ACTA ODONTOLOGICA SCANDINAVICA
2020, VOL. 78, NO. 5, 377–383
https://doi.org/10.1080/00016357.2020.1730000

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE



# Does adolescent self-reported TMD pain persist into early adulthood? A longitudinal study

Ing-Marie Nilsson[a,b,c] and Thomas List[b,c]

[a]Center for Oral Rehabilitation, FTV Östergötland, Norrköping, Sweden; [b]Orofacial Pain and Jaw Function, Malmö University, Malmö, Sweden; [c]Scandinavian Center for Orofacial Neurosciences, Malmö, Sweden

**ABSTRACT**

**Objective:** To follow up 2209 individuals in a longitudinal study and assess self-reported TMD pain, painful and non-painful comorbid conditions, and pain-related disability.

**Material and methods:** During 2012–2014, questionnaires were sent to 2209 eligible individuals who had been screened for TMD pain each year during 2000–2003. The two screening questions were (1) Do you have pain in the temple, face, jaw joint, or jaws once a week or more often? and (2) Do you have pain when you open your mouth wide or chew once a week or more often? If the patient answered 'yes' to one or both of the questions, TMD pain was recorded. Non-respondents received reminders; telephone interviews were offered a randomised group. The questionnaire queried TMD pain, and painful and non-painful comorbid conditions.

**Results:** The overall response rate was 36.5%. Individuals were placed into one of four pain groups defined by their pain experience at baseline and at the follow-up: no TMD pain (69.0%), new TMD pain (13.0%), previous TMD pain (9.9%), and persistent TMD pain (8.1%). Based on the self-report surveys, significantly more responders with TMD pain at follow-up had had pain as adolescents than not. Of adolescents with TMD pain, 45.1% had pain at follow-up as young adults, while 15.8% had pain at follow-up without a previous history of TMD pain. Individuals with persistent TMD pain had high frequencies of comorbid pains ($p < .001$), 45.2% reported moderate-severe depression scores ($p < .001$), and 13.0% had moderate pain-related disability (GCPS).

**Conclusions:** Based on self-report surveys, TMD pain in adolescence appears to triple the risk of TMD pain in young adulthood, and persistent pain increased comorbid pain and psychosocial distress.

**ARTICLE HISTORY**
Received 16 August 2019
Revised 30 January 2020
Accepted 10 February 2020

**KEYWORDS**
Adolescents; bodily pain; depression; longitudinal study; orofacial pain

## Introduction

Temporomandibular disorder (TMD) pain is common, and its prevalence in adolescence is increasing [1,2]. More girls than boys are affected [3], and the TMD pain pattern is in most cases fluctuating [4]. Chronic benign pain in childhood and adolescence is common and to a large extent seems to be persistent, although such pain seldom worsens over time [5]. Temporal patterns of pain (trajectories) have been identified in adolescents, and only a small minority report persistent pain, which was usually a single pain site [6].

Comorbidities of TMD pain may be non-painful or painful. One of the non-painful comorbidities, psychosocial distress, may be a significant component of the clinical presentation of TMD pain and other pain conditions, in adolescents as well as in adults [7–10]. Psychosocial comorbidities have been found to contribute to the onset and persistence of TMD pain [11]. The most common of the painful comorbidities are headache, neck pain, and back pain, which both adolescents and adults with TMD pain frequently report [7,11–16].

The Rammelsberg et al. study on adults with myofascial TMD pain found that, over a 5-year period, 36% were recurrent cases and 31% presented persistent pain. The study was prospective in its design and demonstrated how baseline pain frequency, number of painful palpation sites, and total number of body sites with pain predict persistent pain – chronicity. Those who had recovered from TMD pain had reduced depression scores at the follow-ups; the groups with recurrent or persistent pain experienced no change in depression [17]. A 7.6-year follow-up within the OPPERA study found that individuals who had chronic TMD pain at baseline were able to improve their TMD symptoms and jaw function, and reduce somatic complaints, whereas those who developed TMD pain during this period presented reduced psychosocial function. The authors concluded that clinical and psychosocial variables frequently change in parallel with TMD status [18].

