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ORIGINAL ARTICLE

Prevalence of signs and symptoms indicative of temporomandibular disorders and headaches in 35-, 50-, 65- and 75-year-olds living in Västerbotten, Sweden

NEGIN YEKKALAM & ANDERS WÄNMAN

Department of Clinical Oral Physiology, University of Umeå, Umeå, Sweden

Abstract

Objective. The aim of this study was to analyze and compare prevalence of signs and frequently occurring symptoms indicative of temporomandibular disorder (TMD) and headaches in 35-, 50-, 65- and 75-year-old men and women in Västerbotten County, Sweden. ***Materials and methods.*** From a total target population of 11 324 subjects living in Västerbotten County in the year 2002, 300 individuals in each age group were randomly selected. Of these, 998 (82% response rate) answered and returned a postal questionnaire and 779 (65% response rate) individuals accepted a clinical examination. ***Results.*** The prevalence of frequent TMD symptoms peaked among 50-year-old women and then declined. Women at this age reported significantly higher prevalence compared to men for all TMD symptoms except temporomandibular joint locking. In the 65- and 75-year-olds, the prevalence was practically equal between men and women as well as between these ages. Frequent headaches showed the highest prevalence among 35- and 50-year-old women, with a statistically significant difference between men and women of 50 years of age ($p < 0.05$). Fifty-year-old women had statistically significantly higher prevalence of muscle pain to palpation ($p < 0.001$), temporomandibular joint sounds ($p < 0.01$) and impaired maximal jaw opening capacity ($p < 0.01$), compared to 50-year-old men. ***Conclusions.*** The different symptoms indicative of TMD and headaches showed a similar pattern, with higher prevalence among the 35- and 50-year-old, as compared to the 65- and 75-year-old, participants. The pattern may be related to biological, psychosocial or generation-related factors.

Key Words: *craniomandibular disorders, epidemiology, gender, headache, pain*

Introduction

The term temporomandibular disorders (TMD) refers to musculoskeletal conditions in the jaw, face and temple regions, in terms of pain, temporomandibular joint (TMJ) sounds, impaired jaw opening and associated headaches [1]. Epidemiological studies have indicated that TMD is common in the population and related to a subject's impaired general health and quality of life [2–4]. Longitudinal studies of predominately younger samples have shown that signs and symptoms of TMD increase during the adolescent period and have a fluctuating pattern [5–8], peaking between young adulthood and the middle adult ages [8–10] and gradually decreasing in prevalence afterwards [10–12]. In Västerbotten, Sweden, the first epidemiological study on TMD symptoms was done in 1971, based on inhabitants in the city of Umeå [13]. Since then, surveys have been conducted at ~10-year intervals among the adult population in Västerbotten [14,15]. During the same period, a series of epidemiological studies on the development of oral health were done in the city of Jönköping, Sweden [16,17]. Recently an analysis disclosed a time trend of increasing prevalence of TMD symptoms among adults in Jönköping over a 20-year period [12]. While the first population-based studies on TMD symptoms did not show any large gender-related differences in the prevalence of TMD symptoms [13,18], most studies published during the past decades have indicated an ~2-fold higher prevalence of TMD pain among women compared to men [4,9]. The varying results may mirror differences in the study populations and in methods of measurements. Pain conditions, such as myofascial pain, arthralgia and orofacial pain, seem to have been the

Correspondence: Dr Anders Wänman, Department of Clinical Oral Physiology, University of Umeå, S-901 87 Umeå, Sweden. Tel: +46907856082. E-mail: anders.wanman@odont.umu.se.

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focus of most TMD research during the last decades, while other symptoms also attributed to TMD (i.e. TMJ locking, TMJ sounds, feelings of tiredness in the jaws and impaired jaw opening) have received less attention. Gender differences in pain conditions may be related to structural, systemic, physiologic, biologic, behavioral and socioeconomic factors [19–21]. Signs and symptoms of TMD have also been associated with increases in sick leave, reduced satisfaction with life and higher risks of job and economic loss as well as mood disturbances [10,22,23]. Although several surveys have been done in Sweden [5,6,8,9,11–14], only a few have focused on comparing the prevalence of TMD pain and dysfunction in subjects ranging in age from younger adults to the elderly, in both sexes [11,12]. The Swedish National Board of Health and Welfare has requested population-based studies on oral health regarding specific indicator ages. In Västerbotten, three surveys based on such indictor ages have been conducted (in 1981, 1990 and 2002). One outcome of these studies was gradually improved oral health, as indicated by a decrease in tooth mortality and edentulousness in the adult population [15].

The aim of this study was to analyze and compare the prevalence of TMD signs and frequently occurring TMD symptoms and headaches in 35-, 50-, 65- and 75-year-old men and women living in Västerbotten County, Sweden in 2002.

The hypotheses were:

(1) Clinical signs and symptoms indicative of TMD and headaches would be more commonly registered and reported among women than men.
(2) The 35- and 50-year-old groups would have a higher prevalence of reported TMD symptoms and headaches compared to the older age groups.
(3) Clinically registered TMD signs would show an increasing prevalence with age.

