Matrella).

Electrical stimulation tests. Sensitivity to electrical stimulation was measured using the PainMatcher®.† The PainMatcher® is a controlled, constant current electrical stimulation microprocessor, transmitting monophasic square pulses with a frequency of 10 Hz and 15 mA pulse amplitude to two electrodes. The intensity increases as the duration of the monophasic pulses increases slowly from zero up to 396 μs in four-pulse steps applied between the thumb and index fingers on the right hand. Three distinct constructs were assessed. The electrical perception threshold was defined as the intensity of current needed for the subject to perceive pulses in the thumb and index finger. Electrical pain threshold (EPT) was defined as the electrical stimulus that the subjects first perceived to be painful. Electrical pain tolerance (EPTo) was defined as the most painful electrical stimulus that the subject could tolerate.

Three measurements were made for electrical perception threshold, EPT and EPTo with intervals between repeated measures of approximately <5, 30 and 60 s, respectively.

Translation of commands and instruments. Self-report questionnaires regarding demographics and pain characteristics, instructions for pressure pain measurements and instructions for electric stimulation tests were translated, back translated, reviewed and culturally adapted into the language of each culture to minimise any cultural misunderstanding of the original commands. The Guidelines for Translation and Cultural Equivalency (25) were followed.

Statistical analysis

For descriptive statistics of the samples, a multiple logistic regression was used for comparisons of education and marital status; independent variables included culture (Saudi, Sweden and Italy) and group (cases, controls). For testing the primary study hypothesis, a two-way ANOVA (culture, group), including the interaction term, compared mean values on each of the following variables: PPT, PPTo, electrical perception threshold, EPT and EPTo. As age and education differed significantly between the cultures, the ANOVA models were adjusted for these two variables. When the ANOVA revealed a significant difference among the three cultures, Tukey's HSD was used for multiple comparisons.

Sample size was computed based on published data using the same psychophysical measurement methods. A significance level of $\alpha = 0{\cdot}05$ and power of $1\text{-}\beta = 0{\cdot}90$ were assumed for the comparison of the groups using a one-way ANOVA with Tukey's test. A difference of 60 KPa was considered clinically relevant with a s.d. = 70. The calculations gave an estimated sample size of $n = 40$ in each group. Data were analysed using the Statistical Package for the Social Sciences (SPSS‡), version 21.0 for Windows.

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Results

Table 1 presents descriptive statistics regarding subject demographics for cultures and groups. The Italians were significantly older than the Saudis and Swedes ($P < 0{\cdot}000$), while the Swedes did not differ in age compared to the Saudis. Temporomandibular disorder-free controls, compared to TMD cases, had received more education ($P = 0{\cdot}003$). Characteristic pain intensity did not differ between cultures, while pain duration was lower in Saudis when compared with the Swedes ($P = 0{\cdot}006$). No significance was found between TMD cases included in this study from all cultures with regards to taking analgesics ($P = 0{\cdot}1$).

Table 2 presents cross-cultural and group comparisons of PPT. In the masseter muscle, Italians reported lower PPT values than the Swedes ($P < 0{\cdot}000$), while the Saudis reported higher PPT values compared to the Swedes ($P < 0{\cdot}001$). In the temporalis muscle, Swedes reported lower PPT values than Saudis ($P = 0{\cdot}003$). In the thenar muscle, Swedes reported higher PPT values compared to Saudis and Italians ($P = 0{\cdot}017$). Temporomandibular disorder cases, compared to TMD-free controls, reported lower PPTs in each of the three muscles (all $P < 0{\cdot}001$).

Table 3 presents cross-cultural and group comparisons of PPTo. In the masseter muscle, Italians reported the lowest PPTo values compared to Swedes and Saudis ($P < 0{\cdot}001$). In the temporalis muscle, Italians reported lower PPTo values compared to Swedes ($P = 0{\cdot}006$). In the thenar muscle, Italians reported lower PPTo compared to the Swedes ($P < 0{\cdot}001$). Temporomandibular disorder cases, compared to TMD-free controls, reported lower PPTo in each of the three muscles (all $P < 0{\cdot}001$).

Table 4 presents cross-cultural and group comparisons of the electrical stimulus test. For the EPT, Saudis reported lower values than the Swedes and the Italians ($P = 0{\cdot}002$). For the EPTo, the results were reversed, and Italians reported lower values than the Saudis and the Swedes ($P = 0{\cdot}01$).

