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ORIGINAL ARTICLE

Prevalence of symptoms indicative of temporomandibular disorders in adults: cross-sectional epidemiological investigations covering two decades

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Abstract

Objectives. The aims were (1) to study possible secular trends in the prevalence of temporomandibular disorder (TMD) symptoms in adults and (2) to analyse possible associations between TMD symptoms and background factors. ***Materials and methods.*** The investigation has a repeated cross-sectional design. Three independent, randomly selected samples of ~100 individuals in the age groups of 20, 30, 40, 50, 60 and 70 years, a total of 1704 subjects, participated in the Jönköping studies in 1983, 1993 and 2003. All the subjects were evaluated using a questionnaire and a structured interview relating to the presence of TMD symptoms. Associations between symptoms and the Anamnestic Dysfunction Index (Ai) as dependent variables and each of the independent variables, age group, gender, reported bruxism, trauma (1983), self-perceived health impairment and the year of investigation were analysed in binary logistic regression models.***Results.*** The prevalence of the separate symptoms, apart from for TMJ clicking, did not vary to any statistically significant degree between the different examination years. However, the prevalence of recurrent headache in 20-year-old subjects rose remarkably in 2003 and an increase in the Ai I and Ai II for the whole population was observed during the 20-year period. Reported bruxism, which increased during the study period, and self-perceived health impairment were associated with most of the TMD symptoms and the Ai. ***Conclusions.*** An increase in the prevalence of TMD symptoms expressed as Anamnestic Dysfunction Index I and II has been noted over a 20-year period.

Key Words: *bruxism, headache, secular trends, TMD*

Introduction

In recent decades, temporomandibular disorders (TMD) have been regarded as common pathological conditions and awareness of them has increased among both clinicians and the general population. A large number of mainly cross-sectional epidemiological studies worldwide have been performed and the presented results agree that there is a high prevalence of TMD. However, remarkable disparity in prevalence figures of reported TMD symptoms can be seen in various investigations [1,2], reflecting differences in study populations, definitions, criteria and methodology used. The presence of TMD has previously often been based on the presence of at least one symptom, which has probably contributed to the varying findings, as some symptoms, like TMJ sounds and jaw tiredness, are mild and more common in the population, while others, such as jaw opening limitation or pain in the face, are more severe and much more rarely reported. Whether the diverging prevalence figures have additionally been affected by the different time-points at which the various investigations were performed, and thereby by the different social contexts in the studied populations, is unknown.

The majority of the more recently published population-based surveys have revealed differences in TMD prevalence between different age groups and genders, but the results have not always been consistent. Symptoms have more commonly been reported by younger and middle-aged individuals than by children or elderly persons [3–5]. Some studies have also pointed to a higher prevalence of TMD symptoms among women than men [6–9]. Systemic and local pathophysiological factors, trauma, oral parafunctions, anatomical elements, as well as psychosocial and behavioural components, have been identified and considered as issues connected to the development, elicitation or persistence of TMD [10]. In spite of this,

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controversy remains about the particular aetiological contribution of each of the above-mentioned factors.

During the last few decades, there has been an improvement in oral health when it is measured as an increase in the number of natural teeth and a decrease in edentulousness, as well as the absence of some common pathological dentoalveolar conditions, such as dental caries and periodontal disease. Reports from Scandinavia and other parts of the world support this view [11–13]. An improvement in oral health could be expected to have resulted in an improvement in the function of the stomatognathic system due to improved chewing capacity and occlusal support, as well as a reduction in noxious stimuli from the periphery, for example. By extension, this could potentially have affected the presence of TMD conditions in the population. In a previous study, we found that there were no statistically significant changes in the prevalence of TMD symptoms in children and adolescents over a 20-year period [14]. There is, however, a lack of information regarding potential secular changes in TMD prevalence in adults and this is a reason for conducting the present investigation. The research hypothesis was that the prevalence of TMD symptoms in adults has not changed during a period of 20 years. The specific aim of this study was to evaluate the prevalence figures of symptoms indicative of TMD in three independent, random samples of Swedish adults on three occasions and to follow possible variations over a 20-year-period. A further purpose was to study possible associations between the presence of symptoms indicative of TMD and factors such as age, gender, oral parafunctions, trauma and general health.

Materials and methods

Participants

A series of cross-sectional, stratified, population-based studies was performed in Jönköping, Sweden, in 1983, 1993 and 2003, in order to investigate oral health and oral health habits among community citizens. A random sample of 130 individuals in the age groups of 20, 30, 40, 50, 60 and 70 years was invited to participate in each study. The randomization process was conducted by the County Council. All the subjects were inhabitants of four specific parishes within the City of Jönköping, which is a medium-sized Swedish city. A mailed personal invitation with detailed information about the study and its purpose was sent to all individuals. Furthermore, the subjects were informed that they could withdraw from participation at any time without any consequences and that their individual anonymity was guaranteed. No economic compensation for participation was offered.