Materials and methods

The cross-sectional study was based on 11 324 individuals, aged 35, 50, 65 and 75 years old, residing in the county of Västerbotten, Sweden, in September 2002. The population was stratified into those living in inland (mainly rural) and in coastal (mainly urban) areas. From each of the strata 600 individuals, 150 in each age group, were selected at random. Thus, in total 1200 individuals (300 in each age group) were included in the study sample. Altogether, 987 individuals (response rate 82%) returned a filled-out questionnaire and 779 (response rate 65%) participated in a clinical examination (Table I). Complete data (both from the questionnaire and the clinical examination) were obtained from 768 individuals (64%); 219 (18%) only answered the questionnaire, 11 individuals (1%) only participated in the clinical examination, 21 (2%) could not be reached, 173 (14%) did not want to participate, one person (0.1%) had moved and seven persons (0.6%) had died. The study was approved by the Human Ethics Committee, Faculty of Medicine and Odontology, Umeå University. The study was conducted from September 2002 to February 2003.

Table I. Total number of inhabitants, sample size and number and percentage of participants of the ages 35-, 50-, 65- and 75 years in Västerbotten, 2002.

	Age group				
	35 years	50 years	65 years	75 years	Total
Population	3464	3375	2460	2025	11 324
Sample	300	300	300	300	1 200
Q & CE	207 (69%)	190 (63%)	195 (65%)	176 (59%)	768 (64%)
Q & no CE	38 (13%)	56 (19%)	61 (20%)	64 (21%)	219 (18%)
No Q & CE	7 (2%)		4 (1%)		11 (1%)
Total no. of participants	252 (84%)	246 (82%)	259 (86%)	240 (81%)	998 (83%)
Reason for not participating	40	42	36	55	173
Just visited a dentist	14	12	18	15	59
Do not want to come	9	15	13	28	65
Afraid	7	3			10
Miscellaneous	10	12	5	12	39
Deceased			2	5	7
Non-resident			1		1
Not known	8	12	1		21

Q, questionnaire; CE, clinical examination.

Questionnaire

The questionnaire included 65 questions on socio-demographic characteristics, general health, oral conditions, tobacco use, medication, headaches and oral and TMD symptoms. It was sent, together with a return envelope, to the individual's home address. The survey of symptoms of TMD included TMJ clicking sound, jaw or face pain, jaw tiredness, difficulties in opening wide, headaches and locking of the jaw. Each question addressed the past 3-month period and the symptom occurrence was reported on a frequency scale: No; Yes, occasionally; Yes, once or twice every week; Yes, several times a week; or Yes, daily. In the analysis the answers were dichotomized to denote respondents having symptoms once a week or more often as 'frequent symptom' and those remaining.

Clinical examination

The clinical examinations were performed by four teams in all the county's public dental clinics. Each team was composed of one dentist and one chair-side assistant, who were trained and calibrated before the study started. The percentage agreement and Kappa values obtained for the clinical variables varied from 85–93% and 0.68–0.84, respectively. The clinical examination related to function of the jaw and also to presence of signs of TMD, including TMJ sounds identified following auscultation (without the aid of a stethoscope) and bilateral palpation during mouth opening and closing. TMJ sounds were classified as dull clicking, sharp clicking or crepitation. Locking of one or both TMJs was assessed if the jaw opening was less than 25 mm, or a deviation of 5 mm or more occurred while opening wide. The TMJs were palpated laterally and posteriorly via the auditory meatus to identify TMJ pain to palpation. Only palpation led to a palpebral reflex in the eye or a protection reflex being registered. Pain following TMJ loading was assessed after having the participant bite hard for 30 s on a double wooden spatula (2 mm) placed at the region of the first molars of the right side; elicited pain in the contralateral joint was registered as TMJ load pain. The same procedure was repeated on the left side. TMJ pain during movements (opening wide, laterotrusion and protrusion) was registered. Maximal mandibular opening capacity was measured to the nearest millimeter with the aid of a ruler in accordance with Agerberg [24]. Muscle pain to palpation was assessed of the following muscle and/or tendon sites: anterior, posterior parts and attachments of the temporal muscles, superficial and deep parts of the masseter muscles, the area of the lateral pterygoid muscles' origin, the attachment of the medial pterygoid muscles, the sternocleidomastoid muscles, the trapezius muscles and the muscles of the forearm, thumb and calf. If palpation elicited a palpebral reflex in the eye or a protection reflex, pain at site was registered. Clench symptoms were registered if clenching in centric occlusal position for 30 s evoked fatigue or pain in the jaws.

