Prevalence of symptoms and signs indicative of temporomandibular disorders in children and adolescents. A cross-sectional epidemiological investigation covering two decades

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Abstract

AIMS: These were to 1) estimate the prevalence of subjective symptoms and clinical signs of temporomandibular disorders (TMD) in children and adolescents in the city of Jönköping, Sweden, 2) follow possible variations in TMD signs and symptoms over a 20-year period, and 3) study possible associations between TMD symptoms and signs and factors of interest. **DESIGN:** About 100 individuals in the age groups of 3, 5, 10 and 15 years participated in cross-sectional stratified epidemiological investigations in 1983, 1993 and 2003. **METHODS:** All participants were asked to fill in a questionnaire including questions on general and oral health, dental care habits and some sociodemographic issues. More specific questions recorded the presence or absence of 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; reduced jaw movement capacity; pain during jaw movements; other pain conditions in the jaws or in the TMJ regions. Subjects were examined clinically at each time period for; jaw mobility (maximum jaw opening including vertical overbite, maximum laterotrusion to the right and to the left, maximum protrusion); TMJ function (normal function, deflection on jaw opening of > 2 mm, TMJ clicking or crepitations, TMJ locking, TMJ luxation); pain on jaw movement (no pain on movements, pain on one movement, pain on more than one movement); muscle pain (no muscle pain, pain on palpation in 1-3 sites, pain on palpation in > 3 sites); TMJ pain (no joint pain, pain on lateral palpation of one or both joints, pain on posterior palpation of one or both joints). No functional examination of the masticatory system was performed in children aged 3 and 5 years. **RESULTS:** TMD-related symptoms were very rare in 3- and 5-year-olds. In the age groups of 10- and 15-year-olds, 5-9% of the participants reported more severe symptoms, up to 50% showed one or more TMD signs, while it was estimated that 1-2% were in need of TMD treatment. Several symptoms and signs increased with age. No gender differences, with the exception of recurrent headache, were noted. Oral parafunctions were reported by 11-47%. Apart from a few variables, no statistically significant changes in the prevalence of TMD symptoms and signs were observed over the 20-year period. Clenching/grinding of teeth and general health factors were found to be associated with TMD symptoms and signs. **CONCLUSIONS:** The prevalence of more severe TMD symptoms and signs in children and adolescents was generally low in all three examinations and did not change significantly during the 20-year period. Increasing age, general health factors and oral parafunctions were associated with TMD symptoms and signs in 10- and 15-year-olds.

Introduction

Temporomandibular disorders (TMD), a sub-classification of musculoskeletal disorders, has been defined as a collective term embracing a number of clinical problems that involve the masticatory musculature, the temporomandibular joints and associated structures or both [American Academy of Orofacial Pain, 1996]. Since the end of the 1970s, several epidemiological studies of signs and symptoms of TMD in children and adolescents have been performed. Even if the reported prevalence figures of subjective symptoms and clinical signs differ between studies, it is obvious that TMD have begun to appear by pre-school age [Vanderas, 1987; Nydell et al., 1994]. Due to the large variation in the reported frequencies of TMD signs and symptoms, it is difficult to obtain a comprehensive picture of the 'real' prevalence of TMD in children and adolescents and to estimate the need and demand for treatment.

There are several reasons for the diverging results in previous epidemiological studies. Differences in the composition of the material, the examination methods and the definitions and criteria for the chosen variables are some of the reasons. The inevitable inter- and intra-individual variations between examiners are other explanations. Another important, yet frequently overlooked reason, is that examination methods designed for adults have been used for children, without proper consideration of the difficulties and limitations that exist in the examination of children [Nydell et al., 1994].

A majority of past studies have been cross-sectional in design. A few longitudinal studies have provided important information about the development of TMD. A substantial fluctuation in TMD symptoms and signs has been demonstrated among children and adolescents; most have mild and infrequent symptoms, whereas progression to severe symptoms and signs is rare [Wanman, 1987; Kononen and Nystrom, 1993; Magnusson et al., 2000].

Key words: TMD, treatment need, cross-sectional, parafunctions, headache

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Table 1. Number and gender distribution of Swedish children and adolescents examined in 1983, 1993 and 2003 for temporomandibular disorders (TMD).

	1983			1993			2003		
Age group	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
3	59	42	101	47	53	100	59	37	96
5	42	66	108	58	49	107	45	51	96
10	46	65	111	67	47	114	58	52	110
15	55	52	107	51	51	102	51	45	96
Total	**202**	**225**	**427**	**223**	**200**	**423**	**213**	**185**	**398**

An increase in TMD prevalence with increasing age has been found in children [Magnusson et al., 1985; Nilsson, 2007]. A difference in TMD prevalence between boys and girls during adolescence has also been reported, where TMD prevalence is higher and the severity of signs and symptoms more pronounced in girls compared with boys [Wahlund, 2003; Nilsson, 2007]. General health problems are also more frequently seen in adolescents with TMD compared with a control group [Wahlund, 2003]. Furthermore, adolescents with recurrent headaches more frequently have symptoms and signs of TMD compared with those without headaches [Wanman and Agerberg, 1987], and children and adolescents with TMD often have other painful conditions [Wahlund, 2003; Liljeström, 2007].

