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ORIGINAL ARTICLE

A high prevalence of TMD is related to somatic awareness and pain intensity among healthy dental students

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ABSTRACT

Objective: Dental students have been identified as a group with high risks of developing both temporomandibular disorders (TMD) and psychosocial conditions. Our primary aim was to evaluate the cross-sectional prevalence of TMD diagnoses, as defined in the Diagnostic Criteria (DC)/TMD, among dental students. The secondary aim was to evaluate the prevalence and association of behavioural and psychosocial factors in relation to DC/TMD diagnoses.

Materials and methods: The study was conducted among undergraduate dental students during the second semester of their third year at the Department of Odontology, Medical Faculty, Umeå University, Sweden. Three consecutive cohorts were recruited during August in 2013, 2014, 2015. In total, 54 students were included and examined according the DC/TMD procedure.

Results and conclusions: The prevalence of any DC/TMD diagnosis was 30%. The most prevalent TMD diagnosis was myalgia. Individuals with a TMD-pain diagnosis (i.e. myalgia or arthralgia) reported significantly higher pain intensity levels according to the Graded Chronic Pain Scale (GCPS) as compared to individuals without TMD-pain (Fisher's exact test $p < .001$, two-sided). In addition, individuals with any TMD scored significantly higher jaw functional limitations according to the Jaw Functional Limitation Scale 20 (JFLS-20, $p < .001$) and oral parafunctions according to the Oral Behavior Checklist (OBC, $p = .005$) as compared to individuals without TMD. The psychosocial factors evaluated did not differ between individual with or without a TMD diagnosis. The majority of the dental students reported symptoms that are already identified as risk factors for developing TMD and pain conditions. However, longitudinal data are needed to evaluate how this evolves over time.

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Introduction

Chronic pain conditions are common in the general population [1]. Examples of pain conditions related to soft tissues such as joints, ligaments and muscles in different body regions are back pain, neck pain and temporomandibular disorders (TMD). TMD is an umbrella term that includes not only pain-related conditions in jaw muscles and in the temporomandibular joint (TMJ), but also functional disturbances of the jaws such as locking and clicking [2]. According to Manfredini and co-workers [3], the prevalence of TMD-pain is about 10% in the adult population and as shown by Lövgren and co-workers [4,5], higher in women than in men. Individuals with TMD also report that their condition negatively affects their daily living [6].

Negative impact on daily living in people with TMD is associated with the presence of condition and symptoms related to psychosocial distress. For example, there are comorbidities between TMD and conditions like irritable bowel syndrome (IBS), fibromyalgia and chronic fatigue syndrome [7] as well as depression [1,8], all with strong psychosocial components. Also, people with TMD report an increased somatic awareness [9], sleep disturbances [10], stress (as an internal response) [8], anxiety [11] and somatization problems [12]. In turn, the experience of chronic pain itself has a clear relationship to psychosocial factors [13], thus adding to a complicated relationship between TMD and psychosocial factors [14].

Based on the abovementioned associations of TMD and psychosocial factors, a biopsychosocial model of pain has been adopted when discussing the etiology of TMD [15]. Even though the aetiology is not ascertained, it is currently considered to be multifactorial and evaluated on the individual level. As a consequence, multimodal treatment strategies should be considered for individuals with TMD and coincident psychosocial distress [16]. The multifactorial aspects of TMD are also reflected in suggested diagnostics systems, in which an evaluation of psychosocial factors is suggested to be a part of TMD examinations.

In 1992, the Research Diagnostic Criteria for TMD (RDC/TMD) was introduced both to provide standardized physical diagnosis as well as an assessment of the psychosocial factors that might affect treatment and prognosis. In RDC/TMD,

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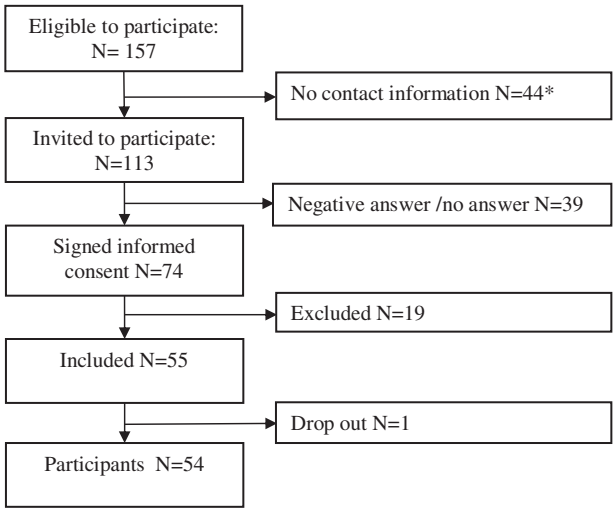