A classification was also made in accordance with the anamnestic dysfunction index (Ai) [25]. Ai 0 denotes no symptoms; Ai 1, mild symptoms (TMJ sound or feelings of tiredness/fatigue of the jaws); and Ai 2, severe symptoms (pain in the face or jaws, pain on jaw movements, difficulties in opening the jaw wide, locking or luxation of the jaw). In this calculation only symptoms reported once a week or more were included. We also calculated the clinical dysfunction index (Di) based on grade of impaired range of maximal jaw opening, impaired TMJ function, presence of jaw muscle sites painful to palpation, TMJ pain and pain on jaw movements as devised by Helkimo [25]. Di 0 denotes no clinical signs; Di 1, mild signs; Di 2, moderate signs; and Di 3, severe signs of mandibular dysfunction.

Statistical method

The data analyses were done with STATA statistical software, version 10. Observed prevalence rates were calculated for each and for combinations of TMD signs and symptoms as well as headache within age-specific strata among men and women. The sample included in the analysis of TMD symptoms consisted of 495 men (51%) and 472 women (49%), with no significant differences in the gender distribution in each age group. The sample available for analysis of TMD signs consisted of 399 men (52%) and 368 women (48%), with no significant differences in the gender distribution in each age group. Due to the stratified sample, all prevalence figures were adjusted in relation to the proportion of individuals living in the respective parts of the county. The proportions were as follows: 35-year-olds, 0.79 (coastal) and 0.21 (inland); 50-year-olds, 0.75 (coastal) and 0.25 (inland); 65-year-olds, 0.70 (coastal) and 0.30 (inland); 75-year-olds, 0.67 (coastal) and 0.33 (inland). To compare the proportions, the Chi-square test was used. If the expected number in a cell was ≤5, Fisher's exact test was used. A p-Value less than 0.05 was considered statistically significant.

Results

The patterns of prevalence of frequent symptoms indicative of TMD and headaches among men and women in the four age groups are presented in Figure 1. The highest prevalence of frequent TMD symptoms was found for TMJ sounds among 50-year-old women (19%). The highest prevalence of frequent headaches (25%) was reported by 35- and 50-year-old women, while a statistically significant difference ($p < 0.05$) was noted between 50-year-

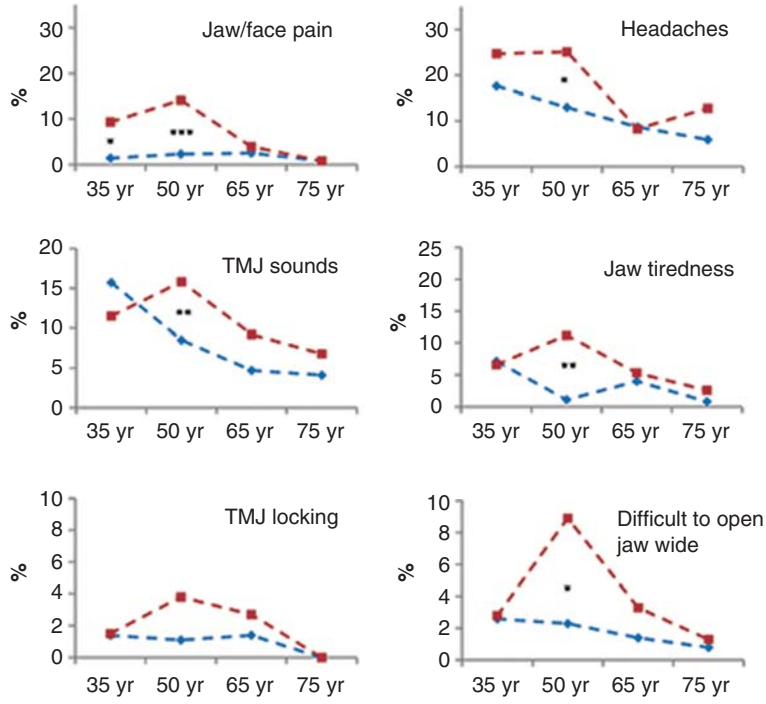

Figure 1. Percentage distribution of prevalence of weekly-to-daily occurring symptoms in the jaw–face–head region during the past 3 months among 35-, 50-, 65- and 75-year-old individuals. Dotted line is an extrapolation between the examined ages. Men (Blue): 35 years ($n = 126$), 50 years ($n = 126$), 65 years ($n = 128$) and 75 years ($n = 115$); Women (Red): 35 years ($n = 115$), 50 years ($n = 118$), 65 years ($n = 128$) and 75 years ($n = 111$). Statistically significant differences in prevalence between men and women indicated: $^{*}p \geq 0.01$ and < 0.05; $^{**}p \geq 0.001$ and < 0.01; $^{***}p < 0.001$.