A 13-year follow-up study found that pain reports in childhood and early adolescence were associated with a history of pain in early adulthood [19]. Likewise, another study found children with headache to be at a higher risk of recurring headache in adulthood [20]. Few studies have collected data on the presence of TMD pain in the same individuals over time [10,21]. We wanted to study those who did not have and those who had had TMD pain as adolescents in an

CONTACT Ing-Marie Nilsson ing-marie.nilsson@regionostergotland.se Center for Oral Rehabilitation, FTV Östergötland, SE-601 82 Norrköping, Sweden

attempt to determine the occurrence of TMD pain in young adulthood and the extent of painful and non-painful comorbidities, although data on comorbidities were not collected at baseline. Longitudinal studies investigating TMD have often focussed on clinical variables, not self-reported pain, which most often is the reason for seeking care [22]. The importance of using patient-reported outcome measures (PROM) has been highlighted, not least concerning conditions such as TMD pain, and should be seen in a biopsychosocial context [23]. Pain is a suffering experience for the individual, and a burden for both the individual and society. The economic burden to society for diagnosing and treating TMD pain is enormous [24]. That aspect makes it also important to prevent young people from developing chronic pain.

In a previous longitudinal study of the same population, we followed a subgroup of adolescents for 4 years. In this group, we noted a fluctuation in TMD pain over time and a few who had continued pain [4]. We wanted to know what happens to adolescents who have TMD pain, and whether they are more likely to develop TMD pain as young adults. Thus the aims of this longitudinal study in 2209 individuals were to *(i)* follow up adolescents without and with TMD pain, assessing the extent that they have developed, or continue to have, TMD pain as young adults and *(ii)* assess the extent that adolescents with TMD pain have painful comorbidities, pain-related disability, and jaw function limitation as adults, and non-painful comorbidities such as depression. Hypotheses: Young adults who had TMD pain as adolescents will report TMD pain to a higher extent than young adults who had no TMD pain as adolescents. Young adults who had TMD pain as adolescents will report painful comorbidities, like headache, neck pain and back pain, pain-related disability, and jaw function limitation, to a higher extent than young adults who had no TMD pain as adolescents. Young adults who had TMD pain as adolescents will report non-painful comorbidities, like depression/anxiety, to a higher extent than young adults who had no TMD pain as adolescents.

## Materials & methods

### Study design

The study was carried out over two time periods, 2000–2003 and 2012–2014. Each year for 4 years during 2000–2003, the 2209 participants were asked two screening questions at their annual dental check-up to determine the presence of ambient or functional jaw pain: (1) Do you have pain in the temple, face, jaw joint, or jaws once a week or more often? and (2) Do you have pain when you open your mouth wide or chew once a week or more often? If the patient answered 'yes' to one or both of the questions, TMD pain was recorded as '1'. If the patient answered 'no' to both questions, TMD pain was recorded as '0' [4]. The reliability and validity of these questions have been found to be good [25,26].

During the second time period, 2012–2014, questionnaires were sent to all eligible individuals ($n = 2209$) who had been screened for TMD pain at their Public Dental Service clinic each year in the first time period [4]. The questionnaire asked the same screening questions about TMD pain as in the first time period. The questionnaire also included instruments covering TMD pain (pain intensity, Graded Chronic Pain Scale [GCPS]), painful comorbid conditions (comorbid pain sites), non-painful comorbid conditions (depression, Patient Health Questionnaire [PHQ-9]), psychosocial status (Patient Health Questionnaire [PHQ-9]), and pain-related disability (Graded Chronic Pain Scale [GCPS] and Jaw Function Limitation Scale [JFLS].

Due to the initial low response rate [$n = 471$], we shortened the postal questionnaire and after the ethics committee renewed their approval of the study, we offered telephone interviews as an alternative to the postal questionnaire. The non-respondents ($n = 1738$) were divided into two groups: individuals with previous TMD pain ($n = 197$) and individuals without previous TMD pain ($n = 1541$). In each group, the individuals were randomised; the individuals were then contacted in the order of randomisation. Reminders were sent to all 197 individuals who had had TMD pain as an adolescent, and to the first 254 (16%) on the list of the individuals who had not, offering the possibility of a telephone interview instead of a postal questionnaire. The remaining 1287 persons in the second group who had had no pain as an adolescent received only the postal questionnaire as a reminder. Sixty-six individuals in the group with TMD pain as adolescents and 55 in the group with no previous TMD pain were interviewed over the telephone. The reason for not offering everybody a telephone interview was lack of time and staff. Also, we wanted to reach as many as possible who had previously had TMD pain, and get their answers. The flow chart in Figure 1 illustrates this procedure.

The Ethics committee of the Faculty of Health Sciences at Linköping University approved the study (Dnr [Daybook No.] 2011/356-32 and 2013/339-32).

