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Incidence and prevalence of temporomandibular joint pain and dysfunction. A one-year prospective study of university students

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Abstract

Objective. The aims of this study were to investigate the incidence and recovery of temporomandibular joint (TMJ) pain and dysfunction during a 1-year period, and to examine factors associated with TMJ signs and symptoms. ***Material and Methods.*** The study population comprised 371 dental students examined at the start of education, out of which 308 were re-examined after 1 year. Case histories were collected with the aid of a questionnaire. The clinical examination involved TMJ mobility, TMJ pain, TMJ sounds, morphological and functional dental occlusion. ***Results.*** The 1-year incidence of TMJ signs and/or symptoms was 12%, with no statistically significant difference between men and women. Reported TMJ sounds (10%) and clinically registered TMJ pain (8%) reached the highest incidence rates. Approximately a quarter of those who had TMJ signs and/or symptoms at baseline had recovered at follow-up. Subjects with a non-symptomatic TMJ were significantly more often found among men and among those with bilateral contacts in centric relation, a normal transverse inter-maxillary relationship, and a stabile mandibular position in centric occlusion. ***Conclusion.*** The 1-year incidence of TMJ pain and/or dysfunction was high among 1st-year university students. The persistence of signs and symptoms during the observation period was related to gender, while incidence and disappearance of symptoms were not. Dental occlusion was not rejected as a possible concurrent factor in relation to TMJ pain and/or dysfunction among university students.

Key Words: *Dental occlusion, longitudinal study, mandibular instability, pain, temporomandibular disorders*

Introduction

Pain and dysfunction related to musculoskeletal disorders are common and constitute a significant health problem in society. Costs in connection with rehabilitation, sick leave, and early retirement, often due to such disorders, are high and consistently increasing. The jaw system, a complex part of the motor system, is often affected by pain and dysfunction related to musculoskeletal disorders/ temporomandibular disorders (TMD). Despite the large number of studies dealing with pain and dysfunction in this region, very little has been published on risk assessment. One reason could be that only a limited number of longitudinal studies have been conducted and very few of these have focused on incidence [1].

Longitudinal population-based studies have found substantial fluctuations in signs and symptoms of TMD [2–6]. The course of symptoms of TMD has been shown to differ between men and women [7]. Possible gender-related differences in incidence as well as in recovery may partly explain the female dominance of utilization of health care related to TMD [7,8]. In a systematic review, depression, number of pre-existing pain conditions, and factors associated with female gender were identified as possible risk factors for development of TMD pain [9]. Persistent oro-facial pain conditions have been associated with female gender, increased age, psychological distress, widespread pain, and ongoing medication [10]. There is no consensus regarding dental occlusion and the development of TMD [11,12]. A reduced incidence of TMD was found in subjects who underwent occlusal adjustments repeatedly compared to controls [13]. In a randomized control trial, women with an earlier history of TMD were found to be more vulnerable to changes in the occlusion than healthy women [14]. In a long-term prospective study, the presence of temporomandibular joint (TMJ) clicking and patterns of parafunctions at baseline was a predictor of TMD 20 years later [15].

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The first aim of this study was to examine incidence, prevalence, and disappearance of signs and symptoms of TMJ pain and dysfunction among university students during their first year of education. The second aim was to analyze whether gender, bruxism, and dental occlusion were related to being healthy in the TMJ or having TMJ pain and/or dysfunction during the 1-year period. The hypotheses were that: (a) the 1-year incidence of TMJ pain and dysfunction was higher than the disappearance leading to increased prevalence, (b) the 1-year period prevalence and course of TMJ pain and dysfunction was related to gender, (c) the 1-year period prevalence of TMJ pain and dysfunction would not show a dependence on dental occlusion.

Material and methods

Study population

During the period 1998 to 2005, all students who attended the dentistry program at Umeå University were invited to participate in a prospective study concerning the risk of developing pain and/or dysfunction in the jaw-face, head-neck system. The examination was done at the beginning of the student's first semester. All except one student gave their informed consent. In total, 371 individuals agreed to participate. Mean age was 23 years; SD 4.9 (18–48 years). At the 1-year follow-up, 308 individuals (114 M and 194 F) were re-examined. The 63 subjects who dropped out between the 1st and 2nd examinations had all interrupted their studies. The drop-outs did not show any crucial differences from the remaining individuals at the baseline examination. A total of 98% of the study population was Caucasian. The study was approved by the Ethics Committee of Umeå University.