The non-response rate was 23% in 1983, 25% in 1993 and 32% in 2003. The range of the non-response rate for the different age groups was 20–24%, 22–28% and 29–36% in 1983, 1993 and 2003, respectively. The reasons for not participating, as well as details relating to the sampling procedures and routines, have been reported previously [15–17]. The ethical rules for research according to the Helsinki Declaration were followed throughout the studies. The investigation in 2003 was also approved by the Ethics Committee at the University of Linköping, Sweden.

Data were gathered using a self-administered questionnaire, an interview and a clinical examination. The present study refers to data collected by questionnaire and interviews with a total of 1704 individuals with the age and gender distribution shown in Table I.

A declining percentage of the samples used complete dentures in one or both jaws: 13% in 1983, 8% in 1993 and 3% in 2003. Denture wearers were found not to differ from non-denture wearers in terms of any symptoms or reported bruxism, but they had a higher median age than non-wearers (65 ± 7.2 years and 43 ± 16.6 years, respectively) and also stated health impairments more frequently (OR = 4.5, CI = 3.2–6.2, $p < 0.0001$). After adjusting for age, denture wearers did not differ from non-wearers in terms of the anamnestic dysfunction index used.

Table I. Number and gender distribution by age group of subjects included in the study.

	1983			1993			2003		
Age	Women	Men	Total	Women	Men	Total	Women	Men	Total
20	55	45	100	50	50	100	38	46	84
30	48	50	98	62	39	101	50	42	92
40	52	47	99	54	39	93	35	47	82
50	60	43	103	45	52	97	50	41	91
60	47	51	98	49	41	90	45	44	89
70	51	48	99	36	63	99	48	41	89
Total	313	284	597	296	284	580	266	261	527

Questionnaire

All the participants were asked to fill in a questionnaire including items on general and oral health, oral care habits and some sociodemographic issues. One question dealt with awareness of tooth clenching/tooth grinding. Information about previous trauma to the face and prior TMD treatment with interocclusal appliances was collected in 1983 and 2003, respectively. General health status was addressed by queries relating to perceived healthiness, ongoing medical treatment and any regular medication. The answer alternatives to all questions were 'yes' or 'no'.

Interview

Prior to the clinical examination, all the individuals participating in the studies were interviewed by trained dentists employed at The Institute for Postgraduate Dental Education in Jönköping, Sweden. The dentists addressed some specific questions and recorded the presence or absence of the following subjective symptoms: tiredness in the jaws on awakening or during chewing; clicking sounds or crepitations from the temporomandibular joints (TMJs); locking/catching of the mandible; luxation of the mandible; difficulty with jaw opening; pain during jaw movements; other pain conditions in the jaws or in the TMJ regions. Based on the answers to these questions, the Anamnestic Dysfunction Index (Ai) according to Helkimo [18] was assessed. The participants were also asked whether they experienced headaches once a week or more often. This question was not registered as a positive answer if migraine headache had been diagnosed.

Statistical methods

The prevalence of subjective reports for each age group, gender and year of investigation was assessed with descriptive statistics. Binary logistic regression analyses were performed in order to assess any associations between TMD-related symptoms and the Ai as dependent variables and each of the independent variables: age group, gender, self-perceived impaired health, trauma (1983), reported bruxism and the year of investigation. Those independent variables that reached a significant association with dependent variables in univariate regression (UR) were included in forward stepwise multiple regression analyses (MR). The odds ratio (OR) and 95% confidence interval (CI) were estimated. All the statistics were produced using the statistical SPSS program, version 16.0 (SPSS, Inc., Chicago, IL). A p-value of < 0.05 indicated a statistically significant difference.

Results

Prevalence of symptoms

Reports of recurrent headache, TMJ clicking, jaw tiredness and an awareness of tooth clenching/grinding were generally common in all three investigations. The reported frequencies of some TMD-related symptoms, general health issues, bruxism and trauma to the face are shown in Table II. The prevalence of the symptoms included in the Ai is presented in Table III. Among those who participated in the investigation in 2003, 6% (range 2–11% in the different age groups) were using or had used an interocclusal appliance. According to the Ai, 73% of the examined individuals in 1983, 67% in 1993 and 62% in 2003 were identified as being without symptoms (Ai 0). The corresponding figures for mild symptoms (Ai I) were 16.5%, 17% and 22%, respectively. Severe symptoms (Ai II) were reported by 10.5%, 16% and 16%. The distribution of the Ai is presented in Figures 1–3.