### Definition of self-reported TMD pain

We defined the first measurement period of 2000–2003 as baseline and follow-up as 2012–2014. According to their responses to the screening questions, we placed individuals into one of four pain groups defined by their pain experience at baseline and at the 10-year follow-up ([*0* = no TMD pain or *1* = TMD pain at baseline]/[*0* = no TMD pain or *1* = TMD pain 10 years later]):

*0/0* (no TMD pain)

*0/1* (new TMD pain)

*1/0* (previous TMD pain)

*1/1* (persistent TMD pain)

### Comorbid pain complaints

We determined presence of other bodily pain complaints by asking the patient, 'Do you have recurrent or chronic pain in your body? Headache? Neck? Back? Stomach? Joints? Chest?

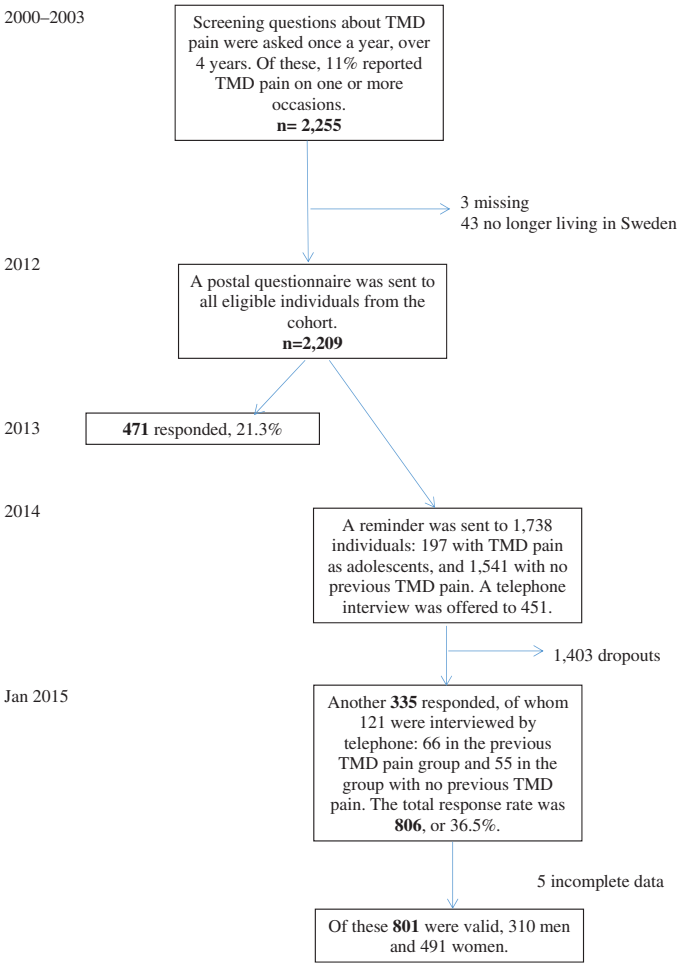


**Figure 1.** Flow chart.

All over your body?' The questions were dichotomous: yes or no.

### *Graded chronic pain scale (GCPS)*

The GCPS is a self-report instrument that uses seven questions to query pain intensity, interference of pain in daily activities, and number of disability days. These items yield a score of 0–IV: Grade 0 is defined as no TMD pain in the last 3 months. Grades I–IV require a patient report of TMD pain once a week or more often. Grade I is defined as TMD pain of low intensity that averages less than 5 on a numeric rating scale (NRS; a 0–10 scale, where 0 = no pain, 10 = worst pain imaginable) and is associated with little pain-related interference with daily living. Grade II is defined as high-intensity pain (5 or above on an NRS) with low amounts of pain-related interference. Grades III and IV reflect moderate and significant pain-related psychosocial disability regardless of pain level [27,28].

### *Jaw function limitation scale-20 (JFLS-20)*

The JFLS-20 is a 20-item instrument for assessing the functional status of the masticatory system. The patient grades the items on a 0–10 NRS anchored by the endpoints 'no limitation' and 'extreme limitation'. Good reliability and validity have been found for the three constructs assessing limitations in mastication, jaw mobility, and verbal and emotional expression [29].

### *Patient health questionnaire-9 (PHQ-9)*

The PHQ-9 is a 9-item depression scale, where each item is scored from 0 to 3; this yields a severity score of 0–27. The PHQ-9 is a reliable and valid measure of depression severity. Individuals scoring $\leq$9, with no–mild depression are considered to have no depressive disorder, while scores $\geq$10 indicate moderate–severe depression [30].