Case history

Case histories were collected using a questionnaire filled out before the clinical examination. The questions on TMJ symptoms addressed presence, location, and frequency of clicking sounds, locking, pain, and difficulties in opening the mouth wide. Frequency was marked on 5-grade scales for each symptom: never, occasionally, once or twice a week, several times a week, daily. Subjects determined their perception of tooth contact pattern at jaw closing on the basis of four statements: teeth contact equally on both sides; teeth contact more distinct on the right-hand side; teeth contact more distinct on the left-hand side; and teeth contact more distinct on the front teeth. The questionnaire also addressed awareness (Yes/No) of tooth-grinding, tooth-clenching, cheek and/or tongue-biting, and frequent use of chewing gum.

Clinical examination

The clinical examinations were performed by two experienced specialists in Clinical Oral Physiology (the authors). At follow-up, each subject was examined by the same examiner as at baseline, and according to the same standardized protocol. The examiners were blinded to the results of the questionnaire. The subjects were in the supine position during the examination. The following variables were registered:

Number of teeth

Morphologic occlusion. (a) The type of occlusion in the anterior posterior direction (angle classification) was judged at the canines and the molars on both sides, with due attention given to the effect of tooth migration, if any. If the molar occlusion deviated from normal/neutral occlusion distally by more than half a cusp width, it was classified as dist-occlusion. If the molar occlusion deviated from normal/neutral occlusion mesially by more than half a cusp width, it was classified as mesio-occlusion. (b) Crossbite was registered in the canine-premolar and molar segments if the buccal cusps of the upper teeth occluded lingually of the buccal cusps of the lower teeth. (c) Scissors bite was registered in the canine-premolar and molar segments if the lingual cusps of the upper teeth occluded buccally of the buccal cusps of the lower teeth. (d) Frontal open bite was registered if overbite was ≤ 0 mm and no contacts were present between upper and lower incisors. (e) Edge-to-edge bite was registered if overbite was $=0$ mm and contacts were present between upper and lower incisors. (f) Deep bite was registered if the overbite was 5 mm or more. Overjet and overbite were measured to the nearest millimeter with a ruler in centric occlusion.

Functional occlusion. (a) Contact pattern in centric relation. The side of the first contact on guided hinge closure was registered. (b) The horizontal, vertical, and lateral distances between centric relation and centric occlusion were measured to the nearest 0.5 mm. (c) Mandibular stability in centric occlusion was measured in the molar segments with the aid of Bausch's occlusion foil (0.008 mm). If the molar teeth could keep a firm grip on the foil during moderate clenching, the occlusion was considered stable bilaterally. If the molar teeth on one side or bilaterally could not keep a firm grip on the foil or could only do so during hard clenching, the mandible was considered unstable in centric occlusion (mandibular instability). (d) Mediotrusive side interferences. Single contact between the maxillary and mandibular teeth on the mediotrusive side inhibiting contacts on the laterotrusive side registered at 3 and 9 mm lateral excursion on the left and right side, respectively.

Temporomandibular joint

(a) *TMJ clicking sounds*. Auscultation and palpation of the presence of reproducible TMJ clicking sounds on opening and closing movements of the jaw without the use of a stethoscope. (b) *TMJ locking*. Locking of one or both TMJs was registered if jaw opening was less than 25 mm or if a deviation of 5 mm or more occurred when opening wide. (c) *TMJ tenderness*. The TMJ was palpated laterally and posteriorly through the auditory meatus. Tenderness was registered when the palpation elicited a palpebral reflex in the eye or a protective reflex. (d) *TMJ pain during movements*. Pain on free movements (opening wide, laterotrusion, protrusion) was registered. (e) *TMJ pain on joint loading*. Each subject was asked to bite hard for 30 s on a double wooden spatula (2 mm) placed in the region of the 1st molars on the right side, with the procedure repeated on the left side. Elicited pain in the contralateral joint was registered as TMJ pain on joint loading.

Those who presented TMJ tenderness to posterior palpation, or had TMJ pain during movements, or elicited TMJ pain on joint loading, were classified as showing clinical signs of TMJ pain.

Classification was also made in accordance with the Research Diagnostic Criteria for TMD (RDC/TMD) [16] Arthralgia (axis 1 IIIa).