Association with background factors

Time/year of investigation. The prevalence of most of the symptoms for the whole samples did not vary to a statistically significant degree between the different examination years. However, the reports of *TMJ clicking* increased to a statistically significant degree and were found to be time dependent (Table IV).

When analysing the separate age groups, it emerged that reported clicking increased specifically in the groups of 30-, 50- and 70-year-olds. Individuals of these ages examined in 2003 were 2–4-times more likely to report TMJ clicking than those examined in 1983 (30 years, UR: OR = 2.7, CI = 1.3–5.4, p = 0.006; MR: OR = 2.6, CI = 1.3–5.3, p = 0.009), (50 years, UR: OR = 2.4, CI = 1.2–4.9, p = 0.017), (70 years, UR: OR = 2.9, CI = 1.3–6.9, p = 0.013; MR: OR = 4.4, CI = 1.4–13.8, p = 0.011). When MR was applied, the year of investigation was not found to be significantly associated with reported TMJ clicking in the age group of 50-year-olds, although 2003 was still associated (p = 0.037) with the symptom.

Further analyses of the different age groups showed that 20-year-olds in 2003 were almost 3-times more likely to report *recurrent headache* than participants of the same age in 1983 (UR: OR = 2.7, CI = 1.2–6.1, p = 0.020). The independent variable year of investigation did not reach significance in MR, although a significant relationship (p = 0.037) with the year 2003 was still found.

The Ai I and II for the whole samples increased during the study period. UR analysis showed a significant association with the independent variable 'year of investigation' for the Ai I (p = 0.009) and

Table II. Percentage distribution, by age group and year of investigation, of recurrent headache, general health issues, reported bruxism and trauma to the face.

	20			30			40			50			60			70			Total		
	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003
Recurrent headache	10	11	23	11	12	8	14	14	12	14	14	17	13	14	6	8	10	7	12	13	12
Impaired health	10	17	7	5	9	10	14	23	12	21	18	31	38	29	25	46	41	40	22	23	21
Under medical care	8	8	10	14	8	10	18	23	18	26	18	28	40	35	32	61	44	50	28	23	25
Regular medication	14	17	13	12	12	17	18	19	24	30	23	34	45	37	47	59	55	65	30	27	33
Tooth clenching/grinding	17	17	33	14	19	26	17	31	33	18	17	26	11	15	14	6	11	8	14	18	23
Trauma	22	nr	nr	25	nr	nr	11	nr	nr	4	nr	nr	14	nr	nr	8	nr	nr	14	nr	nr

nr, not registered.

Table III. Percentage distribution of the symptoms included in the Ai by age group and year of investigation.

	20			30			40			50			60			70			Total		
	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003	1983	1993	2003
Jaw tiredness	8	8	10	5	12	11	14	11	13	12	12	17	7	8	9	4	6	9	8	10	12
TMJ clicking	15	21	24	16	26	33	21	23	19	15	21	29	15	15	13	9	14	23	15	20	24
TMJ crepitation	2	3	4	0	4	1	3	3	1	3	4	4	3	2	2	4	5	3	3	4	3
Locking/ catching	6	8	4	4	11	7	3	7	6	9	7	11	0	6	5	1	3	2	4	7	6
Luxation	2	1	1	2	2	2	2	3	0	2	3	4	0	0	2	1	1	0	2	2	2
Difficulty with jaw opening	4	4	4	5	6	4	4	11	5	5	8	8	3	7	5	1	7	3	4	7	5
Pain on jaw movement	2	2	6	1	3	1	2	6	0	1	4	5	2	3	3	1	1	1	2	3	3
Pain in the face/jaws	4	1	5	2	4	5	5	4	5	5	3	9	2	3	6	1	2	2	3	3	5

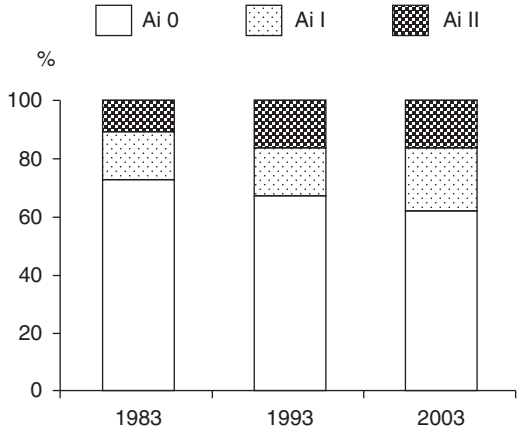

Figure 1. Percentage distribution of the Ai by year of investigation.

subjects examined in 2003 were more likely to be registered as having Ai I compared with those examined in 1983 (1993: ns, 2003: OR = 1.6, CI = 1.2–2.2, $p = 0.003$). Although the association only tended to be significant in MR ($p = 0.054$), the year 2003 was still related to the Ai I ($p = 0.016$). The Ai II was also found to be time-dependent in UR, but the relationship only tended to reach significance in MR ($p = 0.052$) (Table IV).