Only a minor percentage of a child population is judged to be in need of TMD treatment. It has been suggested that those few individuals who consistently have symptoms and signs of TMD at follow-up examinations form a high-risk group that might display a demand and need for treatment. This high-risk group of adolescents has been estimated at 3% [Kononen and Nystrom, 1993]. This is in line with the results of a study of adolescents aged 12-18 years [Wahlund, 2003], where 7% of this group reported pain in relation to TMD and, of these, 50% required treatment, i.e. 3.5% of the whole group. For younger children, a need for treatment not exceeding 1% of the population has been reported [Bakke et al., 1990].

Longitudinal studies covering a long time period would provide more detailed information about the natural variation in TMD over time and also about possible correlations to age, gender and other related factors. Repeated cross-sectional studies of TMD performed on a population in a restricted geographical area might demonstrate possible changes in TMD prevalence over time and in relation to demographic changes in the population.

A series of such extended epidemiological studies was performed in 1973, 1983, 1993 and 2003 in order to describe the oral health in the general population of the city of Jönköping, Sweden. TMD symptoms and signs were included in the registrations made in 1983, 1993 and 2003. A random sample of approximately 100 individuals in the age groups of 3, 5, 10 and 15 years participated in these studies. These epidemiological studies are cross-sectional and stratified in design and cover the population in a limited geographical area over a long period of time.

The aims of this paper were to present the prevalence figures for subjective symptoms and clinical signs of TMD in children and adolescents in the city of Jönköping, Sweden, and to follow possible variations in TMD signs and symptoms over a 20-year period. This investigation also aimed to study possible associations between TMD symptoms and signs and related factors such as general health, oral parafunctions, trauma and recurrent headache.

Material and methods

Participants. In 1983, 1993 and 2003, three independent and randomly selected samples of children and adolescents in the age groups of 3, 5, 10 and 15 years were selected. The subjects were all inhabitants of four specific parishes within the city of Jönköping (Sweden), and they were invited to participate in an oral health study. These studies were part of a series of cross-sectional stratified epidemiological investigations of the oral health of the inhabitants of Jönköping initiated in 1973. The results relating to dental health and dental care habits have previously been presented in several separate publications [Hugoson et al., 2005; Hugoson et al., 2008].

In each age group 130 subjects were selected to participate in each investigation and received a mailed personal invitation. They were informed about the study and its purpose, the examination methods and a questionnaire they would be asked to answer in connection with the clinical examination. Personal anonymity was guaranteed and participation was voluntary. The rate of non-responders for the different age groups was 15-22% in 1983, 12-23% in 1993 and 15-26% in 2003. The reasons for not responding, as well as details relating to the sampling procedures and routines, have been reported previously [Hugoson et al., 2005].

The age and gender distribution of the children and adolescents who participated in each investigation is shown in Table 1. Among participants in the four different age groups, 3-17% and 2-12% in 1993 and 2003 respectively were born in a country other than Sweden. The corresponding figures for the country as a whole were 3-8% in 1993 and 3-9% in 2003. No information was available about the ethnic background of the 1983 participants.

Questionnaire. On arrival for the clinical examination, all participants were asked to complete a questionnaire including questions on general and oral health, dental care habits and some sociodemographic issues. The questions were formulated somewhat differently for children than for adults and they were mainly the same throughout the three investigations. Their parents answered the questionnaires for the 3- and 5-year-old children.

There were 2 questions related to the function of the masticatory system, specifically whether the child/adolescent had pain or discomfort during chewing and whether the child/adolescent had pain or discomfort when opening the jaw. The adolescents and the parents of the children were also asked to answer questions about general health status, such as ongoing medical treatment and any regular medication. Different queries regarding oral parafunctions were included in the questionnaire in two of three examinations. In 1983, the participants aged 10 and 15 years were asked about nail biting and in 2003, all participants/parents were asked if they were aware of tooth clenching or tooth grinding. In 1983, a question relating to previous trauma to the face was addressed to 10- and 15-year-old subjects. Moreover, in 2003, the same age groups were asked to report on any previous TMD treatment with interocclusal appliances. The answer alternatives to all questions were 'yes' or 'no'.

Clinical examination. All the individuals participating in the studies were examined clinically, but no functional examination of the masticatory system was performed in children aged 3 and 5 years. Experienced dentists from The Institute for Postgraduate Dental Education in Jönköping, Sweden carried out the examinations at a dental clinic. The dentists were calibrated in terms of the clinical TMD signs to be registered before the start of each investigation.