Figure 1. Flowchart of the recruitment process. *Only eligible participants leaving contact information with the recruitment administrators could be invited. This is in accordance with the ethical approval.

this biopsychosocial model of pain was integrated by adopting a two-Axis model [17]. The RDC/TMD Axis I provided a physical assessment by diagnostic criteria, and Axis II, an assessment of psychosocial status and pain-related disability. Since the introduction of RDC/TMD, it has been widely used in both research and clinical settings [3]. In 2014, an extensive evaluation of this diagnostic criteria showed that despite a high reliability of Axis I diagnosis, the validity was below the suggested target [18]. Based on these findings, a revised version of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) was launched in 2014 [18]. The DC/TMD also consists of a two-Axis model where Axis I is comprised of diagnostic criteria based on clinical signs and symptoms for the most common pain-related and intra-articular TMD. The DC/TMD Axis II consists of an assessment of psychosocial and behavioural factors related to TMD based on reliable and valid questionnaires. Therefore, clinicians and researchers are nowadays recommended to use DC/TMD when categorizing TMD subdiagnoses. The prevalence of TMD as defined by the DC/TMD has been studied among adolescents in Norway [19]. However, the prevalence of DC/TMD diagnoses in selected, well-defined, non-patient samples is not yet known.

A well-defined sample is undergraduate students in dentistry, i.e. dental students, since they are primarily between 20 and 30 years old and are included in a context controlled by a curriculum. As academic students in general [20], dental students are at risk of developing symptoms related to psychosocial distress [21]. The cause for this risk was suggested to be related to a complex curriculum with theoretical learning, clinical practice and patient care, in parallel [20]. Therefore, the psychosocial factors and the impact among dental students have been extensively studied over the years, however, strategies aiming for a reduction of stress levels have not been concluded [22]. Since psychosocial factors are associated with TMD in the general population, the same could be expected in a more well-defined sample of dental students.

Previous studies have reported a prevalence of TMD to 30–50% among dental students [23,24], which is considerably higher when compared to the prevalence in the general population (10%). However, TMD prevalence in dental students is primarily based on self-reported symptoms from questionnaires. The prevalence based on clinical examinations according to defined diagnostic criteria and reliable and valid questionnaires are likely to be different when compared to prevalence based on only self-reported symptoms [25].

To more precisely determine the prevalence of TMD and related psychosocial factors in dental students, an evaluation of the prevalence of TMD according to the DC/TMD conditions is warranted. The primary aim of this study was to evaluate the cross-sectional prevalence of TMD diagnoses among dental students as defined in the DC/TMD. The secondary aim was to evaluate the prevalence and association of psychosocial factors in relation to DC/TMD diagnoses.

Materials and methods

Study setting and participants

The study was conducted among undergraduate dental students during the second semester of their third year at the Department of Odontology, Medical Faculty, Umeå University, Sweden. Three consecutive cohorts were recruited during August in 2013, 2014, 2015. In total, 157 dental students (2013 – 55, 2014 – 53, and in 2015 – 49 students) were invited to participate; 54 students were finally included in the study (Figure 1).

Inclusion criteria were age below 45 years, and enrolment in the second semester of the third year at Dentistry program at the time of invitation. Exclusion criteria were any self-reported neurological, inflammatory, autoimmune (including type 1 diabetes), endocrinological, connective, rheumatic, fibromyalgia or cancer diagnosis. Students with self-reported pain in the neck-shoulder region were also excluded if they had pain for more than 3 days the last month and average pain intensity of >2 on a 0–10 graded numerical rating scale [26] during the last week. We also excluded students with pain in neck-shoulder during the last 6 months that influenced daily activities. Students were also excluded if long lasting symptoms related to severe trauma to the head, shoulder or neck were present.