Reports of *tooth clenching or grinding* increased gradually and statistically significantly during the 20-year study period and showed a significant time dependence (Table IV).

When analysing the age groups, it was found that individuals aged 20, 30 and 40 years examined in 2003 were 2–3-times more likely to be aware of these oral parafunctions compared to participants of the same ages examined in 1983 (20-year-olds, UR: 1993: ns; 2003: OR = 2.4, CI = 1.2–4.7, $p = 0.016$; MR: 1993: ns; 2003: OR = 2.5, CI = 1.2-4.9, $p = 0.012$), (30-year-olds, UR: 1993: ns; 2003: OR = 2.2, CI = 1.0–4.7, $p = 0.040$; MR: ns), (40-year-olds, UR: 1993: OR = 2.3, CI = 1.1–4.5,

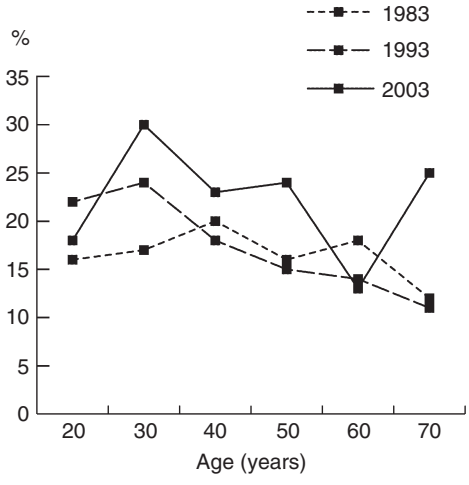

Figure 2. Percentage distribution of the Ai I by age group and year of investigation.

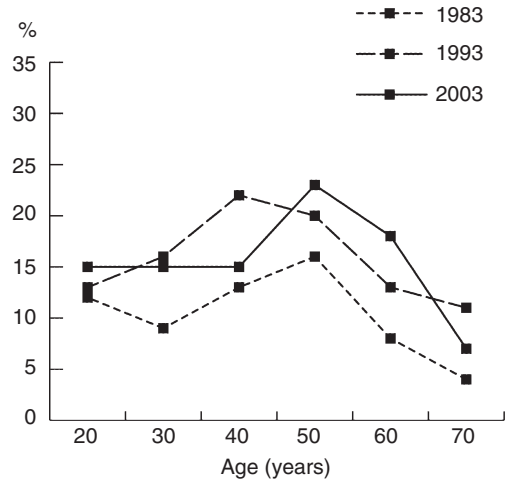

Figure 3. Percentage distribution of the Ai II by age group and year of investigation.

$p = 0.021$; 2003: OR = 2.5, CI = 1.2–5.1, $p = 0.012$; MR: 1993: OR = 2.1, CI = 1.0–4.2, $p = 0.048$; 2003: OR = 2.8, CI = 1.3–5.8, $p = 0.007$).

Age groups. Some TMD symptoms were found to be age-dependent. The associations between age groups and *TMJ clicking*, *locking/catching of the mandible*, *jaw tiredness*, *pain in the face/jaws* and *recurrent headache* are presented in Table IV.

The Ai I tended to have an association with the variable of age in UR ($p = 0.051$) and especially with the groups of 30-year-olds (OR = 1.8, CI = 1.2–2.8, $p = 0.006$) and 40-year-olds (OR = 1.8, CI = 1.0–2.5, $p = 0.048$). The Ai II was found to be age-dependent in both UR and MR, as shown in Table IV. A strong age-dependence for reported *bruxism* was also found (Table IV).

Gender. Female gender was found to be related to *jaw tiredness* (Table IV). Moreover, females in the age group of 20-year-olds ran a 2-fold higher risk than men of having *recurrent headache* (UR: OR = 2.1, CI = 1.0–4.1, $p = 0.043$). This association, however, only tended to be significant when MR analysis was applied ($p = 0.056$).

Bruxism. All TMD symptoms, with the exception of TMJ crepitations, were strongly associated with an awareness of tooth clenching/grinding. Table IV shows the associations for *recurrent headache*, *jaw tiredness*, *pain in the face/jaws*, *TMJ clicking* and *locking/catching*. Other TMD symptoms were dependent on reported bruxism as follows: *luxation* (UR/MR: OR = 3.9, CI = 1.8–8.3, $p < 0.001$); *difficulty with jaw opening* (UR: OR = 3.1, CI = 2.0–5.0, $p < 0.0001$; MR: OR = 3.1, CI = 1.9–4.8, $p < 0.001$); *pain on jaw movement* (UR: OR = 5.2, CI = 2.7–9.9, $p < 0.0001$; MR: OR = 4.9, CI = 2.5–9.3, $p < 0.0001$).