Prior to the clinical examination of the 10- and 15-year-old individuals, the dentists addressed some more specific questions and recorded the presence or absence of the following subjective symptoms:

- fatigue 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;
- reduced jaw movement capacity;
- 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 [1974] was assessed. The participants aged 10 and 15 were also asked whether they experienced headaches once a week or more often. This question was not registered as a positive answer if other than tension-type headache had been medically diagnosed.

Five main domains of jaw function according to the Clinical Dysfunction Index [Helkimo, 1974] were recorded in the 10- and 15-year-olds:

(A) jaw mobility (maximum jaw opening including vertical overbite, maximum laterotrusion to the right and to the left, maximum protrusion);
(B) TMJ function (normal function, deflection on jaw opening of > 2 mm, TMJ clicking or crepitations, TMJ locking, TMJ luxation);
(C) pain on jaw movement (no pain on movements, pain on one movement, pain on more than one movement);
(D) muscle pain (no muscle pain, pain on palpation in 1-3 sites, pain on palpation in > 3 sites);
(E) TMJ pain (no joint pain, pain on lateral palpation of one or both joints, pain on posterior palpation of one or both joints).

TMJ sounds were not registered separately in 2003, but their presence was recorded as non-normal TMJ function. Some of the criteria for domains (C), (D) and (E) were somewhat different in 1983 compared with 1993 and 2003. For (C), the criterion 'pain on more than one movement' was 'pain on opening less than 20 mm'. For (D) and (E), the criteria for muscle and joint pain were 'tenderness on palpation or side difference' and 'pain provoking palpebral reflex'.

The muscles that were palpated were the anterior origin and the insertion of the temporal muscle, the superficial masseter muscle and the region of the lateral pterygoid muscle. All the sites were palpated bilaterally.

The clinical registrations were combined to produce a dysfunction point score and the Clinical Dysfunction Index (Di) according to Helkimo [1974] was calculated in 1993 and 2003. In 1983, the Di was calculated after the aforementioned modifications.

Statistics. The prevalence of subjective reports and clinical signs for each age group, gender and year of investigation was estimated with descriptive statistics. Differences in the prevalence of symptoms and signs between the years of investigation were tested for statistical significance using the chi-square test. Logistic regression analyses for the whole material and for the separate investigations were performed in order to find any possible associations between TMD-related symptoms or signs and age group, gender, health

status, trauma and oral parafunctions. In order to make the statistical analyses possible, the Clinical Dysfunction Index II and III were pooled together. All the statistics were produced using the statistical program SPSS, version 13.1 (SPSS, Inc., Chicago, IL, USA). A p-value of < 0.05 indicated a statistically significant difference.

Results

Prevalence of signs and symptoms. The prevalence of TMD-related symptoms and general health problems in 1983, 1993 and 2003 is shown in Tables 2 and 3. Particularly, in the age groups of 3- and 5-year-olds, complaints of pain in connection with the function of the masticatory system were very rare. The most prevalent symptoms reported by 10- and 15-year-olds were clicking sounds from the TM joints (2-17%), recurrent headache (6-13%) and jaw tiredness (3-9%). Between 5-9% of the subjects in each investigation reported more severe TMD symptoms and were thus classified as having Ai II (Figures 1 and 2).

The TMD signs recorded at the clinical examination were grouped in 5 domains and the prevalence of the dysfunction score for each domain and age group is shown in Table 4. The most frequent TMD sign was muscle tenderness on palpation (21-32%). Up to 50% of subjects had at least one clinical sign indicative of TMD. The distribution of the clinical dysfunction index (Di) is presented in Figures 3 and 4.

In 2003, the maximum jaw-opening capacity was also recorded in millimetres. The mean values for the different age groups were as follows: 3 years: 40 mm (range 28-48 mm), 5 years: 42 mm (range 34-67 mm), 10 years: 51 mm (range 38-65 mm), 15 years: 56 mm (range 40-78 mm).

Reports of oral parafunctions were common. In 2003, 23% and 19% of the parents of the children in the age groups of 3- and 5-year-olds, respectively had noticed that their child used to clench or grind his or her teeth. In the same year, 12% of the examined 10-year-olds and 11% of the 15-year-olds were aware of tooth clenching and/or grinding. Furthermore, 47% of the 10-year-old children and 44% of the 15-year-old adolescents examined in 1983 reported nail biting.

Reports of trauma to the face were also frequent. In 1983, 28% of the subjects in the age group of 10 years and 22% of the 15-year-olds reported some trauma to the face. In the latter age group, trauma was reported significantly more frequently by boys than girls (p=0.009). In 2003, 3% and 1%, respectively, of the 10- and 15-year-olds reported that they used or had used an interocclusal appliance.