Clinical examination procedure

Data collection was conducted between 24th August and 27th January during 2013, 2014, 2015. All included individuals were examined according the DC/TMD procedure. A DC/TMD diagnosis is based on self-reported pain or functional disturbances during the last 30 days from the DC/TMD Symptom Questionnaire and a clinical examination [18]. To qualify for a DC/TMD diagnosis, the self-reported symptoms should be reproducible and verified by the examiner during the clinical examination. To meet the criteria for a DC/TMD-pain diagnosis, it was required that the pain provoked during the clinical examinations was also familiar to the individuals' major complaint. The DC/TMD diagnoses are then established by following the DC/TMD decision tree, which takes into

account both the Symptom Questionnaire and the clinical examination. The possible DC/TMD diagnoses derived from the DC/TMD diagnostic decision tree [18] were pain-related TMD and headache, and intraarticular joint disorders and degenerative joint disorders. One individual may qualify for several diagnoses.

The pain-related TMD included myalgia, arthralgia or headache attributed to TMD. For subgroups of myalgia, we used local myalgia and myofascial pain with referral. Headache attributed to TMD could only be established when the individual already fulfilled the criteria for any of the pain-related TMD. Furthermore, the intra-articular joint disorders included disc displacement with reduction, disc displacement with reduction with intermittent locking, disc displacement without reduction without limited opening, disc displacement without reduction with limited opening and degenerative joint disease.

Calibration of clinical examiners

The clinical examinations were performed by one of four well-trained and calibrated examiners working at the Department of Odontology, Faculty of Medicine, Umeå University (authors AL, CÖ, AI or EL). Prior to data collection, all four examiners were calibrated and tested for their diagnostic reliability by the DC/TMD Training and Calibration Center in Malmö, Sweden in accordance with accepted standards [27]. After completing the examinations, all examiners independently diagnosed all individuals using the DC/TMD decision tree. The inter-examiner reliability for the Axis I diagnoses individually arrived at for each student was calculated. For students where the initial diagnoses did not correspond between all examiners, a consensus discussion took place. The frequencies of diagnoses, as well as statistical calculations of associations, were based on the results from these discussions.

Assessment of psychosocial factors

Psychosocial factors were evaluated using the Axis II questionnaire, and in the analyses of the relation to DC/TMD diagnoses validated cut-offs were used when provided, i.e. for the Graded Chronic Pain Scale (GCPS), 0–IV [28], Patient Health Questionnaire (PHQ-9), 0–4 [29], Generalized Anxiety Disorders Assessment (GAD 7), 0–3 [30,31], physical symptoms (PHQ-15), 0–3 [32,33], Perceived Stress Scale (PSS 10), 0–2 [34], and the Pain Catastrophizing Scale (PCS), 0–1 [35]. The Jaw Functional Limitation Scale 20 (JFLS-20) [36] was dichotomized into any item $\geq$5 set to one (1) and the remaining set to zero (0). The Oral Behavior Checklist (OBC) was dichotomized into sum score $>$16 set to one (1) and the remaining set to zero (0) [37,38]. Pain drawings were categorized as no pain, local pain (i.e. pain located to the jaw, face or head), regional pain (i.e. local pain and pain in the neck/shoulders area), or widespread pain (i.e. local pain and pain at any site in the rest of the body) (modified from Suvinen and co-workers [39] and Koutris and co-workers [40]).

Statistical methods

Descriptive statistics (median and range where appropriate) were used to characterize the study sample. The inter-examiner reliability on a diagnostic level of DC/TMD Axis I diagnoses, based on the questionnaire and clinical examinations, was assessed and calculated with Cronbach's alpha. Inter-examiner reliability above 0.7 was considered 'good' [41].

In the analysis, all three cohorts were merged to represent baseline data. The sample was categorized as no TMD, pain-related TMD and any TMD. Pain-related TMD was defined by either qualifying for myalgia (local myalgia or myofascial pain with referral) or arthralgia, whilst any TMD was defined by any TMD diagnosis according to the DC/TMD. The arthralgia diagnoses are presented per side, whilst the intra-articular DC/TMD diagnoses are presented per individual.

Due to the ordinal character of the data, non-parametrical methods were used. For the comparison between groups, the Fisher's exact test was used. A p value $<$.05 was considered statistically significant. The data were analysed with SPSS (IBM SPSS Statistics for Macintosh, Version 24.002, IBM Corp., Armonk, NY).

Results

The study population consisted of 20 men (37%) and 34 women (63%). The median age was 24 years.

The inter-rater reliabilities for the individual diagnoses ranged from 0.82 to 1.0, and there was no significant difference between the different diagnoses (Table 1).