Table IV. Background variables found in regression analyses to be significantly associated with some TMD symptoms, the Ai II and awareness of bruxism.

Dependent	Independent	UR (OR, 95% CI, *p*)	MR (OR, 95% CI, *p*)
Recurrent headache	Age group:	ns	
	20	1.8, 1.0–3.0, 0.034	
	50	1.8, 1.1–3.1, 0.025	
	Awareness of bruxism	2.8, 2.0–3.9, < 0.0001	2.7, 1.9–3.7, < 0.0001
	Not totally healthy	3.2, 2.3–4.3, < 0.0001	3.0, 2.2–4.2, < 0.0001
Jaw tiredness	Age group:	$p = 0.037$	ns
	40	2.2, 1.2–4.0, 0.009	
	50	2.2, 1.2–4.0, 0.007	
	Female gender	1.6, 1.1–2.2, 0.006	1.6,1.1–2.3, 0.009
	Awareness of bruxism	6.0, 4.2–8.4, < 0.0001	5.6, 3.9–8.0, < 0.0001
	Not totally healthy	2.4, 1.7–3.4, < 0.0001	2.4, 1.7–3.5, < 0.0001
Pain in the face/jaws	Age group:	ns	
	50	3.3, 1.2–9.0, 0.023	
	Awareness of bruxism	5.3, 3.1–8.9, < 0.0001	4.9, 2.9–8.2, < 0.0001
	Not totally healthy	3.5, 2.1–5.9, < 0.0001	3.3, 2.0–5.6, < 0.0001
TMJ clicking	Year of investigation:	$p = 0.002$	$p = 0.006$
	1993	1.4, 1.0–1.9, 0.025	ns
	2003	1.7, 1.3–2.3, < 0.001	1.7, 1.2–2.3, 0.001
	Age group:	$p = 0.016$	$p = 0.011$
	30	1.8, 1.2–2.8, 0.004	2.1, 1.3–3.4, 0.002
	40	ns	1.6, 1.0–2.7, 0.049
	Awareness of bruxism	1.8, 1.3–2.4, < 0.001	1.5, 1.1–2.0, 0.010
	Not totally healthy	1.4, 1.1–1.9, 0.012	1.7, 1.2–2.3, 0.001
Locking/catching	Age group:	$p = 0.017$	ns
	20	3.0, 1.2–7.6, 0.024	
	30	3.6, 1.4–9.1, 0.006	
	50	4.6, 1.9–11.3, 0.001	
	Awareness of bruxism	3.1, 2.0–4.7, < 0.0001	3.1, 2.0–4.7, < 0.0001
Ai II ($n = 1362$)	Year of investigation:	$p = 0.004$	ns
	1993	1.7, 1.2–2.4, 0.004	
	2003	1.8, 1.2–2.5, 0.002	
	Age group:	$p = 0.001$	$p = 0.010$
	20	2.0, 1.1–3.5, 0.018	ns
	30	2.2, 1.3–3.9, 0.006	2.3, 1.2–4.5, 0.009
	40	2.7, 1.6–4.8, < 0.001	2.5, 1.3–4.7, 0.004
	50	3.2, 1.8–5.4, < 0.001	3.0, 1.6–5.5, < 0.001
	60	1.8, 1.0–3.2, 0.047	ns
	Awareness of bruxism	4.9, 3.5–6.7, < 0.0001	4.3, 3.1–6.1, < 0.0001
	Not totally healthy	2.1, 1.5–2.9, < 0.0001	2.4, 1.7–3.5, < 0.0001
Awareness of bruxism	Year of investigation:	$p = 0.001$	$p < 0.001$
	1993	1.4, 1.0–1.9, 0.049	ns
	2003	1.8, 1.3–2.5, < 0.001	2.0, 1.4–2.7, < 0.0001
	Age group:	$p < 0.0001$	$p < 0.0001$
	20	3.0, 1.8–5.3, < 0.0001	3.9, 2.2–6.9, < 0.0001
	30	2.7, 1.5–4.7, < 0.001	3.4, 1.9–6.1, < 0.0001
	40	4.0, 2.3–6.9, < 0.0001	5.1, 2.9–8.9, < 0.0001

Table IV. (*Continued*).