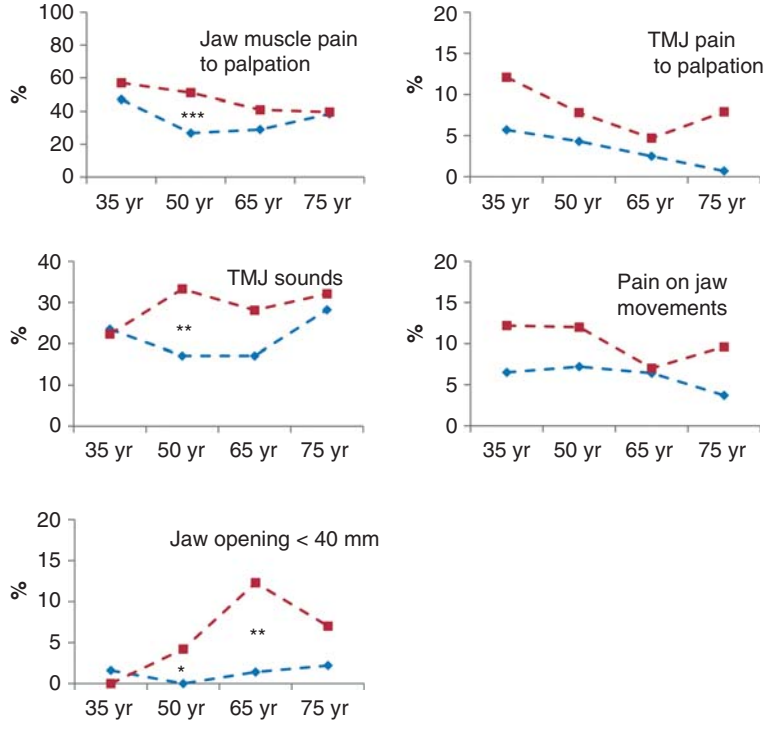

Figure 2. Percentage distribution of clinical signs of dysfunction of the jaw system among 35-, 50-, 65- and 75-year-old individuals. Dotted line is an extrapolation between the examined ages. Men (Blue): 35 years ($n = 111$), 50 years ($n = 94$), 65 years ($n = 104$) and 75 years ($n = 90$); Women (Red): 35 years ($n = 96$), 50 years ($n = 96$), 65 years ($n = 91$) and 75 years ($n = 85$). Statistically significant differences in prevalence between men and women indicated: $^{*}p$-Value ≥ 0.01 and < 0.05; $^{**}p \geq 0.001$ and < 0.01; $^{***}p < 0.001$.

old men and women. The prevalence pattern was quite similar for the six symptoms among women, showing a significantly lower prevalence among the 65–75-year-olds compared to the 50-year-olds ($p < 0.05$), for all symptoms except TMJ locking. The prevalence of the included symptoms did not differ statistically significantly between age groups among men.

The prevalence of TMD signs is presented in Figure 2. The pattern indicates a higher prevalence of TMD signs among women; however, statistically significant differences between genders were found only for muscle pain to palpation (50-year-old women), TMJ sounds (50-year-old women) and impaired maximal jaw opening (50- and 65-year-old women). No significant age-related difference was found for TMD signs, except for impaired jaw opening capacity among women ($p < 0.01$).

Among men, the peak prevalence of TMD symptoms according to the Ai (21%) was noted in the group of 35-year-olds (Figure 3). The difference in relation to the other ages was statistically significant ($p = 0.01$). No statistically significant age-related difference was found for the individual symptoms among men. Among women, the peak prevalence of TMD symptoms according to the Ai (29%) was noted for 50-year-old women ($p < 0.001$). A statistically significant age-related difference was found for all individual symptoms, except for jaw tiredness and jaw locking among women.

There was a statistically significant difference between men and women for presence of signs of dysfunction according to the Di in the groups of 50-year-olds ($p < 0.001$) and 65-year-olds ($p < 0.01$). One-third to 2/3 of the study population had a Di registration >0. No statistically significant difference in Di distribution was found between age groups, among either men or women (Figure 4).

Figure 5 presents a graph of the prevalence of frequently occurring symptoms indicative of TMD or frequent headaches in combination with moderate-to-severe signs indicative of TMD. In total, 10% of the study population had such a combination (15% of