Fig. 1. Distribution (in %) of the Anamnestic Dysfunction Index (Ai) for Swedish10-year-olds in 1983, 1993 and 2003.

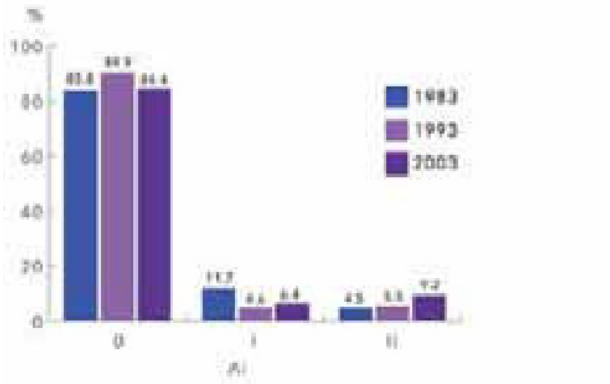

Fig. 2. Distribution (in %) of the Anamnestic Dysfunction Index (Ai) for Swedish 15-year-olds in 1983, 1993 and 2003.

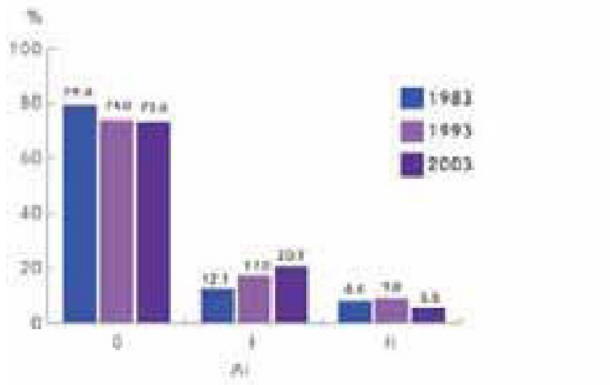

Fig. 3. Distribution (in %) of the Clinical Dysfunction Index (Di) for 10-year-olds in 1983, 1993 and 2003.

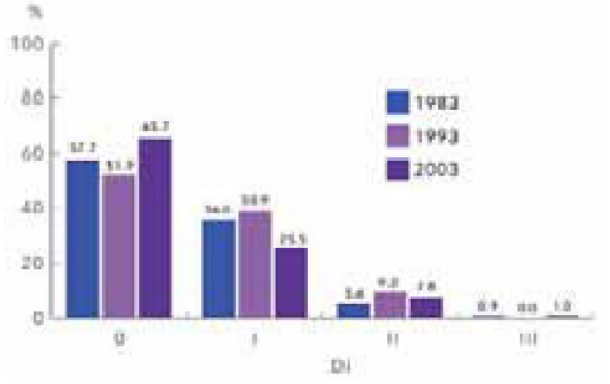

Fig. 4. Distribution (in %) of the Clinical Dysfunction Index (Di) for 15-year-olds in 1983, 1993 and 2003.

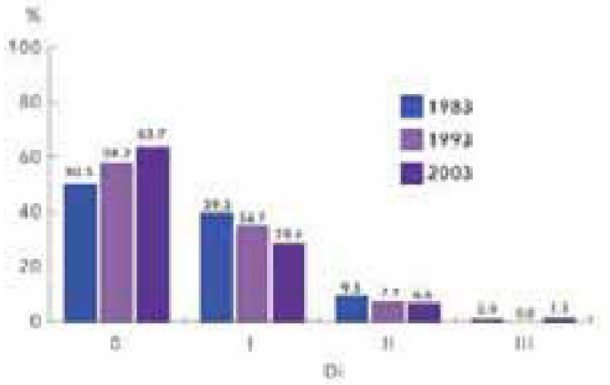

Table 2. Prevalence (in %) of some TMD-related symptoms and general health problems reported by Swedish children and adolescents in 1983, 1993 and 2003. n.r. = not registered.

	1983				1993				2003			
	3y	5y	10y	15y	3y	5y	10y	15y	3y	5y	10y	15y
Pain on chewing	2	1	1	3	0	0	5	4	0	2	7	5
Pain on jaw opening	0	0	1	2	1	0	2	4	0	0	2	1
Recurrent headache	n.r.	n.r.	7	9	n.r.	n.r.	6	9	n.r.	n.r.	13	13
Impaired health	11	3	9	11	2	4	n.r.	n.r.	4	5	n.r.	n.r.
Under medical care	15	12	10	9	2	6	10	11	2	7	12	9
Regular medication	7	4	5	7	2	6	6	10	8	7	7	7

Table 3. Prevalence (in %) of TMD symptoms according to the Anamnestic Dysfunction Index (Ai) reported by 10- and 15-year-old subjects in 1983, 1993 and 2003.