Dependent	Independent	UR (OR, 95% CI, *p*)	MR (OR, 95% CI, *p*)
	50	2.8, 1.6–4.9, < 0.001	3.2, 1.8–5.7, < 0.0001
	60	ns	1.8, 1.0–3.4, 0.047
	Not totally healthy	1.5, 1.1–2.0, 0.005	2.0, 1.5–2.7, < 0.0001

Year of investigation: '1983', Age group: '70', Gender: 'male', Awareness of bruxism: 'no', Self-perceived health impairment: 'totally healthy' and Ai: 'Ai 0' were used as referents.
UR, univariate regression analysis, MR, multiple regression analysis, ns, not significant.

A similar dependence on reported bruxism was found for the Ai I (UR: OR = 2.6, CI = 1.9–3.6, $p < 0.0001$; MR: OR = 2.4, CI = 1.7–3.3, $p < 0.0001$) and the Ai II (Table IV). Furthermore, the only factor that was able to discriminate significantly between subjects with Ai I and Ai II was awareness of bruxism (UR/MR: OR = 1.9, CI = 1.3–2.7, $p = 0.001$).

Self-perceived health impairment. Awareness of *bruxism* (Table IV), as well as all TMD symptoms, except for locking/catching and luxation of the mandible, was found to be dependent on self-perceived health impairment. The associations for *recurrent headache*, *jaw tiredness*, *pain in the face/jaws*, *TMJ clicking* and *locking/catching* are shown in Table IV. Other TMD symptoms were associated as follows: *TMJ crepitations* (UR/MR: OR = 2.8, CI = 1.6–5.1, $p < 0.001$); *difficulty with jaw opening* (UR: OR = 2.0, CI = 1.2–3.1, $p = 0.004$; MR: OR = 1.9, CI = 1.2–3.1, $p = 0.006$); *pain on jaw movement* (UR: OR = 2.4, CI = 1.3–4.7, $p = 0.009$; MR: OR = 2.2, CI = 1.1–4.4, $p = 0.019$).

The Ai I (UR: OR = 1.7, CI = 1.3–2.3, $p < 0.001$; MR: OR = 2.2, CI = 1.6–3.1, $p < 0.001$) and the Ai II (Table IV) were also strongly dependent on self-perceived health impairment.

Trauma. No statistically significant associations between trauma to the face and any particular symptoms or the Ai as a whole could be revealed.

Discussion

The present study with its repeated cross-sectional design aimed mainly to elucidate the issue of possible trends in the prevalence of TMD symptoms in an adult population over a 20-year period. To our knowledge, this kind of information referring to the entire age span of adulthood has not been available previously. In order to be able to extrapolate the findings of an epidemiological survey, the sample has to be representative of the population. The participation rate was somewhat lower in 2003 than in the other two examinations. The reasons for not participating were similar on all three occasions [15–17] and to those reasons described by Bernhardt [19]. An overall response rate of 68–77% is comparable to figures reported in other epidemiological surveys [9,19–21]. We therefore assume that the findings in our study can be regarded as representative of the adult non-patient population from which the present sample has been extracted.

A common concern in epidemiological research is the validity and reliability of the method used to assess the presence of a disorder. Questionnaires are a very common data source and are considered generally reliable [21,22], although their validation is not easy. The present questionnaire, set up in the early 1980s, was not validated before the start of the study. The individual queries considered neither the frequency, except for recurrent headache, nor the intensity of the symptoms, factors that have been shown distinctly to affect prevalence estimates and have been said to increase the reliability and the clinical relevance [23]. However, these questions remained basically unchanged throughout the investigation in order to facilitate the comparison of longitudinal data. Further information was collected using a structured interview conducted by experienced dentists. One inherent disadvantage of an interview is that the answers can be biased by the face-to-face communication with the interviewer. Another disadvantage is that the information that is given may vary between different interviewers. In this study, all the included items were described in written form in detail in order to be formulated and, if needed, explained in as standardized a way as possible.

The Anamnestic Dysfunction Index, a part of the Helkimo Indices [18], has been used widely since the 1970s in both epidemiological and clinical research. The constructed validity and utility of the index has been discussed and criticized [24,25]. There are certain shortcomings when it comes to using the Ai and the lack of assessment of the frequency and intensity of the symptoms is one of the most important ones. The more frequent and intense a symptom is, the greater the perceived impairment and, possibly, the more probable the presence of the disorder to be measured. This kind of information would therefore greatly improve the reliability of the measurement. Another and nowadays often discussed disadvantage of the Ai is the lack of assessment of psychosocial and behavioural factors that may contribute to the disorder [26]. Over the years, several other index systems have also been established. Ohrbach and

Stohler [27] reviewed nine different index systems and concluded that they all had some disadvantages. In another review, Carlsson and DeBoever [28] stated that 'it is a complex and probably impossible task to construct an ideal index which can encompass the many specific disorders of TMD'. During the last 2 decades, the Research Diagnostic Criteria for TMD (RDC/TMD) [26] has been developed and is being used increasingly in research, but the validity of these criteria has also been criticized [29]. It has to be remembered that the Ai was constructed as a criteria system, assessing the presence and severity of TMD symptoms and not as a diagnostic instrument, as it does not provide information about the specific TMD diagnostic entity the reported symptoms constitute. At the start of the present investigation in the early 1980s, the use of the Ai in epidemiological research was the norm. The consistent application of the same index has been chosen in order to assist the comparability of the data in a longitudinal perspective.