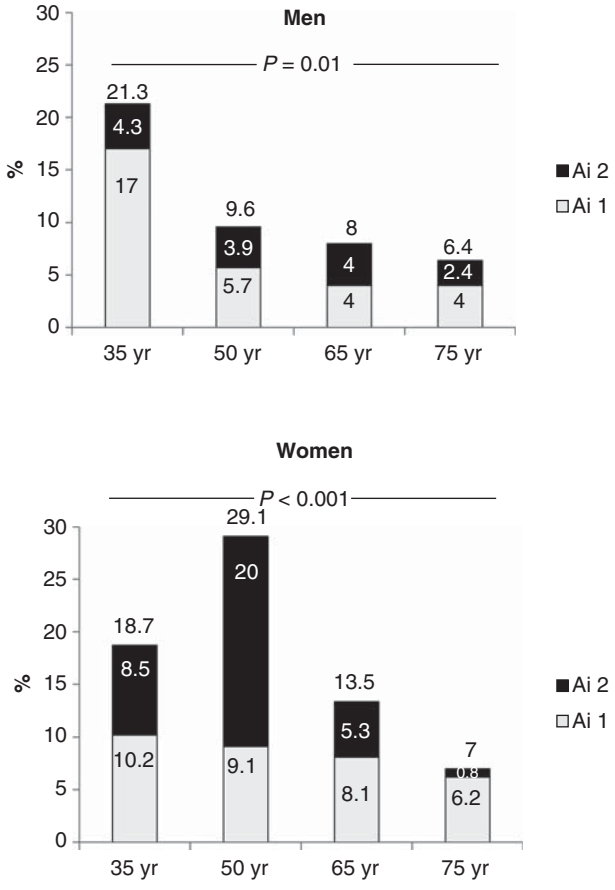

Figure 3. Percentage distribution of prevalence of weekly-to-daily symptoms in the jaw–face region during the past 3 months according to the anamnestic dysfunction index (Ai) among 35-, 50-, 65- and 75-year-old individuals. Ai 1 denotes mild symptoms (TMJ sounds or jaw tiredness) and Ai 2 denotes severe symptoms (jaw pain or impaired jaw opening or jaw locking or luxation). Men: 35 years ($n = 126$), 50 years ($n = 126$), 65 years ($n = 128$), and 75 years ($n = 115$); Women: 35 years ($n = 115$), 50 years ($n = 118$), 65 years ($n = 128$) and 75 years ($n = 111$).

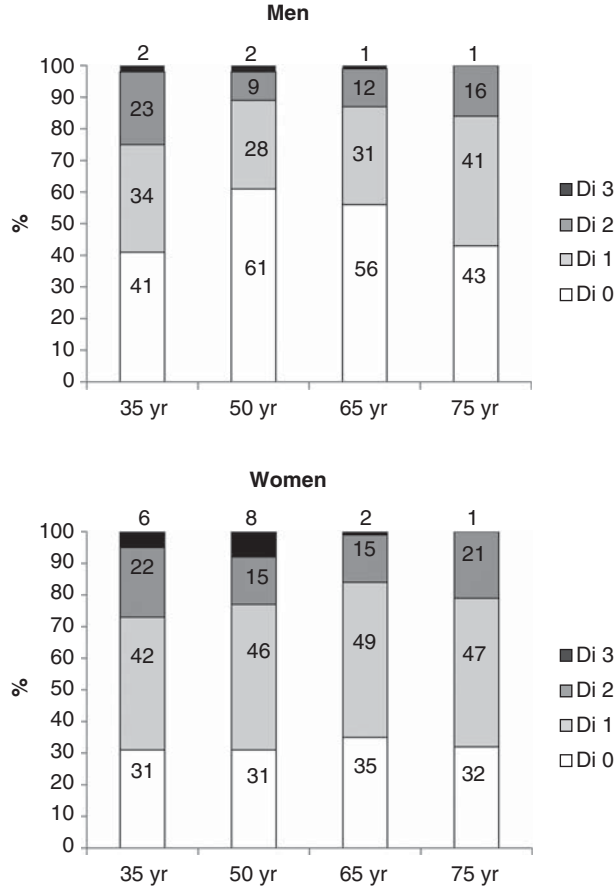

Figure 4. Prevalence of clinical signs of dysfunction of the jaw system according to the clinical dysfunction index (Di) among 35-, 50-, 65- and 75-year-old individuals. Di 0 denotes no signs, Di 1 denotes mild signs, Di 2 denotes moderate signs and Di 3 denotes severe signs of dysfunction. Men: 35 years ($n = 111$), 50 years ($n = 94$), 65 years ($n = 104$) and 75 years ($n = 90$); Women: 35 years ($n = 96$), 50 years ($n = 96$), 65 years ($n = 91$) and 75 years ($n = 85$).

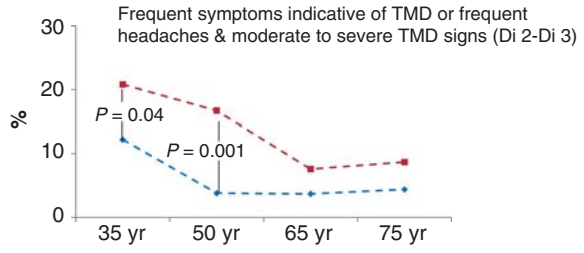

Figure 5. Prevalence of those with a combination of moderate-to-severe clinical signs of dysfunction of the jaw system according to the clinical dysfunction index (Di) and frequent headaches or frequent symptoms indicative of temporomandibular disorders among 35-, 50-, 65- and 75-year-old individuals. Dotted red line denotes women and dotted blue line denotes men. Men: 35 years ($n = 111$), 50 years ($n = 94$), 65 years ($n = 104$) and 75 years ($n = 90$); Women: 35 years ($n = 96$), 50 years ($n = 96$), 65 years ($n = 91$) and 75 years ($n = 85$). A statistically significant difference between men and women for the conditions is indicated with a p-Value.

the women and 6% of the men, $p < 0.001$). A statistically significant difference between men and women in the younger age groups was noted, but not in the older age groups.