TMD SYMPTOMS	1983		1993		2003	
	10y	15y	10y	15y	10y	15y
Jaw tiredness	3	4	3	9	4	7
TMJ clicking	12	16	2	14	5	17
TMJ crepitation	2	0	1	4	0	4
Locking/catching	1	5	1	5	0	2
Luxation	0	1	0	0	0	0
Reduced jaw movement capacity	2	2	1	1	1	0
Pain on jaw movement	3	2	3	2	5	2
Other pain in the face/jaws	1	1	1	4	4	2

Table 4. Prevalence (in %) of TMD-related signs according to the Clinical Dysfunction Index (Di) registered in Swedish 10- and 15-year-olds. The scores of 0, 1 and 5 represent levels of increasing severity.

TMD SIGNS		1983		1993		2003	
		10y	15y	10y	15y	10y	15y
Impaired jaw mobility	0	96	93	85	96	97	96
	1	4	8	14	3	3	3
	5	0	0	1	1	0	1
Impaired TMJ function	0	84	77	93	85	94	91
	1	16	23	7	15	5	9
	5	0	0	0	0	1	0
Pain on jaw movement	0	87	92	99	98	97	99
	1	8	4	1	2	3	1
	5	5	5	0	0	0	0
Muscle pain	0	74	72	68	70	79	78
	1	23	21	30	25	19	19
	5	3	7	2	5	3	3
TMJ pain	0	87	93	85	91	89	90
	1	13	8	8	6	6	6
	5	0	0	7	3	6	4

Table 5. Variables found to be associated with recurrent headache in multiple stepwise logistic regression analyses. OR = Odds Ratio, CI = 95% Confidence Intervals for OR, n.s.= not significant.

Variables	Year of examination		
	1983	1993	2003
Female gender	p=0.038 OR=3.3 CI=1.1-10.0	n.s.	p=0.004 OR=5.0 CI=1.7-14.6
Regular medication	n.s.	n.s.	p=0.041 OR=4.1 CI=1.1-15.8
Di	**Di I:** p=0.009 OR=5.8 CI=1.5-21.6 **Di II/III:** p=0.005 OR=10.1 CI=2.0-51.1	**Di II/III:** p<0.001 OR=18.7 CI=1.3-9.6	**Di I:** p=0.008 OR=3.7 CI=1.4-9.6
Di domain: Muscle pain	p<0.001 OR=9.9 CI=3.3-30.5	p=0.002 OR=13.8 CI=2.6-74.9	n.s.
Di domain: Pain on jaw movement	n.s.	p=0.041 OR=20.6 CI=1.1-374.4	p=0.012 OR=23.3 CI=1.9-271.7
Di domain: TMJ pain	n.s.	p=0.011 OR=11.3 CI=1.7-73.1	n.s.

An estimation of the need for TMD treatment in the population groups aged 10 and 15 was made. Participants who were registered as having an Ai II and a Di II or III were regarded as being in need of treatment. Only 1-3 subjects (1-2%) in each age group and at each examination fulfilled these criteria for the need for TMD treatment.

Changes over the 20-year period. Regarding general health problems, statistically significantly more 3-year-olds had impaired health (p=0.020) and were receiving medical care (p<0.001) in 1983 compared with the situation at the two subsequent examinations. The overall reports of TMD symptoms, and subsequently the Ai distribution, did not change to a statistically significant degree during the 20-year time period. The only difference found for any single subjective variable was that clicking was reported significantly more frequently by the 10-year-olds in 1983 compared with the same age group examined in 1993 and 2003 (p=0.006).

Among the clinical variables, 'impaired jaw mobility' was statistically significantly commoner in the 10-year-old children examined in 1993 compared the same age group in 1983 and 2003 (p<0.001). 'Impaired TMJ function' was statistically significantly more frequently found in 1983 compared with the other two examinations both in the 10-year-olds (p=0.017) and in the 15-year-olds (p=0.029). The same difference between the first examination and the two subsequent examinations was observed for 'pain on jaw movement' in 10-year-olds (p<0.001). Some variation in the distribution of Di as a whole could be seen between the three examination years, but the differences were not statistically significant.

Associations between variables. Pain/discomfort on chewing was significantly related to age. Children in the oldest age groups of 10 and 15 years reported this symptom 6 times more frequently than 3-year-olds (10-year-olds: p=0.019, OR =6.0, CI =1.3-26.6; 15-year-olds: p=0.026, OR =5.5, CI =1.2-25.0). Moreover, children on regular medication reported three times more pain or discomfort on chewing compared with those who were not receiving any medication (p=0.033, OR =3.0, CI =1.1-8.1). Tiredness in the jaws on waking or on chewing was also related to age; 15-year-olds reported this symptom more frequently than 10-year-olds (p=0.033 OR=2.4, CI=1.1-5.2). The same complaint was also found to be correlated with general health. Subjects who were receiving medical treatment had three times higher risk of having this TMD symptom compared with healthy subjects (p=0.021, OR =3.3, CI =1.2-8.9).