Each TMJ symptom (clicking, pain, locking) was dichotomized into frequently occurring symptoms (once a week or more) and not frequently occurring symptoms (never or occasionally). A variable was constructed based on the cumulative prevalence of TMJ pain and/or dysfunction during 1 year (1-year TMJ pain and/or dysfunction). Those who during the study period neither had signs nor reported symptoms related to the TMJ constituted a "normal TMJ" group ($n=191$). The "dysfunctional TMJ" group ($n=117$) was constituted of the cumulative presence of frequent TMJ symptoms and/or TMJ signs at baseline and follow-up.

Statistical methods

Associations between data on the nominal level were examined using the chi-squared test. Changes in distribution for dichotomized variables between the two examinations were calculated using McNemar's test and for ordinal variables the Marginal homogeneity test. Associations between gender, dental occlusion, and 1-year TMJ pain and dysfunction were assessed by odds ratios (OR) in unconditional logistic regression models. A p-value <0.05 was considered statistically significant.

Results

Occlusion

The mean number of teeth was 28.7 (SD 1.9) at baseline and 28.8 (SD 1.9) at follow-up. Almost 90% of the sample had a normal inter-maxillary sagittal relationship (Table I). Unilateral contact in centric relation was commonly registered and increased significantly between the two examinations ($p<0.001$). Mandibular instability in centric occlusion was registered in 11% at baseline and among 15% of the study population at the follow-up, with no statistically significant difference between the registrations. Approximately one-third had mediotrusive side interferences during lateral excursions. The presence of mediotrusive side interferences at 9 mm lateral excursion increased significantly ($p=0.015$) between baseline and follow-up.

Table I. Percentage distribution of dental occlusion at baseline and at the 1-year follow-up among 308 university students

		Baseline (%)	Re-exam (%)	p-value
Morphologic occlusion	Neutro-occlusion	88	87	
	Dist-occlusion	10	8	ns
	Mesio-occlusion	2	3	
	Normal overbite	75	77	
	Open bite	7	7	
	Edge-to-edge	4	3	ns
	Deep bite	14	13	
	Normal bite	90	89	
	Cross-bite unilateral	7	8	
	Cross-bite bilateral	2	3	ns
	Scissors bite	0	0	
	Any divergence from normal occlusion	35	36	ns
Overjet	$\geq$5 mm	12	10	ns
Centric occlusion	Mandibular instability	11	15	ns
Centric relation	Unilateral contact	62	74	<0.001
Slide in centric	Lateral slide $\geq$1 mm	8	5	ns
Eccentric occlusion	Mediotrusive side interferences at 3 mm	9	12	ns
	Mediotrusive side interferences at 9 mm	29	35	0.015
	Any mediotrusive side interference present	32	35	ns

ns = non-significant.