Discussion

This study shows that headaches and symptoms indicative of TMD have quite similar age- and gender-related patterns. From the ages of retirement, the prevalence of frequent TMD symptoms and headaches was almost the same in men and women. The first hypothesis was, thus, partly rejected. Middle-aged women had the highest prevalence of TMD symptoms in this sample of 35-, 50-, 65- and 75-year-olds. The condition of having both frequent symptoms and moderate-to-severe signs of TMD was significantly more commonly seen among women and, for 10% of the total study population, a figure that closely approximated the estimated needs for active treatment owing to TMD [26].

The gender-related pattern of frequent TMD symptoms was not uniform across the age groups, based on the cross-sectional analysis. A lower and similar prevalence of TMD symptoms and headaches in older ages was generally observed. Most TMD symptoms were reported at a fairly low prevalence among men, except for TMJ sounds, while women reported a high prevalence of most TMD symptoms, especially in the group of 50-year-olds. In a questionnaire study among 50-year-olds living in two counties in Sweden in 2002 [27], 16.5% of the women and 12% of the men reported TMJ sounds, while pain in the TMJ region was reported among 12.4% of the women and 6.7% of the men. The differences between men and women were statistically significant. These prevalence figures were, compared to the results from the present study, fairly similar for women, but higher among men. In a survey from the city of Jönköping, Sweden, in 2003 [12], among 20–70-year–olds, a peak of severe TMD symptoms was also observed in the group of 50-year-olds (men and women taken together). The results based on two cohorts in Göteborg, Sweden, of 70-year-old subjects examined in 1992–1993 and 2000–2001, respectively [3], resemble both prevalence figures and the non-significant differences between men and women in this age group. In a study based on a German population of 20–79 years old, gender differences were observed for TMD symptoms in the 20–59-year-old age groups, but not in the sample of 60–80-year-olds [28]. Even though these studies were done in almost the same period, direct comparisons of prevalence figures are hazardous, since neither the wording of the questions nor the interview methods were the same. The observed age-related pattern of TMD symptoms and headaches were, however, fairly similar in the surveys from other communities in Sweden [12,29]. A similar pattern of declining prevalence of reported pain in the jaw–face region from middle age onwards has been found previously in a sample from the US [30]. In a sample of Sami women living in the Arctic region of Sweden [31], the lowest prevalence of grievous TMD symptoms and headache was found in the oldest age group (61–70 years old). It is not known whether the observed declining prevalence of symptoms relates to changes in the trigeminal innervations due to an aging process or if it reflects other age-associated effects, such as presence of co-morbid diseases, and changed living conditions [32]. The most pronounced change seems to affect women around the time of menopause. A decrease in pain perception in women after menopause may relate to changes in sex hormones [33], but such alteration has also been questioned [34], and can hardly explain the decrease in reported TMJ locking and sounds, especially since the prevalence of registered TMJ sounds did not follow a similar pattern. The noted decrease in frequent symptoms in the jaw–face region may also be related to adaptation and normalization processes; if a subject has had a symptom for a long time and even adjusted his or her behavior accordingly, the awareness of the symptom may subside. A further possibility is that the noted age difference may be related to specific changes in the individual's social life following retirement, and fewer demands from work and family life. The observation may even be related to generation-specific differences. This hypothesis is to some extent supported in cross-sectional studies from the city of Jönköping [12] and from the counties of Örebro and Östergötland, Sweden [27], indicating a time trend of an increasing prevalence of TMD symptoms. The second hypothesis was rejected concerning men and partly accepted with respect to women.

Signs of TMD were commonly registered in this study as well as in others using similar methodology [8,11,28,35]. The similarity in distribution of the four

grades of the dysfunction index between ages was striking; thus the third hypothesis was rejected. This result differed from those of Salonen et al. [11] and Rutkiewicz et al. [35], who observed an increasing prevalence of clinical signs with age, but were similar to that found in a German population [28]. The two most common signs were tenderness to palpation at jaw muscle sites and temporomandibular joint sounds. The validity of these clinical signs in relation to an ongoing or potentially harmful disorder has been questioned [36,37]. In a prospective study based on dental students, presence of clinical signs without presence of symptoms predicted onset of both TMD pain and headache during a 2-year period [38]. In an analysis of the significance of presence and distribution of sites tender to palpation, those with jaw muscle tenderness and neck/shoulder muscle tenderness as well as those with a generalized pain pattern had significantly higher risk of TMD symptoms and headaches [39]. These clinical signs, although frequently observed in the population, may thus indicate a pathophysiological process that is related to pain and dysfunction. In clinical practice the co-existence of both signs and symptoms is an essential part in the diagnostic process. From that perspective it was interesting to note that, when frequent symptoms and moderate to severe signs were combined, the prevalence of this construct was close to estimates of treatment needs owing to TMD [26,40].