Table 6. Variables found to be associated with Ai II in multiple stepwise logistic regression analyses. OR = Odds Ratio, CI = 95% Confidence Intervals for OR, n.s.= not significant.

Variables	Year of examination		
	1983	1993	2003
Clenching/grinding teeth	not registered	not registered	p=0.005 OR =6.9 CI =1.8-26.9
Di	**Di I:** p=0.009 OR=15.9 CI =2.0-128.8 **Di II/III:** p=0.001 OR = 48.0 CI = 4.8-476.1	n.s.	**Di II/III:** p=0.006 OR =10.4 CI =1.5-55.1
Di domain: Impaired TMJ function	n.s.	p=0.010 OR=5.6 CI=1.5-21	n.s.
Di domain: Muscle pain	P<0.001 OR=26.8 CI=5.1-139.3	n.s.	n.s.
Di domain: Pain on jaw movement	n.s.	n.s.	p=0.001 OR=64.5 CI=5.8-715.7

Reports of both TMJ clicking (p<0.001, OR =2.9, CI =1.7-5.1) and catching/locking of the mandible (p=0.013, OR =6.7, CI =1.5-30.6) were significantly related to the older age group of 15-year-olds. Children and adolescents on regular medication reported more problems with catching or locking of the jaw (p=0.006, OR =5.5, CI =1.6-18.8). On all three examinations, recurrent headache was found to be associated with the Clinical Dysfunction Index. The same symptom was shown to be related, albeit inconsistently, to female gender and regular medication (Table 5).

A relationship was found between the Anamnestic Dysfunction Index of grade II and clenching or grinding of teeth (Table 6). Moreover, Ai II was inconsistently associated with the Clinical Dysfunction Index. The Di domain 'TMJ function' was found to be age related. This TMD sign was statistically significantly more common among subjects aged 15 compared with 10-year-olds (p=0.021, OR =1.8, CI =1.1-2.9).Finally subjects who had a clinical dysfunction of Di II or III reported significantly more frequently that they were on medical treatment than those who had a clinical dysfunction of Di I (p=0.008, OR=3.5, CI=1.4-8.8).

Discussion

Previous epidemiological investigations have reported on either the point prevalence Nilner, 1983; Kononen et al., 1987; Widmalm et al., 1995a; Abdel-Hakim et al., 1996; Thilander et al., 2002; Farsi, 2003; Wahlund, 2003; Feteih, 2006; Nilsson, 2007] and/or incidence [Nilsson, 2007] of TMD in children and adolescents or have followed different age groups longitudinally [Heikinheimo et al., 1989; Kononen and Nystrom, 1993; Wanman, 1996; Magnusson et al., 2000]. To the authors' knowledge, this is present study the first to investigate the TMD prevalence in specific young populations, from the same geographical area, at different time-points covering a 20-year period.

Subjects. The number of non-responders varied between 12% and 26% and was higher in 2003 compared with 1983 and 1993. Comparable [Wahlund, 2003; Brattberg, 2004; Liljeström, 2007] or higher rates [LeResche et al., 2005] have been reported from other epidemiological studies. The ethnic composition of the study population was similar to that of Sweden as a whole. However, in both 1993 and 2003, a higher percentage of subjects born in a country other than Sweden was noted in the age group of 15 compared with the figures for the whole country. As the overall TMD prevalence was quite low and subjects not born in Sweden did not differ statistically significantly in any of the studied variables from subjects born in Sweden, we assume that these diversities did not have any bearing on the results. The results of these investigations could therefore be applicable to the whole Swedish population.

The Helkimo Indices. These have not been validated on children, but they have been used in many previous epidemiological and clinical investigations (for a review see Nydell

et al. [1994] and Hirsch and Sehrer [2000]). These Indices were the norm at the time when the first of the present investigations was performed in 1983 and they continued to be used in the subsequent studies in order to facilitate the longitudinal data assessment.

Questionnaire. The two questions used in the questionnaire, 'Do you have pain or discomfort in your jaws on chewing?' and 'Do you have pain or discomfort in your jaws on opening your mouth?' have been widely used but have not been validated and the results should therefore be interpreted with some caution. It is well known that questions relating to pain may be difficult to apply to children at different stages of cognitive development, as their ability to think in an abstract manner is not fully developed until the age of 12 [Gaffney, 1993]. As a result, they may lack the ability before that age to relate or express their pain in a conventional way. Hence, only the two above-mentioned questions were addressed to the youngest individuals of 3 and 5 years of age parents answered and them. Nevertheless, information about pain experience in children and adolescents is of importance and may impact on predicting pain later in life. In a longitudinal study of 335 children aged 8-14, Brattberg [2004] found that reports of pain in childhood and early adolescence are associated with reports of pain in early adulthood; recommending that 'more attention should be given to problems of pain and ill-health in childhood, especially amoung young girls'.