Discussion

Demographic and TMD pain characteristics

Age, pain duration and pain intensity reported in the study were in accordance with similar clinical studies indicating a generalisability of the population studied (26–29). Temporomandibular disorder cases had less education compared to the controls, which is in accordance with previous studies indicating that chronic TMD pain is more prevalent in lower socio-economic groups (30, 31). The Italian group was significantly older than the other culture groups, and it has been reported that pain sensitivity might be

Table 1. Demographics and pain characteristics: descriptive statistics by culture and group

	Culture			*P*-values		
Characteristics	Saudi	Swedish	Italian	Culture	Group	Interaction
Age (years), mean ± (s.d.)						
Cases	32 ± (10)	34 ± (15)	40 ± (12)	0·000**·***	NS	NS
Controls	30 ± (12)	35 ± (14)	39 ± (8)			
Education (≥12 years), *N* (%)						
Cases	23 (59%)	34 (83%)	26 (62%)	NS	0·003	NS
Controls	36 (92%)	37 (92%)	31 (74%)			
Marital status (married), *N* (%)						
Cases	17 (34%)	26 (53%)	27 (54%)	NS	NS	NS
Controls	21 (42%)	26 (54%)	32 (64%)			
CPI						
(cases only): mean ± (s.d.)	54 ± (25)	56 ± (20)	62 ± (21)	NS	–	–
Pain duration (months)						
(cases only): mean ± (s.d.)	28 ± (26)	70 ± (74)	54 ± (74)	0·006*	–	–

CPI, Characteristic pain intensity; NS, non-significant.
*Significant difference between Saudis and Swedes.
**Significant difference between Saudis and Italians.
***Significant difference between Swedes and Italians.

Table 2. Pressure pain threshold (PPT): TMD cases and TMD-free controls, tests adjusted for age and education

	Culture			*P*-values		
Characteristics	Saudis	Swedes	Italians	Culture	Group	Interaction
Right masseter m.: mean ± (s.d.)						
Cases	201 ± (50)	167 ± (50)	148 ± (57)	0·000*,**,***	0·000	NS
Controls	231 ± (56)	222 ± (66)	173 ± (63)			
Right temporalis m.: mean ± (s.d.)						
Controls	228 ± (68)	179 ± (53)	199 ± (81)	0·003*	0·000	NS
Cases	250 ± (68)	249 ± (96)	212 ± (86)			
Thenar m. of the right hand: mean ± (s.d.)						
Cases	344 ± (80)	349 ± (144)	342 ± (105)	0·017*,***	0·000	NS
Controls	406 ± (88)	490 ± (137)	406 ± (101)			

NS, non-significant.
*Significant difference between Saudis and Swedes.
**Significant difference between Saudis and Italians.
***Significant difference between Swedes and Italians.

Table 3. Pressure pain tolerance (PPTo): TMD cases and TMD-free controls, tests adjusted for age and education

	Culture			*P*-values		
Characteristics	Saudis	Swedes	Italians	Culture	Group	Interaction
Right masseter m.: mean ± (s.d.)						
Cases	312 ± (81)	290 ± (94)	244 ± (74)	0·000**,***	0·000	NS
Controls	349 ± (95)	343 ± (119)	293 ± (101)			
Right temporalis m.: mean ± (s.d.)						
Cases	344 ± (93)	323 ± (108)	320 ± (88)	0·006***	0·000	NS
Controls	391 ± (108)	421 ± (169)	337 ± (89)			
Thenar m. of the right hand: mean ± (s.d.)						
Cases	507 ± (101)	586 ± (243)	495 ± (137)	0·000*,***	0·000	NS
Controls	589 ± (160)	756 ± (236)	559 ± (137)			

NS, non-significant.
*Significant difference between Saudis and Swedes.
**Significant difference between Saudis and Italians.
***Significant difference between Swedes and Italians.