Strengths and limitations

The study was based on a random selection from among four age groups living in two parts of a county in northern Sweden, one densely and one sparsely populated. To ensure representativeness of the population under study, the prevalence figures were weighed in relation to the regional demography. The response rate to the questionnaire was good and the number of participants attending the clinical examination acceptable. Non-response bias might still have affected the prevalence figures to some degree, since there may have been a shift towards higher presence of disorders among the participants offered a clinical examination that was free of charge. This was also the reason that we included all respondents to the questionnaire in this report. In the questionnaire only the presence of symptoms occurring weekly to daily during the past 3 months was taken into account, to reduce the risk of recall bias. Questions capturing symptoms that occur with a frequency of weekly or more often have been shown to increase the reliability of the measurement [41]. We used a small number of examiners thoroughly calibrated, and in the registrations of signs of palpation only those that elicited a palpebral reflex were used, since this has been shown to improve the reliability of the measurement [42].

Owing to the design of the study, it is not possible to identify a direct causal relationship. The analyses were based on a study population examined during the period from Autumn 2002 to Spring 2003. The results should, thus, be mirrored to studies done in a similar time period and among similar age groups. Even though some time has passed since the data were gathered, we consider the results important for the understanding of TMD signs and symptoms at different ages, as well as among men and women. Future analyses might focus on relationships between sociodemographic characteristics, general health and TMD.

Conclusions

Frequent symptoms of TMD and headaches show a similar pattern, with higher prevalence during the period of 35–50 years of age as compared to the period 65–75 years old. The pattern may be related to biological, psychosocial or generation-related factors.

Acknowledgments

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Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

[1] Okeson JP. Differential diagnosis and management considerations of temporomandibular disorders. In Okeson JP, editor. Orofacial pain: guidelines for assessment, diagnosis, and management. Chicago, IL: Quintessence; 1996. p 113–84.

[2] Dahlström L, Carlsson GE. Temporomandibular disorders and health–related quality of life. A systematic review. Acta Odontol Scand 2010;68:80–5.

[3] Österberg T, Carlsson GE. Relationship between symptoms of temporomandibular disorders and dental status, general health and psychosomatic factors in two cohorts of 70-year-old subjects. Gerodontology 2007;24:129–35.

[4] Johansson A, Unell L, Carlsson GE, Söderfeldt B, Halling A, Widar F. Association between social and general health factors and symptoms related to temporomandibular disorders and bruxism in a population of 50-year-old subjects. Acta Odontol Scand 2004;62:231–7.

[5] Wänman A, Agerberg G. Two-year longitudinal study of symptoms of mandibular dysfunction in adolescents. Acta Odontol Scand 1986;44:321–31.

[6] Wänman A, Agerberg G. Two-year longitudinal study of signs of mandibular dysfunction in adolescents. Acta Odontol Scand 1986;44:333–42.

[7] Könönen M, Nyström M. A longitudinal study of craniomandibular disorders in Finnish adolescents. J Orofac Pain 1993; 7:329–36.