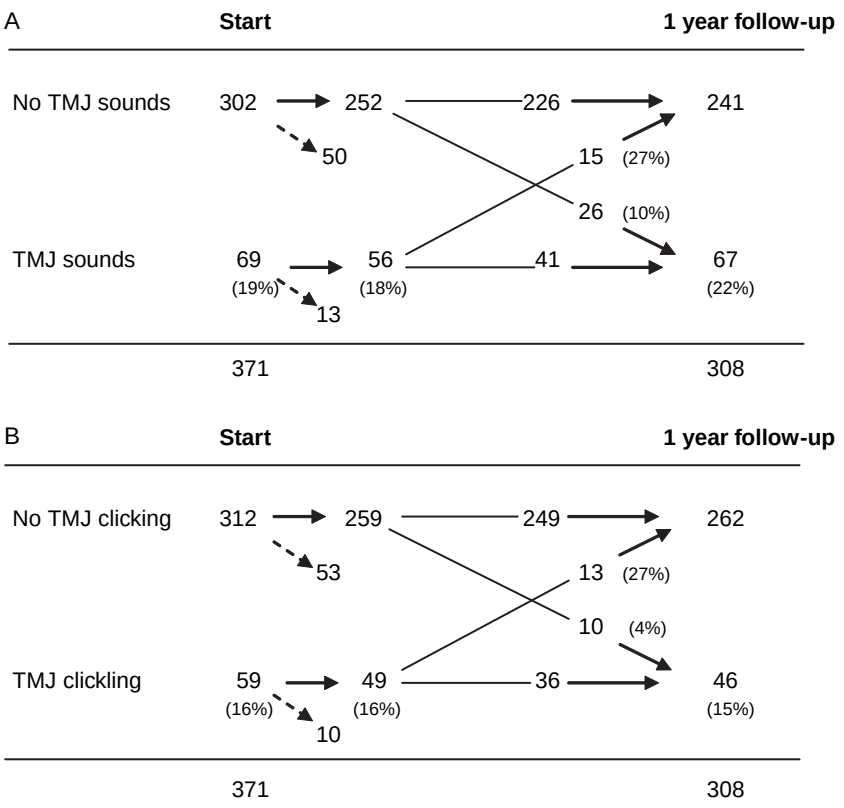

Figure 1. Prevalence, one-year incidence, and longitudinal course of (A) reported and (B) registered temporomandibular joint sounds among 1st-year dental students. Broken arrows indicate drop-outs.

One-year course of temporomandibular joint symptoms and signs

The prevalence, 1-year incidence, and disappearance of reported and registered TMJ clicking sounds are presented in Figure 1. There was a highly statistically significant relationship ($p < 0.001$) between reported and registered TMJ clicking at both examinations. The incidence of reported TMJ clicking sounds was 10%. Twenty-seven percent of those with TMJ clicking sounds at baseline did not have these symptoms at follow-up. The incidence of clinically registered TMJ clicking sounds was 4%. Clicking disappeared in the case of 27% of those with registered TMJ clicking at baseline (Figure 1). The risk of developing TMJ sounds (reported) was significantly increased with the presence of registered TMJ sounds (OR 17.0; 95% CI 5.9-49.1) at baseline.

Prevalence, 1-year incidence, and disappearance of reported and registered TMJ pain are presented in Figure 2. There was a highly statistically significant relationship between reported TMJ pain and clinical signs of TMJ pain ($p = 0.002$) at baseline and at follow-up ($p < 0.001$). The incidence of reported TMJ pain was 4%. Forty-two percent of those with TMJ pain at baseline did not have these symptoms at follow-up. The incidence of clinically registered signs of TMJ pain was 8%. Signs of TMJ pain disappeared among 48% between baseline and follow-up. The risk of developing TMJ pain (reported) was significantly increased with presence of reported TMJ sounds (OR 6.9; 95% CI 2.0–23.8), clinically registered TMJ sounds (OR 11.7; 95% CI 3.3–42.0) and clinically registered TMJ pain (OR 6.3; 95% CI 1.5–26.1) at baseline. The risk of developing TMJ pain (clinically registered) was significantly increased with presence of reported TMJ sounds (OR 3.6; 95% CI 1.4–9.2) at baseline.

Frequent locking was rarely reported at baseline (1%) and at follow-up (0.6%). A similar pattern was found for frequent occurrence of difficulties in closing the jaw (1% and 0.6%, respectively). Difficulties in opening the jaw wide were reported by 2% at baseline and by 3% at follow-up. The mean maximal opening capacity of the total sample at baseline was 55.3 mm (SD 6.1, range 41–77 mm) and at follow-up 54.6 mm (SD 6.0, range 39–79 mm).

During the 1-year study period, 62% did not report symptoms nor did they have any clinical signs of TMJ pain and/or dysfunction. The incidence of TMJ signs and/or symptoms was 12% and 26% recovered (Figure 3). Women were significantly more likely to have signs and/or symptoms at both examinations (persistent) compared to men (Table II). Incidence and recovery were not significantly related to gender.