### *Statistical analysis*

Descriptive statistics and 95% CI were used to analyse the data. The chi-square test and Fisher's exact test analysed between-group differences for categorical variables. Analyses were adjusted for gender. Relative risk was calculated for the proportion with current TMD pain. The level of significance was set at $p < .05$.

## Results

The questionnaire response rate was 36.5% ($n = 806$); 801 responded to all TMD pain items. Figure 1 presents a flow chart of the study.

Table 1 presents the distribution of responders among the four pain groups. The incidence of TMD pain over this follow-up period would be 104 of 657 who had not previously reported pain, or 15.8% over 10 years, 1.58% per year, or 1.58 per 100 person-years of follow-up.

The proportion with current TMD pain was significantly higher in the group that had had pain as adolescents. Of the adults who had had TMD pain as adolescents, 45.1% had pain at follow-up. Of those who did not report TMD pain as adolescents, only 15.8% had TMD pain at follow-up. TMD pain in adolescence appears to almost triple the risk of TMD pain in young adulthood (relative risk = 2.9, 95% CI [2.2–3.7]).

Table 2 shows the proportion of responders in each TMD pain category who had comorbid complaints at follow-up. Individuals with *persistent TMD pain* had high proportions of painful comorbidities, as did those with *new TMD pain*. Individuals with *previous TMD pain* reported fewer comorbidities than the *persistent TMD pain* group. Those without TMD pain at either time point (the *no TMD pain* group) reported the fewest pain complaints.

All reported pains were significantly more common in the *persistent TMD pain* group than in the *no TMD pain* group. Significantly more individuals in the *previous TMD pain* group reported painful comorbidities than in the *no TMD pain* group. The *persistent TMD pain* group had significantly more severe joint pain and pain in many parts of the body than did the *new TMD pain* group. Compared with the two groups without TMD pain at follow-up (the *previous* and the *no TMD pain* groups), persons with *persistent TMD pain* were nearly

15 times more likely to report pain from multiple bodily regions (32.3% vs 2.2%).

Jaw function was evaluated using the 20-item JFLS where higher scores indicate higher limitation (Table 3). Individuals with pain at follow-up (the *persistent* or *new TMD pain* groups) had clear limitations in jaw function compared with individuals with no pain at follow-up (the *previous* and the *no TMD pain* groups). The JFLS subscales also showed substantial differences between *persistent* and *new TMD pain* versus *previous* and *no pain*. Mastication, mobility, and communication subscores were 6–14 times higher among those presently experiencing TMD pain than those who were not.

The majority of individuals in the *persistent* (59%) and the *new* (71%) *TMD pain* groups had pain of low intensity and little pain-related disability (GCPS grade I). In these pain profiles, 29% and 22%, respectively, reported TMD pain of higher intensity and low pain-related disability (GCPS grade II); 13% and 7% had GCPS grade III, moderate pain-related disability. No patient had grade IV pain-related disability. Individuals with *new TMD pain* scored an average pain intensity of (mean, 95% CI) NRS 3.5 (95% CI [3.15–3.91]) and individuals with *persistent TMD pain* scored slightly higher, an average NRS of 4.4 (95% CI [3.90–4.81]).

Moderate to severe depression measured with the PHQ-9 was much more common for individuals who reported pain as young adults (the *persistent* [45%] and the *new* [32%] *TMD pain* groups) compared to those who did not report current pain (the *previous* [16%] and the *no* [7%] *TMD pain* groups). Comparisons of the proportions of depression within the *no* and the *persistent TMD pain* groups differed significantly ($p < .001$). Comparisons of the *no* with the *previous* ($p = .066$) *TMD pain* groups and of the *new* with the *persistent* ($p = .092$) *TMD pain* groups showed borderline or no significant differences (Table 4).

## Discussion

Our main findings are that around half of the teenagers who report TMD pain will have pain as young adults, and that a

**Table 1.** Distribution of the 801 eligible responders at the follow-up of temporomandibular disorder (TMD) pain among adolescents (baseline, 2000–2003; follow-up, 2012–2014; 1 = TMD pain; 0 = no TMD pain).

| TMD pain | | |
|---|---|---|
| | Follow-up | |
| Baseline | 1 | 0 |
| 1 | $n = 65$ (8%) | $n = 79$ (10%) |
| 0 | $n = 104$ (13%) | $n = 553$ (69%) |

These form the four TMD pain groups in the present study: 1/1 = persistent TMD pain, 1/0 = previous TMD pain, 0/1 = new TMD pain, and 0/0 = no TMD pain.