Table 4. Electrical stimulation: TMD cases and TMD-free controls, tests adjusted for age and education

	Culture			*P*-values		
Characteristics	Saudis	Swedes	Italians	Culture	Group	Interaction
Perception threshold: mean ± (s.d.)						
Cases	3·1 ± (1·1)	3·5 ± (1·3)	3·7 ± (0·9)	0·032*,**	NS	NS
Controls	3·2 ± (1·0)	3·7 ± (1·2)	3·7 ± (0·9)			
EPT: mean ± (s.d.)						
Cases	5·0 ± (2·7)	6·1 ± (3·1)	5·9 ± (2·2)	0·002*,**	0·001	NS
Controls	5·4 ± (2·7)	7·2 ± (3·5)	8·3 ± (2·5)			
EPTo: mean ± (s.d.)						
Cases	13·7 ± (9·1)	15·7 ± (9·3)	11·7 ± (6·0)	0·010**,***	NS	NS
Controls	18·8 ± (15·7)	16·6 ± (6·6)	14·0 ± (6·7)			

EPT, electric pain threshold; EPTo, electric pain tolerance; NS, non-significant.
*Significant difference between Saudis and Swedes.
**Significant difference between Saudis and Italians.
***Significant difference between Swedes and Italians.

affected in the elderly (32). Thus, all measures in the study were adjusted by taking age and number of years of education as covariates to control for differences in baseline values, thereby eliminating possible confounding variables for the observed differences in cultures.

Impact of culture on mechanical and electrical pain sensitivity

As TMD is a musculoskeletal pain condition characterised by higher sensitivity to mechanical stimulus, the masseter and anterior temporalis muscles were selected for measurement in our study. Studies from Italy (33, 34) and Sweden (9, 35) have reported mean PPTs for the masseter muscle of pain-free subjects and patients, and they correspond well with our PPT values indicating a generalisability of the subjects.

The overall significantly lower PPT, PPTo and EPTo values in this study among the Italian females reflect higher pain sensitivity within that culture. This is in accordance with earlier studies that found Italians less stoic and more expressive of pain when compared to other cultures (1, 2). The significant differences found between Saudi and Swede females in this study concerning PPT values in the masseter muscle and concerning EPT values were not in accordance with that reported previously in which no significant differences were found (9).

Level of acculturation could explain these differences because Swedish TMD-free female controls in this study were compared with Middle Eastern Saudi females living in the Saudi Arabian culture, while the Middle Eastern TMD-free controls in the study by (9) live in Sweden, have the same level of education and assimilated the Swedish lifestyle and culture.

The significant differences between TMD cases versus TMD-free controls found in this study in the PPT and PPTo for the trigeminal and non-trigeminal sites were in accordance with previous case–control studies that used the same tests (16, 37). This higher pain sensitivity to mechanical stimulus among TMD cases suggests greater hyperexcitability of the peripheral and central nociceptive system, compared to TMD-free controls (38).

The non-trigeminal site, thenar, was also compared with two different stimuli – pressure pain and electric stimuli. We found small differences between cultures in electrical measurements and these differences were contradictory to what we found in mechanical stimulation, and these differences may be related to cultural variations rather than stimulus type. One explanation could be that electrical stimulus not only is perceived as painful but also has been reported to have a strong sensation of discomfort. In our study, we did not measure discomfort between cultures, and therefore, the influence of this outcome is unclear. A second explanation could be that varying skin properties such as epidermal innervation might partially explain differences in pain sensitivity between cultural groups (24).

Study strength and limitations

To the best of our knowledge, this study is the first that jointly examines deep pressure and cutaneous electric stimulation among TMD cases and TMD-free controls in subjects who are clearly different culturally, defined as representing a specific cultural identity and living in the country of origin, thereby avoiding acculturation bias. Second, two stimulation modalities were used in the study. One study concluded that single pain testing modality probably provides an incomplete picture of pain sensitivity (39). Third, reliable methods were used such as mechanical (40) and electrical stimulation, (41) and all instruments and instructions used were translated according to published standards. A potential limitation in the study is that body mass index (BMI) was not calculated for the participants, even though there are contradictory findings regarding positive correlation between BMI and PPT (42, 43). Another potential limitation is that healthcare systems and accessibility to healthcare might influence pain sensitivity. In our study, we do not have data either to support or reject this possible limitation. However, regarding cost for treatments, they are similar in the three cultures as oro-facial pain treatment is either free or subsidised. In addition, all three sites were tertiary care centres with a similar accessibility.

Conclusions

In conclusion, this study found cultural differences between groups in the PPT, PPTo and EPTo. Overall, Italian females reported the lowest values of PPT, PPTo and EPTo, while Swedes reported significantly higher PPT and PPTo values in the thenar muscle.

Values of PPT, PPTo and EPTo differed more across cultures than did electrical perception and EPT. Cultural factors may influence response to type of pain test.

Disclosure

No conflict of interests are declared.

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