The prevalence of any TMD diagnosis, according to DC/TMD, was 30% (Table 2) with myalgia as the most frequent diagnosis. Individuals with a TMD-pain diagnosis reported significantly higher classification according to the GCPS, as compared to individuals without TMD-pain (p = .001, two-sided) (Table 3). The majority of the individuals who reported any pain according to the GCPS, without qualifying for a TMD-pain diagnosis, instead reported pain in their pain drawing (p < .001, two-sided). In total, 34 individuals (65%) reported local, regional or widespread pain (Table 4).

There were no significant differences between individuals with any TMD as compared to no TMD with regard to severity of depression (PHQ-9, p = .478, two-sided), anxiety (GAD-7, p = .342, two-sided), stress (PSS, p = .054, two-sided) or pain catastrophizing (PCS, p = .308, two-sided) (Table 5). Among individuals with any TMD, there was a significant difference in somatic awareness (PHQ-15, p = .029, two-sided). In addition, individuals with any TMD scored significantly higher jaw functional limitations (JFLS-20, p < .001, two-sided) and oral parafunctions (OBC, p = .005, two-sided), as compared to individuals without TMD.

Discussion

In this selected sample of dental students, the prevalence of TMD was 30%. Among the psychosocial factors reported in DC/TMD Axis II only somatic awareness and pain intensity were significantly related to a concurrent DC/TMD diagnosis.

Table 1. Inter-rater reliability (IRR) between four calibrated examiners (Cronbach's alpha) for measures on diagnostics according to the DC/TMD criteria.

Diagnosis	IRR (95% confidence interval)
Myalgia	0.94 (0.91–0.96)
Myofascial pain with referral	1.0
Headache attributed to TMD	0.91 (0.87–0.95)
Arthralgia right	0.93 (0.89–0.95)
Arthralgia left	0.90 (0.85–0.94)
Disc displacement with reduction	0.82 (0.73–0.89)
Degenerative joint disease	NA[a]
Disc displacement with reduction with intermittent locking	NA
Disc displacement without reduction without limited opening	0.85 (0.77–0.90)
Disc displacement without reduction with limited opening	NA

[a]Not included since the scale had no (zero) variance items.

Table 2. DC/TMD diagnoses in the study sample ($n = 54$).

Diagnosis	*N* (%)
Myalgia	15 (27.8)
Myofascial pain with referral	2 (3.7)
Arthralgia right	4 (7.4)
Arthralgia left	4 (7.4)
Pain-related TMD (myalgia or arthralgia)	15
Headache attributed to TMD	8 (14.8)
Disc displacement with reduction	3 (5.6)
Degenerative joint disease	0
Disc displacement with reduction with intermittent locking	0
Disc displacement without reduction without limited opening	3 (5.6)
Disc displacement without reduction with limited opening	0
Any TMD diagnosis	16 (29.6)
No TMD diagnosis	38 (70.4)

Myofacial pain with referral was used as a subdiagnosis to myalgia and headache attributed to TMD as a subdiagnosis to pain-related TMD. Individuals could qualify for multiple diagnosis and thus be represented in more than one of the different diagnoses.

In addition, individuals with TMD reported significantly higher functional limitations and oral parafunctions.

In this cross-sectional study of prevalence of TMD in dental students, we used the DC/TMD to determine the prevalence of TMD diagnoses. Any diagnostic system has its pros and cons but the fundamentals of any diagnostic test are based on accuracy and reproducibility. DC/TMD is a reliable and valid system for the most common TMD-pain diagnoses, as well as for one intra-articular diagnosis (i.e. disc displacement without reduction with limited opening) [18].

To the best of our knowledge, this is the first study using the DC/TMD to evaluate the prevalence of TMD among dental students. The prevalence of a condition is highly dependent on the criteria used, its frequency, and its duration. Our result on the prevalence of TMD (30%) is considerably higher when compared to population based samples over the same age periods [3,4]. However, this is in line with previous findings of prevalence based on self-reported symptoms [23] or on the Research Diagnostic Criteria for TMD (RDC/TMD) [17,42,43]. In comparing self-reported symptoms with clinical diagnoses, self-report has been suggested to be the criterion standard for assessment of pain [44]. For this reason, self-reported assessment of pain within the last 30 days is also included in a DC/TMD diagnosis. However, a slightly lower prevalence of clinical diagnoses, as compared to self-reported symptoms, is reasonable to expect due to that different

Table 3. The Graded Chronic Pain Scale (GCPS) in relation to TMD-pain diagnosis ($N = 53$).