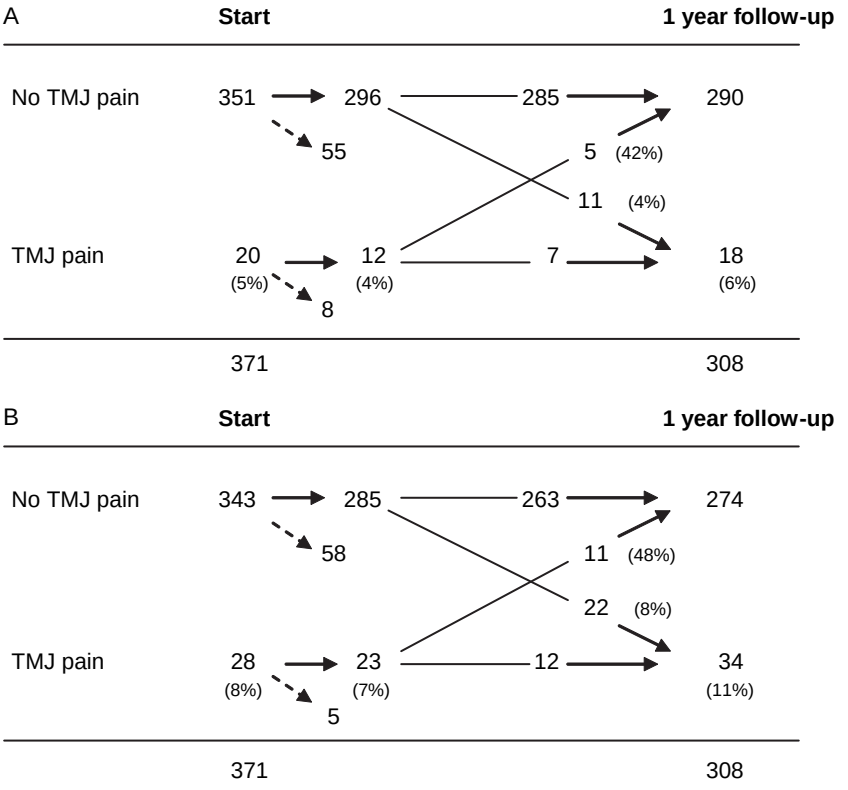

Figure 2. Prevalence, one-year incidence, and longitudinal course of (A) reported frequent temporomandibular joint pain and (B) clinical signs of TMJ pain among 1st-year dental students. Broken arrows indicate drop-outs.

Factors associated with the one-year cumulative prevalence of TMJ pain and dysfunction

The outcome of the analyses is presented in Table III. Female gender was associated with a 2-fold risk of having TMJ pain and/or dysfunction during the study period (OR 2.0; 95% CI 1.2–3.4). Those who were aware of tooth-clenching and/or grinding (bruxism) were more likely to have TMJ pain and/or dysfunction (OR 1.6; 95% CI 1.1–2.6). Crossbite was the only deviation from normal occlusal morphology with a statistically significant co-morbidity to TMJ pain and/or dysfunction (OR 2.9 95% CI 1.3–6.5). A unilateral contact pattern in centric relation was significantly related to TMJ pain and/or dysfunction (OR 2.0; 95% CI 1.2–3.3), while a lateral slide in centric of 1 mm or more, or the presence of mediotrusive side interferences, was not. The factor in dental occlusion that showed the highest odds ratio in regard to the 1-year period prevalence of TMJ pain and dysfunction was presence of mandibular instability (OR 3.5; 95% CI 1.6–7.3).

Discussion

The study demonstrates that the 1-year incidence of TMJ pain and/or dysfunction is high and confirms a fluctuating pattern of this disorder. Females were twice as likely as men to have TMJ pain and/or dysfunction during the 1-year period studied. The

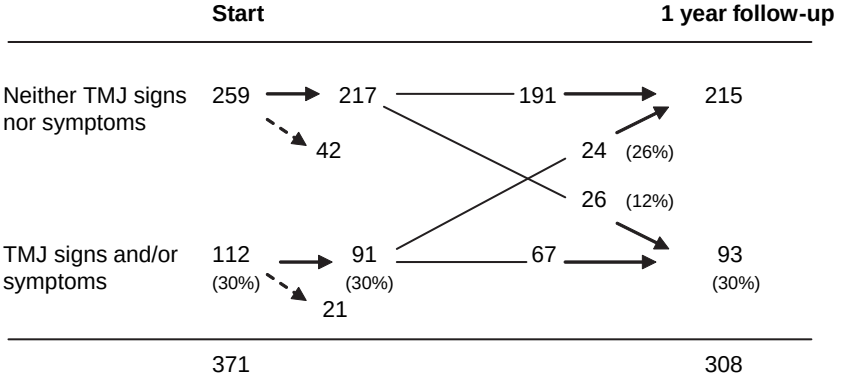

Figure 3. Prevalence, one-year incidence, and longitudinal course of temporomandibular joint signs and/or symptoms among 1st-year dental students. Broken arrows indicate drop-outs.

Table II. Distribution of the natural course of TMJ pain and/or dysfunction during a 1-year period among men and women

	No TMJ signs or symptoms	Incidence	Disappearance	Persistence	
	n (%)	*n* (%)	*n* (%)	*n* (%)	*P*-value
Men ($n=112$)	81 (72)	9 (8)	7 (6)	15 (13)	
Women ($n=196$)	110 (56)	17 (9)	17 (9)	52 (27)	0.026*
Total ($n=308$)	191 (62)	26 (8)	24 (8)	67 (22)	

*Chi-square test.