Complaints such as jaw tiredness, TMJ clicking and recurrent headache were the most prevalent symptoms reported in all three examinations, while other symptoms like facial pain and reduced jaw movement capacity were more rarely stated. The frequency rates of symptoms are close to those reported by other investigations [6–8,30,31]. According to the Ai, 27–38% of the examined adult population reported TMD symptoms. This finding is in agreement with the result of a meta-analysis of 51 population studies [8], which concluded that there was an overall dysfunction rate of 30% based on an Ai 0 rate of 70%. The prevalence figure for mild TMD symptoms (Ai I) was 16–22% and this agrees well with the result of a Dutch survey of a stratified sample of 6577 subjects reporting a rate of 16.6% for the Ai I [8]. However, the same authors reported a lower (4.9%) rate of more severe symptoms (Ai II) compared with the present study (10.5–16%). This discrepancy can possibly be explained by the time frame ('recently or in the past weeks') for the symptoms registered in the Dutch study. Nevertheless, comparisons between the prevalence rates of both individual symptoms and the Ai reported by various surveys are problematic because of obvious methodological differences, as stated above.

Unlike other studies [6–9,32], the present investigation did not reveal any striking gender differences for either the individual symptoms or the Ai. However, tiredness in the jaws and recurrent headache in the age group of 20 years were reported more frequently by women than men. A female predominance in TMD pain symptoms, including headache, has often been documented in recent years [5,20,31]. There is some evidence of different courses for TMD pain symptoms in women and men, as women have been found to be more likely to have persistent pain than men [21,30,33]. Moreover, studies have shown that women report both more frequent and more severe symptoms compared with men [6–9,33]. Genetic, hormonal, behavioural and psychosocial aspects have been discussed as possible causes of this gender difference [34,35], but the question of female predominance remains mainly unanswered.

Our results showed an overall decrease in reported TMD symptoms, presented as a decreasing Ai I and II, with advancing age, which agrees with previous reports [3,4,36]. We also found an age-dependence for some symptoms and for the Ai. TMJ clicking was related to the age groups of 30 and 40 years, which is in quite good agreement with reports by Kamisaka et al. [21] concluding that younger individuals, under 40 years of age, run a greater risk of having precipitating TMJ noises. Pain-related symptoms, like jaw tiredness and pain in the face/jaws, were associated with somewhat older ages of 40 and 50 years. On the other hand, recurrent headache was found to be associated with both a younger age group, 20-year-olds, and an older one, 50-year-olds. When studying TMD pain symptoms in relation to age and different ethnic backgrounds, based on data from a National Health Interview Survey of 30,978 US adults, Isong et al. [31] concluded that age appeared to play a larger role in women than in men. When it comes to the variation between the genders, it is feasible that an interaction of biological, psychosocial and behavioural factors could contribute to different courses for the various symptoms during the life span.

Like other TMD symptoms, recurrent headache was strongly related to awareness of bruxism. Headaches, mostly tension-type headaches, have often been associated with TMD in both clinical and epidemiological studies [19,23,37]. In a review of myofascial TMD pain and tension-type headache, Svensson [38] considered possible common pathophysiological mechanisms resulting in a reciprocal relationship between the two conditions. In our study, headache that had been diagnosed as migraine was excluded, but no attempts have been made to obtain a more specific diagnostic classification of the symptom. Nevertheless, various types of headache have also been connected with TMD and a recent population-based, cross-sectional investigation of 1230 subjects found that TMD symptoms were more commonly reported by individuals with different kinds of headache, including migraine, episodic tension-type headache and chronic daily headache, compared with subjects with no complaints of headache [39].

In the 2003 study, 6% of all the subjects were using or had used an interocclusal appliance. Other studies have reported that ~3% of the adult population were receiving/had ever received TMD treatment [6] or had sought care for TMD pain in the previous 6 months [40]. The data are not comparable, as treatment with an interocclusal appliance is just one out of a number of methods used in the management

of TMD. Moreover, in our study, the indication for the appliance use was not specified and might have been other than TMD, e.g. awareness of bruxism without symptoms or progressive occlusal attrition.