**Table 4.** Proportion with depressive symptoms in the various TMD pain profiles at follow-up, as rated on the Patient Health Questionnaire (PHQ)-9, a 9-item depression scale that yields an overall severity score between 0 and 27.

| | Overall PHQ-9 score | | |
|---|---|---|---|
| TMD pain group | 0–9 (no–mild depression) *N* (%) | 10–27 (moderate–severe depression) *N* (%) | Total *N* (%) |
| *No TMD pain* | 486 (90.7) | 50 (9.3) | 536 (100) |
| *Previous TMD pain* | 62 (83.8) | 12 (16.2) | 74 (100) |
| *New TMD pain* | 68 (68.0) | 32 (32.0) | 100 (100) |
| *Persistent TMD pain* | 34 (54.8) | 28 (45.2) | 62 (100) |
| Total | 650 (84.2) | 122 (15.8) | 772 (100) |

The following comparisons between groups were significant:
No TMD pain – New TMD pain: $p = <.001$.
No pain – Persistent TMD pain: $p = <.001$.
Previous TMD pain – Persistent TMD pain: $p = .001$.

**Table 2.** Proportion with bodily pain in temporomandibular disorder (TMD) pain categories at the follow-up.

| | Pain profile | | | | | | |
|---|---|---|---|---|---|---|---|
| | *No TMD pain–0/0* | *Previous TMD pain–1/0* | | *New TMD pain–0/1* | | *Persistent TMD pain–1/1* | |
| Painful comorbidity | (%) | (%) | $p^a$ | (%) | $p^b$ | (%) | $p^c$ |
| Headache | 15.4 | 36.7 | <.001 | 55.8 | .081 | 69.2 | <.001 |
| Neck pain | 19.3 | 30.4 | .023 | 58.7 | .862 | 60.0 | <.001 |
| Back pain | 24.9 | 34.2 | .078 | 47.1 | .215 | 56.9 | <.001 |
| Stomach pain | 13.4 | 19.0 | .179 | 30.8 | .834 | 32.3 | <.001 |
| Joint pain | 8.9 | 21.5 | .001 | 22.1 | .013 | 40.0 | <.001 |
| Chest pain | 4.3 | 2.5 | .758 | 10.6 | .969 | 10.8 | .033 |
| Pain in multiple body regions | 2.2 | 11.4 | <.001 | 14.4 | .006 | 32.3 | <.001 |

[a]Comparison of *No TMD pain–0/0* and *Previous TMD pain–1/0*. [b]Comparison of *New TMD pain–0/1* and *Persistent TMD pain–1/1*. [c]Comparison of *No TMD pain–0/0* and *Persistent TMD pain–1/1*.

**Table 3.** TMD pain groups and scores for the 20-item Jaw Function Limitation Scale (JFLS), *at the follow-up*.

| | | JFLS-20 subscales | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mastication | | Mobility | | Verbal and emotional communication | | JFLS Total | |
| TMD pain groups | *N* | Mean | 95% CI | Mean | 95% CI | Mean | 95% CI | Mean | 95% CI |
| *No TMD pain* | 537 | 0.1 | 0.08–0.16 | 0.1 | 0.07–0.15 | 0.1 | 0.04–0.11 | 0.1 | 0.07–0.12 |
| *Previous TMD pain* | 79 | 0.2 | 0.05–0.33 | 0.2 | 0.05–0.28 | 0.1 | 0.02–0.09 | 0.1 | 0.06–0.18 |
| *New TMD pain* | 103 | 0.9 | 0.59–1.12 | 0.8 | 0.53–1.08 | 0.6 | 0.35–0.82 | 0.7 | 0.48–0.93 |
| *Persistent TMD pain* | 65 | 1.0 | 0.76–1.29 | 1.4 | 0.97–1.84 | 0.8 | 0.51–1.08 | 1.0 | 0.72–1.25 |
| Total | 784 | 0.3 | 0.24–0.35 | 0.3 | 0.25–0.38 | 0.2 | 0.15–0.25 | 0.3 | 0.20–0.30 |