	TMD-pain	No TMD-pain	Fisher's exact test[a]
GCPS 0	0	21	$p < .001$
GCPS I	13	17	
GCPS II	2	0	
GCPS III	0	0	
GCPS IV	0	0	
Total	15	38	

[a]Individuals with a DC/TMD-pain diagnosis scored significantly higher pain intensity levels according to the GCPS.

Table 4. The GCPS in relation to individuals' pain drawings ($N = 52$).

	No pain	Local pain	Regional pain	Widespread pain	Fisher's exact test[a]
GCPS 0	16	4	0	0	$p < .001$
GCPS $\geq$1	2	14	7	9	

Pain drawings were categorized as no pain, local pain (i.e. pain located to the jaw, face or head), regional pain (i.e. local pain and pain in the neck/ shoulders area), or widespread pain (i.e. local pain and pain at any site in the rest of the body).
[a]Individuals with self-reported pain in their pain drawings reported significantly higher pain intensity levels according to the GCPS.

criteria have to be fulfilled in order to qualify for an actual diagnosis.

An additional factor that could possibly influence the prevalence is the compliance of the students to the diagnostic procedure. The dental students examined were themselves well trained and educated in the DC/TMD method. Therefore, it could be assumed that our participants interpreted the diagnostic procedure as it was intended, and in doing so generated accurate prevalence numbers. As expected, TMD-pain was most frequent among the TMD diagnoses, and among TMD-pain myalgia without concurrent arthralgia was rare [25]. In contrast to what we expected, we found a small number of disc displacements diagnoses, whereas these diagnoses in general, and disc displacement with reduction explicitly, are common in the general population [3]. One possible reason could be related to the reported lower sensitivity of the DC/TMD for the diagnostics of intra-articular joint disorders. Taken together, our results indicate that the DC/TMD Axis I is an appropriate method also for a selected population.

The revision of RDC/TMD leading to the DC/TMD Axis II was primarily focused on an increased scope and improved clinical efficiency [18]. The revised version also incorporated assessment of the core set of outcome domains for the efficacy and effectiveness of treatment for chronic pain as recommended by the 'Initiative on Methods, Measurement, and Pain Assessment in Clinic Trials (IMMPACT)' [45]. The psychosocial aspects involved in TMD are probably at least as important for treatment outcome as pain intensity and actual physical diagnoses [14].

The GCPS is considered a reliable and valid method to measure pain intensity (characteristic pain intensity [CPI]) and consequences of pain (and pain-related disability items [DI]) during the last month [28]. The majority of students fulfilling the criteria for a TMD-pain diagnosis simultaneously reported a low pain intensity without interference in their daily living (GCPS grade I or II) while no individuals reported any pain-related disabilities (GCPS grade III or IV). Therefore, we interpreted the outcomes from the GCPS in this sample as a

Table 5. Psychosocial factors in relation to any DC/TMD diagnosis ($N = 53$, $^*N = 52$ due to missing data).

Questionnaire data		Any TMD (%)	No TMD (%)	Fisher's exact test (p value)
Severity of depression (PHQ-9)	≥1	5 (9.6)	7 (13.5)	.478
sum score 0–4*	0	11 (21.2)	29 (55.8)	
Anxiety (GAD-7)	≥1	6 (11.3)	9 (17.0)	.342
sum score 0–3	0	10 (18.9)	28 (52.8)	
Stress (PSS)	≥1	8 (15.1)	8 (15.1)	.054
sum score 0–2*	0	8 (15.1)	29 (54.7)	
Catastrophizing (PCS)	1	1 (1.9)	0	.308
sum score 0–1	0	15 (28.8)	36 (69.2)	
Somatic awareness (PHQ-15)	≥1	10 (18.9)	10 (18.9)	**.029**
sum score 0–3	0	6 (11.3)	27 (50.9)	
Jaw Functional Limitation Scale-20 (JFLS-20)	1	7 (13.2)	1 (1.9)	**<.001**
Any item ≥5 = 1	0	9 (17.0)	36 (67.9)	
Oral Behavior Checklist (OBC)	1	16 (30.2)	23 (43.4)	**.005**
sum score >16 = 1	0	0	14 (26.4)	