In close agreement with previous reports [6,7], 14–23% of the participants stated awareness of tooth clenching or grinding. In agreement with Österberg et al. [4], we also found that subjects in the oldest age groups reported bruxism less frequently than younger individuals. Awareness of bruxism is not identical to presence of bruxism, as many individuals may have a parafunctional activity without being aware of it and others may have been aware of tooth clenching or grinding that has ceased. Tooth attrition is the most frequently used indication, although indirect, of bruxism, but objectively measuring an activity of this kind is very difficult [41]. The role of bruxism as a factor potentially related to the aetiology of TMD and other pain conditions in the craniofacial region and the complexity of this relationship has been discussed in extensive reviews [42–44]. We found a highly statistically significant association between awareness of bruxism and almost every TMD-related symptom and with the Ai, which is in accordance with previous results [6,9,30]. In a longitudinal prospective study of 402 individuals followed from the age of 15 to the age of 35 years, Magnusson et al. [5] reported that bruxism was a predictor of both symptoms and clinical signs 20 years later, but also of the demand for TMD treatment. The same authors also discussed the negative predictive value of bruxism, since the absence of reports of tooth grinding in adolescence was related to a higher probability of not demanding treatment later in life and they stated that 'such parafunctions cannot be ruled out as possible aetiologic factors in the development of TMD' [5]. Similarly, Ciancaglini et al. [45] stated that 'in the general adult population absence of craniofacial pain is often accompanied by absence of bruxism'.

Extrinsic trauma to the face has been discussed as a factor that is possibly aetiologically related to TMD [10], but the results of previous studies have diverged. The present investigation, in agreement with some others [6,9], was unable to find a significant relationship between trauma and any of the studied symptoms. However, other studies have provided evidence of a positive association [46–48]. In a 4-year longitudinal study of 672 randomly selected adults, Kamisaka et al. [21] found that trauma was related to the precipitation of TMJ pain and limited mouth opening but did not perpetuate any TMD symptoms, concluding that 'the symptoms usually resolve'.

Epidemiological research has often documented a co-morbidity between general health impairment, mostly various pain conditions, and TMD [9,49], as well as headache [19,23,50]. The co-existence of orofacial pain and pain symptoms from spinally innervated, but even more remote areas, has often been studied in recent years [49,51,52]. The exact nature of this relationship has not been fully explored, but common underlying biological [53] mechanisms have been discussed. The present study found strong significant associations between almost all the TMD symptoms studied and reports of perceived health impairment. This corroborates the results of a recent epidemiological survey of 50-year-olds, showing that self-perceived poor general health was the strongest risk indicator of reported TMD pain [54].

A few separate symptoms reported by individuals in specific age groups increased statistically significantly during the observation period. The prevalence of recurrent headache in young individuals aged 20 years in 2003 was found to be more than twice as high as it was 20 or 10 years earlier. Information on any secular trends in headache prevalence in the adult population is sparse, but a Danish study of 25–36-year-olds found that the prevalence of frequent tension-type headache in particular increased significantly during a 12-year period and that female gender was a risk factor [55]. The reasons for the remarkable increase we found are unknown. Concurrently, an increase of almost the same magnitude was noted in terms of awareness of bruxism in the same age group. Whether there is an aetiological link between these observations or whether both are related to other, not studied factors is unclear and remains to be proved by further research. Furthermore, an increase in the Ai I and II over the 20-year period was found. The increase in the Ai I probably reflects the significant increase observed in reported TMJ clicking. No significant changes in the prevalence of any specific symptoms included in the Ai II have been shown. For this reason, the increase in this index degree could instead be explained by an overall increase in most of the involved symptoms. Whether this result is influenced by inherent shortcomings of the index system is not known.

To the authors' knowledge, no previous information is available regarding secular trends for the prevalence of TMD symptoms for the entire adult age span and over a long period of time. However, and in agreement with our results, another Swedish epidemiological study [56] of two cohorts of 50-year-old subjects found that orofacial pain symptoms and reported bruxism increased significantly during a 10-year period (1992–2002) that is chronologically very close to the second half of the present survey. The authors [56] concluded that the observed increase in symptoms was concurrent with social and structural changes in society, probably reflecting increased levels of stress for individuals. For decades, psychosocial factors, such as anxiety and emotional distress, have been considered in TMD aetiology and recent research has shown a relationship between stress and bruxism [57], as well as between stress and headaches [50]. During the 1990s, an increase in stress-related disorders and sick leave was noted in Sweden [58].

Our findings of an increase in both the Ai I and Ai II over a 20-year period, as well as the reports of an increase in orofacial pain symptoms [56], could be seen in the same context.

Knowledge of prevalence trends related to TMD is an important consideration when planning public health economics, future personnel resources and research fields. Further repeated population-based investigations, covering long time periods, from both Sweden and other parts of the world, would add essential information in this area and would verify the validity of our findings.

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