Clinical examinations. No functional examination of the masticatory system was performed in the groups of 3- and 5-year-olds, because of difficulties when examining and interpreting palpatory findings in young children. The discomfort related to the whole examination procedure, and particularly to palpation, can be expressed as pain. In order to overcome this problem in clinical settings, Magnusson and Helkimo [2001] proposed a more concise functional examination of the masticatory system in children, including the palpation of 'a few informative jaw muscles' recommending the masseter and temporal muscles as such. Moreover, Nydell et al. [1994] suggested the use of stricter, well-defined examination methods in clinical registrations, i.e. the use of the palpebral reflex as a criterion for pain upon palpation of the masticatory muscles and TMJs.

The criteria for three of the Di domains were somewhat altered in 1983, possibly affecting the results regarding the prevalence of these domains and of the Di as a whole in this year. A less than optimal registration of TMJ sounds in 2003 study might have had some bearing on the documented prevalence of the 'impaired TMJ function' domain and of the Di in 2003. Caution is thus recommended when interpreting the observation of differences in prevalence of various Di domains between the examinations.

Variability and validity. A common methodological question for many epidemiological studies is the potential effect of inter- and/or intra-observer variability on the validity of the results. Earlier research has shown that variability between observers, especially in the clinical registrations of some TMD signs, can be high and that it is generally greater than intra-observer variability [Kopp and Wenneberg, 1983; Wahlund, 2003]. It has therefore been suggested that, in longitudinal studies, wherever possible one observer should be involved in clinical registrations or that the observers should be calibrated [Carlsson et al., 1980]. In the present series of investigations, three or four different dentists in each study examined the subjects. One of these dentists participated in all the examinations, another in two of them and some others only once. Although the examiners were thoroughly calibrated in terms of the clinical TMD signs to be registered before the start of each investigation, no particular estimation of inter- or intra-observer variability was made. Consequently, the registration of clinical signs and estimation of the resulting Di might have been affected by examiner variations.

Symptoms. In the studied populations of 10- and 15-year-olds, the most frequently reported symptoms (TMJ clicking, recurrent headache, jaw tiredness, pain on chewing) and recorded signs (muscle pain on palpation, TMJ sounds) were similar to those described in many other previous epidemiological investigations [Kononen et al., 1987; Wanman, 1987; Farsi, 2003; Wahlund, 2003; Feteih, 2006]. We also found that the majority of these common symptoms and signs increased from the age of 10 to the age of 15, supporting the results of previous studies [Thilander et al., 2002; Wahlund, 2003; Nilsson, 2007]. However, comparisons of the present prevalence figures for the separate symptoms or signs and those reported by others are difficult. In a thorough review of 40 epidemiological studies, Nydell et al. [1994] analysed possible reasons for the large divergences between the different investigations and attempted to estimate the clinical relevance of the reported frequencies using a set of stricter diagnostic criteria.

Gender. In accordance with reports by Farsi [2003] and Widmalm et al. [1995b] but in contrast to the results of several other studies [Heikinheimo, 1989; Thilander et al., 2002; Wahlund, 2003; Feteih, 2006; Hirsch et al., 2006a; Nilsson, 2007], the present survey was unable to reveal any gender difference in TMD prevalence, as study design and sample sizes could be possible explanations of these conflicting results. In a 20-year longitudinal survey, Magnusson et al. [2000] concluded that the gender differences were small in childhood, but from late adolescence women reported more symptoms and exhibited more clinical signs than men. Factors related to hormonal function have been widely discussed in recent years as feasible reasons for the female predominance in TMD populations. In a cross-sectional, population-based survey of 3,101 adolescents (aged 11-17), LeResche et al. [2005] found that pubertal development was a better pain predictor than age and facial pain increased with pubertal development for both girls and boys, but no gender differences could be demonstrated.

A female predominance among individuals with recurrent headache was observed in this study, corroborating earlier reports [Egermark-Eriksson, 1982; Nilner, 1985; Wahlund, 2003; Laurell et al., 2004]. In a nationwide questionnaire survey involving 1,975 individuals aged 9, 12 and 15, Brun Sundblad et al. [2007] found that various types of headache were twice as prevalent in girls as in boys and prevalence doubled from the age of 9 to the age of 15. Furthermore, Wanman [1987] reported that both the frequency and intensity of recurrent headaches was significantly higher in girls than in boys at the ages of 17, 18 and 19. However, other studies reported on a more uniform gender distribution [Kononen et al., 1987; Farsi, 2003; Feteih, 2006]. Contrary to the results of a recent survey by Liljeström [2007], we found an association between TMD, especially the Clinical Dysfunction Index, and recurrent headache. As in some previous studies [Wanman and Agerberg, 1987; Thilander et al., 2002], the present study provided support for an association between various TMD symptoms and/or signs and recurrent headache.