Sum scores categorized as:
PHQ-9: 0 = no, 1 = mild, 2 = moderate, 3 = moderately severe and 4 = severe depression, respectively.
GAD-7: 0 = no, 1 = mild, 2 = moderate and 3 = severe anxiety, respectively.
PSS: 0 = low, 1 = moderate and 2 = high perceived stress, respectively.
PCS: 0 = normal and 1 = clinically relevant catastrophizing.
PHQ-15: 0 = no, 1 = low, 2 = medium and 3 = high physical symptoms, respectively.
Bold indicates significant values.

measure of pain intensity. As an observation, 17 individuals without TMD-pain still reported a local, regional or widespread pain pattern, and approximately two out of three individuals reported any pain within the last month. In addition, one-third also reported regional or widespread pain. In a recent publication, Suvinen and co-workers [39] found that patients with TMD-pain according to RDC/TMD, and with a concomitant widespread pain according to a pain drawing, reported higher levels of depression and somatization as well as lower levels of general health as compared to patients with localized pain.

It was also suggested by Koutris and co-workers [40] that according to patients' pain drawings, regional pain and widespread pain along with somatization and depression are comorbid factors to TMD-pain. Therefore, pain drawings can be a useful complementary tool for biopsychosocial assessment and treatment planning for individuals with TMD-pain. When considering pain as a risk factor for additional pain sites, and where the number of additional pain sites increases the risk of another pain disorders as well as chronic pain, it could be suggested that dental students are at risk of developing TMD and perhaps also psychosocial comorbidities. However, the predictive value of number of additional pain sites on psychological comorbidities remains to be investigated in longitudinal studies.

In pain management, early interventions were suggested to be important to prevent chronicity [46]. In addition, a study by Gatchel and co-workers [47] showed that early intervention significantly lowered the prevalence of chronic pain and emotional distress in patients at high risk. Even though stress, severity of depression and anxiety was not significantly associated with a TMD diagnosis, approximately 20–30% of the dental students reported such symptoms. Given the fact that academic students are at risk of developing TMD and psychological conditions [22,23], our results reinforce the importance of early interventions not only in patients with pain but also among dental students. On the other hand, and based on dental students' knowledge of TMD, when compared to the general patient these students are already at better chances of an early identification which may improve their prognosis.

In a large prospective cohort study, somatic awareness was identified as a risk factor for developing first-onset TMD [9]. In our study, somatic awareness was significantly associated with a TMD diagnosis. Furthermore, when regarding the functional limitations reported in our study, the results show higher self-reported functional limitations among the dental students with DC/TMD diagnosis as compared with students without DC/TMD diagnosis. JFLS-20 is an instrument for assessing functional status in terms of mastication, vertical jaw mobility, verbal and motional expression and diverse oral functions of the jaw system [36]. In turn, this may have implications on basal jaw functions such as eating, yawning and communication that contribute to the individual's perception of their general health status.

The OBC is an instrument for assessing oral activities (e.g. clenching and other oral parafunctions) during sleep or waking hours [48]. Our dental students with DC/TMD diagnosis reported higher parafunctions as compared to the students without DC/TMD diagnosis. In a biopsychosocial framework, bruxism activities may be a likely trigger onset of TMD-pain at an individual level together with psychosocial factors [49]. It may therefore be of importance for dental students to be aware of self-reported bruxism.

Taken together, with regard to the assessment of axis II findings, our results are in line with expected associations between physical diagnoses and behavioural and psychosocial factors.

Strengths and limitations

We used a valid and reliable examination procedure for our assessment of TMD and associated psychosocial impairments. In addition, all examiners were calibrated according to accepted standards. The prevalence of TMD was evaluated in a small, healthy, specific sample with well described inclusion and exclusion criteria. However, on the contrary selection bias may influence the results since individuals were invited on voluntary basis and nothing is known about

non-responders. Taken together, these factors are regarded as limitations of this study. With regard to the study setting, the dental curriculum may vary between different universities, therefore, we regard our findings representative for those settings that are similar to ours.

Conclusions

The results indicate that the DC/TMD Axis I and II are an appropriate diagnostic method also for a selected population. The majority of our dental students reported symptoms that are already identified as risk factors for developing TMD and pain conditions. However, longitudinal data are needed to evaluate how this evolves over time.

Acknowledgements

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Disclosure statement

The authors declare no conflicts of interests.

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