Table III. Logistic regression analysis of baseline factors as independent variables and presence of 1-year TMJ pain and/or dysfunction as dependent variable. Percentage distribution, odds ratio (OR), and 95% confidence interval

Baseline factors		Total N in group	% 1-year TMJ pain and/or dysfunction	OR (95% CI)
Age	≤21 years	173	38.2	1.0
	>21 years	135	37.8	1.0 (0.6–1.6)
Gender	M	112	27.7	1.0
	F	196	43.9	2.0 (1.2–3.4)
Bruxism	No	158	32.3	1.0
	Yes	150	44.0	1.6 (1.04–2.6)
Morphological occlusion				
Normal occlusion		199	33.7	1.0
Any deviation		109	45.9	1.7 (1.04–2.7)
Sagittal occlusion				
Neutro-occlusion		270	37.8	1.0
Mesio-occlusion		7	42.9	1.2 (0.3–5.6)
Dist-occlusion		31	38.7	1.0 (0.5–2.2)
Vertical occlusion				
Normal		232	35.8	1.0
Open or edge-to edge		32	40.6	1.2 (0.6–2.3)
Deep bite		44	47.7	1.6 (0.9–3.2)
Transversal occlusion				
Normal		277	35.7	1.0
Crossbite		29	62.1	2.9 (1.3–6.5)
Overjet				
<5 mm		271	36.9	1.0
≥5 mm		37	45.9	1.5 (0.7–2.9)
Contact in RP				
Bilateral		117	28.2	1.0
Unilateral		191	44.0	2.0 (1.2–3.3)
Lateral slide in centric				
<1 mm		284	36.6	1.0
≥1 mm		24	54.2	2.0 (0.9–4.7)
Mandibular stability in IP				
Stable		274	34.7	1.0
Instability		34	64.7	3.5 (1.6–7.3)
Perceived occlusal stability				
Equal		223	36.3	1.0
Unequal		85	42.4	1.3 (0.8–2.1)
Mediotrusive side interferences (MI)				
No		209	38.8	1.0
Yes		99	36.4	0.9 (0.6–1.5)
MI at 3 mm lateral excursion				
No		280	38.2	1.0
Yes		28	35.7	0.9 (0.4–2.0)
MI at 9 mm lateral excursion				
No		219	38.4	1.0
Yes		89	37.1	0.9 (0.6–1.6)

presence of crossbite and mandibular instability in centric occlusion was significantly related to the 1-year period prevalence of TMJ signs and symptoms, while presence of mediotrusive side interferences was not.

Longitudinal observation studies are necessary when studying incidence and the natural course of a disorder. Longitudinal designs are also an essential element in the assessment of etiology [1,17]. The study population was chosen to allow for observation of subjects at roughly the same age, with a homogeneous educational level, and with daily social environments as much alike as possible, facing an equivalent work load, i.e. that of being a dental student. In this study we had the opportunity to examine the sample at a standardized time interval, to be cost-effective, and to minimize drop-outs. The participation rate at follow-up was 83% of the basic sample and was considered acceptable. Abstraction or generalization based on observations of a selected sample should be done with ample care. According to Rothman et al. [18], the ability to abstract universal statements from observations is not exclusively related to the sample's representatives of larger populations. Instead, the selection of study samples should ascertain the presence of characteristics that enable competing scientific hypotheses to be distinguished. The study sample in this observational study could be regarded as having been drawn from a population of predominantly healthy, young adults (approximately 90% of the subjects were within 18 to 30 years of age) presenting the aforementioned presence and variability of characteristics studied.

Symptoms were collected using a questionnaire filled out prior to the clinical examination, and those occurring once a week or more often were used as inclusion criteria for reported pain and dysfunction. Setting the time frame for the occurrence of symptoms at once a week or more increases reliability [19] and may also improve clinical significance, since demand for treatment due to pain and dysfunction in the jaw system has been related to symptom frequency [20]. The clinical examination followed a standardized routine protocol using well-known methods in clinical research and was carried out by two experienced examiners. Since the examiners were blinded to the results from the questionnaire before and during the clinical examination we avoided bias from the participants' case histories. In accordance with the recommendations for prospective clinical studies [21] each subject was examined by the same examiner at baseline and at follow-up. Use of the term 'incidence' may be discussed in the context of TMD. Based on knowledge from previous prospective studies of adolescents, it cannot be ruled out that some of the subjects with no symptoms at the start of the study in the past have had symptoms in the TMJ region. In this study, we used the term 'incidence' selectively to describe the onset of TMJ pain and dysfunction following a 1-year period using the start of the study as the zero-time.