[8] Magnusson T, Egermark I, Carlsson GE. A prospective investigation over two decades on signs and symptoms of temporomandibular disorders and associated variables. A final summary. Acta Odontol Scand 2005;63:99–109.
[9] Wänman A. Longitudinal course of symptoms of craniomandibular disorders in men and women. A 10-year follow-up study of an epidemiologic sample. Acta Odontol Scand 1996; 54:337–42.
[10] Macfarlane TV, Blinkhorn AS, Davies RM, Kincey J, Worthington HV. Oro-facial pain in the community: prevalence and associated impact. Community Dent Oral Epidemiol 2002;30:52–60.
[11] Salonen L, Hellden L, Carlsson GE. Prevalence of signs and symptoms of dysfunction in the masticatory system: an epidemiologic study in adult Swedish population. J Craniomandib Disord Facial Oral Pain 1990;4:241–50.
[12] Köhler AA, Hugoson A, Magnusson T. Prevalence of symptoms indicative of temporomandibular disorders in adults: cross-sectional epidemiological investigation covering two decades. Acta Odontol Scand 2012;70:213–23.
[13] Agerberg G, Carlsson GE. Functional disorders of the masticatory system. I. Distribution of symptoms according to age and sex as judged from investigation by questionnaire. Acta Odontol Scand 1972;30:597–613.
[14] Agerberg G, Bergenholts A. Craniomandibular disorders in adult populations of West Bothnia, Sweden. Acta Odontol Scand 1989;47:129–40.
[15] Pihlgren K, Forsberg H, Sjödin L, Lundgren P, Wänman A. Changes in tooth mortality between 1990 and 2002 among adults in Västerbotten County, Sweden: influence of socioeconomic factors, general health, smoking, and dental care habits on tooth mortality. Swed Dent J 2011;35:77–88.
[16] Hugoson A, Koch G. Thirty year trends in the prevalence and distribution of dental caries in Swedish adults (1973–2003). Swed Dent J 2008;32:57–67.
[17] Hugoson A, Sjödin B, Norderyd O. Trends over 30 years, 1973–2003, in the prevalence and severity of periodontal disease. J Clin Periodontol 2008;35:405–14.
[18] Helkimo M, Carlsson GE, Hedegård B, Helkimo E, Lewin T. Function and dysfunction of the masticatory system in Lapps in northern Finland. Preliminary report of an epidemiological investigation. Sven Tandlak Tidskr 1972;65:95–105.
[19] Macfarlane TV, Glenny AM, Worthington HV. Systematic review of population-based epidemiological studies of orofacial pain. J Dent 2001;29:451–67.
[20] Mundt T, Mack F, Schwahn C, Bernhardt O, Kocher T, Biffar R. Association between socio-demographic, behavioral, and medical conditions and signs of temporomandibular disorders across gender: Results of the study of health in Pomerania (SHIP-0). Int J Prosthodont 2008;21:141–8.
[21] Fillingim RB, King CD, Ribeiro-Dasilva MC, Rahim–Williams B, Riley JL 3rd. Sex, gender, and pain: a review of recent clinical and experimental findings. J Pain 2009;10: 447–85.
[22] Hoffmann RG, Kotchen JM, Kotchen TA, Cowley T, Dasgupta M, Cowley AW. Temporomandibular disorders and associated clinical morbidities. Clin J Pain 2011;27: 268–74.
[23] Bernhardt O, Gesch D, Schwahn C, Mack F, Meyer G, John U, et al. Risk factors for headache, including TMD signs and symptoms, and their impact on quality of lie. Results of the study of health in Pomerania (SHIP). Quintessence Int 2005;36:55–64.
[24] Agerberg G. Maximal mandibular movements in young men and women. Swed Dent J 1974;67:81–100.
[25] Helkimo M. Study on function and dysfunction of the masticatory system. II. Index for anamnestic and clinical dysfunction and occlusal state. Sven Tandlak Tidskr 1974;67:101–21.
[26] Kuttila M, Niemi PM, Kuttila S, Alanen P, Le Bell Y. TMD treatment need in relation to age, gender, stress, and diagnostic subgroup. J Orofac Pain 1998;12:67–74.
[27] Johansson A, Unell L, Carlsson EG, Söderfeldt B. Gender differences in symptoms related to temporomandibular disorder in a population of 50-year-old subjects. J Orofac Pain 2003;17:29–35.
[28] Gesch D, Bernhardt O, Alte D, Schwahn C, Kocher T, John U, et al. Prevalence of signs and symptoms of temporomandibular disorders in an urban and rural German population: results of a population-based study of health in Pomerania. Quintessence Int 2004;35:143–50.
[29] Molarius A, Tegelberg A. Recurrent headache and migraine as a public health problem–A population-based-study in Sweden. Headache 2006;46:73–81.
[30] Von Korff M, Dworkin SF, Le Resche L, Kruger A. An epidemiologic comparison of pain complaints. Pain 1988; 32:173–83.
[31] Mienna CS, Wänman A. Self-reported impact on daily life activities related to temporomandibular disorders, headaches, and neck-shoulder pain among women in a Sami population living in Northern Sweden. J Orofac Pain 2012;26:215–24.
[32] Gibson SJ, Helme RD. Age-related differences in pain perception and report. Clin Geriatr Med 2001;17:433–56.
[33] Craft RM. Modulation of pain by estrogens. Pain 2007;132: S3–12.
[34] Stening KD, Berg G, Hammar M, Voster H, Eriksson O, Amandusson A, et al. Influence of estrogen levels on thermal perception, pain thresholds, and pain tolerance: studies on women undergoing *in vitro* fertilization. J Pain 2012;13:459–66.
[35] Rutkiewicz T, Könönen M, Suominen-Taipale L, Nordblad A, Alanen P. Occurrence of clinical signs of temporomandibular disorders in adult Finns. J Orofac Pain 2006; 20:208–17.
[36] Greene CS, Marbach JJ. Epidemiologic studies of mandibular dysfunction: a critical review. J Prosthet Dent 1982;48: 184–90.
[37] Van der Weele L, Dibbets J. Helkimo's index: a scale or just a set of symptoms. J Oral Rehabil 1987;14:229–37.
[38] Marklund S, Wiesinger B, Wänman A. Reciprocal influence on the incidence of symptoms in trigeminally and spinally innervated areas. Eur J Pain 2010;14:366–71.
[39] Wänman A. The relationship between muscle tenderness and craniomandibular disorders: a study of 35-year-olds from the general population. J Orofac Pain 1995;9:235–43.
[40] Wänman A, Wigren L. Need and demand for dental treatment. A comparison between an evaluation based on an epidemiologic study of 35-, 50- and 65-year -olds and performed dental treatment of matched age groups. Acta Odontol Scand 1995;53:318–24.
[41] Wahlund K, List T, Dworkin SF. Temporomandibular disorders in children and adolescents: reliability of a questionnaire, clinical examination and diagnosis. J Orofac Pain 1998; 12:42–51.
[42] Carlsson GE, Helkimo M, Agerberg G. Observer differences in clinical examination of the masticatory system. Tandlakartidningen 1974;66:565–72.