Jaw-opening. The maximum jaw-opening capacity recorded in 2003 was in close agreement with previous reports describing diverse young Swedish populations [Nilner, 1983; Wahlund, 2003]. Studies from other countries [Farsi, 2003; Hirsch et al., 2006b] have reported somewhat lower values for individuals aged between 10 and 17 years. It seems reasonable to assume that there may be differences in maximum jaw-opening capacity among populations with different ethnic backgrounds.

Oral parafunctions. The participants themselves or their parents often reported an awareness of various oral parafunctions. Nail biting was found to be more frequent (44-47%) than clenching or grinding teeth (11-12%) in the age groups of 10 and 15 years. This finding is in agreement with several previous surveys [Nilner, 1983; Magnusson, 1986; Kononen et al., 1987; Wanman, 1987; Kononen and Nystrom, 1993; Feteih, 2006]. This was not unexpected, as individuals who bite their nails are almost always aware of their parafunction, whereas awareness of tooth clenching or grinding, even during the daytime, is rare; 23 and 19% respectively of parents of children in the age groups of 3 and 5 years reported an occurrence of tooth clenching or grinding. When studying child populations of similar age, Widmalm et al. [1995a] found that the rate of bruxism was comparably frequent (20%) to that in the present study, whereas, Castello et al. [2005] reported a higher rate (32%) and Farsi [2003] a much lower prevalence (8.4%). Different ways of collecting data using questionnaires or interviews, asking parents or children, could be possible reasons for these variations. Tooth clenching or grinding was found to be associated with TMD symptoms, particularly the Ai, which is in accordance with a previous report on the relationship between bruxism and pain symptoms [Widmalm et al., 1995a]. Furthermore, other studies have reported an association between oral parafunctions and both clinical signs of dysfunction and recurrent headache [Nilner, 1985; Wanman and Agerberg, 1987]. On the other hand, Castello et al. [2005] concluded that parafunctional habits, with the exception of atypical swallowing, were not determinants of the presence of TMD symptoms and/or signs.

Trauma. In this study, trauma to the face was common among 10- and 15-year-olds. Nilner [1983] reported a history of trauma in 17% of a group of adolescents aged 14-17 years. Confirming observations by others [Wanman, 1987; Wahlund, 2003], we found trauma was significantly commoner among boys than girls in the age group of 15 years. However, in this investigation, disagreeing with reports in previous studies [Wahlund, 2003; Fischer et al., 2006] no significant association between trauma to the face and TMD could be shown.

General health. Issues concerning general health were shown to be associated to several separate TMD symptoms and to more severe clinical dysfunction (Di II or III) in children and adolescents. Different aspects of general health impairment, mainly various pain symptoms, have previously been studied and, in agreement with the present results, found to coincide with TMD [Agerberg, 1974; Abdel-Hakim et al., 1996; Wahlund, 2003; Hirsch et al., 2006a].

General considerations. Overall, no significant changes in the prevalence of TMD were observed in these young populations during a 20-year period. The prevalence of some of the reported symptoms and signs fluctuated between the different years, but no obvious trend could be identified. Information on this particular area is generally lacking. However, methodological limitations as mentioned above and relating, for example, to examiner variability and inconsistency in variables in combination with a sample that was possibly too small may have affected the result.

The need for treatment for TMD was low and estimated at 1-2% for the age groups of 10 and 15 years. This finding is in close agreement with a Danish report [Bakke et al., 1990]. In our study, the need for treatment was estimated by using a combination of Ai and Di. In a review, Hirsch and Sehrer [2000] concluded that previous investigations showed a mean prevalence of 7.8% for moderate to severe dysfunction (Ai=II and Di=II or III) when Helkimo Indices where used. This figure indicates a far greater need for treatment than that estimated on the basis of the same criteria in the present investigation. Furthermore, Hirsch and Sehrer [2000] stated that 'differences in TMD findings between ethnic groups and different parts of the world apparently exist', the need for TMD treatment in children and adolescents is multifaceted and requires further research.

Conclusions

Our results show a low and consistent prevalence of more severe TMD symptoms and signs in childhood and adolescence during a 20-year period of evaluation. A point that should be emphasised is the need to develop reliable ex-

amination methods suitable for children at different levels of cognitive maturity. Further research, including longitudinal epidemiological studies covering the whole age span of childhood, is recommended in order to obtain a more comprehensive view of both the natural course of TMD and the factors associated with or predisposing to it, as well as to facilitate the appropriate treatment at an early stage.

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