In concurrence with many previous observational studies based on non-patient samples, clicking sounds from the TMJ during opening and closing were common [1–5,7]. Few studies are available concerning the 1-year incidence of TMJ sounds, but the results were in line with those reported previously [22,23], thus indicating a high incidence rate of symptomatic disk interference. A fluctuating pattern of both registered and reported sounds was confirmed, but it should also be noted that these dysfunctional signs and symptoms remained at the follow-up among almost three-quarters, in line with previously reports [24,25]. The disappearance of TMJ clicking sounds was not once associated with an impaired jaw opening capacity, supporting previous findings showing a low risk of TMJ locking [25,26]. It cannot be ruled out that the clinical examination may have increased the subjects' awareness of TMJ sounds, since the study showed a significantly higher incidence of reported TMJ sounds among those with clinically registered TMJ sounds at baseline.

The prevalence of pain located in the TMJ region was in line with previous epidemiological studies of adult samples [27,28] and the median value reported in a review of younger samples [29]. The 1-year course indicates the predominantly on/off character of TMJ pain. The study draws attention to TMJ sound as a potential risk indicator for the incidence of TMJ pain compared to those with no TMJ sounds. In some respects this increased risk contradicts the notion that internal derangement is just a variant of normality and should not be given overdue attention in risk assessment [30]. The higher likelihood of discovering subjects with a non-symptomatic TMJ among representatives of the male gender [1,9] was supported in this study.

The distribution and variation of morphological and functional dental occlusal found in this study were in line with previous reports based on Scandinavian populations [31,32]. The significance of dental occlusion as a contributing factor to development of TMDs is questionable and subject to debate [11–14,17,33–35] and during the past decade tuned down [36]. Inconsistent results in regard to comorbidity between factors in the dental occlusion and the presence of TMDs involve several factors. Some of the contradictions are probably related to variability in measurements and sample sizes. Differences and difficulties in defining the disorder in focus may also be part of the contradiction. We used a reasonably homogeneous non-patient sample and prospective design, and deliberately delimited the study to signs and symptoms in the TMJ and to defined aspects of the dental occlusion. The statistical approach was to compare between those with

no signs and symptoms in the TMJ region during a 1-year period and the others.

The presence of mandibular instability in centric occlusion was associated with a tilting of the mandible on harder clenching – confirmed also by the naked eye in this sample. Since we have not found any previous report of similar measurement of mandibular stability we can only conclude that this deviation from optimal occlusion was frequently present and as equally common bilaterally as unilaterally. One previous study has indicated that symmetry of intensity of tooth contacts is more important than symmetry of contact distribution in relation to craniomandibular function [37]. In a study on university students, TMD subjects had greater bilateral asymmetry in number of contacts than did controls [38]. The occlusal contact area was smaller and bite force and chewing efficiency were lower in patients with anterior disk displacement than among controls [39]. These findings may be the outcome of the same basic biomechanical factor (i.e. mandibular instability in centric occlusion), although they were measured differently. The findings indicate that instability in intercuspal position is associated with TMJ pain and dysfunction and warrants further exploration. For many years, mediotrusive side or non-working side interferences/ contacts have been held detrimental to mandibular function, but more recently have been ascribed with a potential protective effect on the TMJ [35]. Neither a detrimental nor a protective effect was supported in our analysis.

In conclusion, the 1-year incidence of TMJ pain and dysfunction was no higher than its disappearance during the observation period. The first hypothesis is accordingly rejected. Females had a higher 1-year period prevalence of TMJ pain and dysfunction and the study showed a higher occurrence of persistent symptoms among females. The onset and recovery of TMJ symptoms was more evenly distributed between the genders. The second hypothesis was thus partly accepted. The presence of crossbite as well as mandibular instability in centric occlusion was associated with an approximately 3-fold higher risk of having TMJ pain and dysfunction during the period studied. The third hypothesis was thus partly rejected.

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