The JFLS-20 items are graded on a 0–10 numeric rating scale anchored by the endpoints 'no limitation' and 'extreme limitation'. The number of items on the JFLS subscales vary: mastication, 6; mobility, 4; verbal and emotional communication, 10.

history of TMD pain in adolescence almost triples the risk of reporting TMD pain as a young adult. Similar results have been reported in a longitudinal, Finnish study among adults, where previous TMD pain, defined as palpatory muscle pain, not self-report, could predict TMD pain 11 years later [31]. In this study pain over an extended period of time is associated with higher levels of depression and negative effects on jaw function. Those with persistent TMD pain reported more disability than those with new TMD pain. Persistent TMD pain is also related to a greater risk of pain in other areas of the body and of painful comorbidities which may be signs of central sensitisation [32].

Twelve to 15 years ago, we studied TMD pain in adolescence. We followed up these same adolescents as young adults, and we hypothesised that those who had reported recurrent and long-standing TMD pain problems as adolescents would also report pain problems as young adults. To our knowledge, no similar longitudinal follow-up study – on such a large TMD pain population in this younger age group – has been conducted. We chose patient-reported outcome measures, and we have included painful and non-painful comorbidities. Analysis of those data indicated that TMD pain in young adulthood seemed to have no association with intermittent, recurrent or continuous TMD pain at baseline. Therefore we formed new groups based on their history.

The response rate was 36.5%. An analysis of those who responded versus those who did not revealed no significant differences in age. Significantly more women than men responded. The response rate among those with TMD pain as adolescents was higher than among those initially TMD pain free, approximately 56% vs. 33%. This is most likely due to the telephone calls we made to all individuals who had had TMD pain as adolescents and only a subset of those not reporting TMD pain. The response rate was low but in line with previous work; for example, Tolonen et al. observed that survey response rates have declined over the past 25 years [33]. Also, young adults appear less likely to respond to surveys than older adults [34]. In our study, individuals with TMD pain at baseline were more likely to respond to the questionnaire than those without pain, and it is therefore possible that we may have overestimated the proportion of subjects with TMD pain. Based on how the study was organised and the difficulties in securing responses, we were unable to contact all study participants and achieve a higher response rate. The main question was how those with TMD pain felt when they became adults, and to compare with those who had not had pain as adolescents. We wanted to reach as many as possible who had had TMD pain in adolescence. Since there was a high drop-out rate, we decided to make a telephone call, which was not possible to do to the whole group. Therefore we selected a representative sample in a randomisation process. This is, however, a limitation compared to asking the questions in person. The group with no TMD pain as adolescents was handled the same way; order of contact was random. Thus, age and gender were unequal in the two groups.

Another limitation of the present study is the lack of repeated follow-ups during the 10-year-period. One result is that those who reported pain at both measurement points (the *persistent TMD pain* group) may have been pain-free at various times during the longitudinal follow-up, and not truly had persisting pain. The methodology for assessing pain also varied: at baseline, the TMD pain screening questions were asked verbally; at the follow-up, the questions were asked on a written questionnaire. When questions are asked verbally, it is possible for the questioner to provide details, for example, concerning the intended pain location. However, one study found that verbal enquiry alone yielded more inconsistent results than the written questionnaire [35]. The two screening questions used in the present study were tested for verbal use, and reliability and validity were both previously found to be very good [25].

Hunfeld et al. conducted a 3-year follow-up study of a group of adolescents with persistent pain and assessed pain, quality of life, and impact of pain on the family. Over the 3 years, the researchers found that conditions were stable and unchanged. The adolescents were coping well with their pain [36]. Brattberg followed a group of children and adolescents three times over 13 years, until they were young adults. She found 59% of women and 39% of men reporting pain as young adults. Twenty percent reported pain in all three assessments. Predictors for pain in young adulthood were back pain, headache once a week or more, and 'feeling nervous' at the age of 8–14 years [19]. Our study design does not allow us to find predictors, but it does seem likely that TMD pain in adolescence increases the risk of having TMD pain as young adult.

Individuals with TMD pain as young adults (the *new* and the *persistent TMD pain* groups) reported pain-related disability due to TMD pain; they also had pain in other body sites. The prospective study of Lim et al. also found that higher reports of headaches, muscle soreness or pain and other pains accompanied development of TMD compared with those without TMD [37]. Those with present TMD pain in our study also have significantly higher depression scores than those without, but the length of time the patient has had pain is not a significant factor. These comorbidities are burdens for the individual, and are important to recognise as they affect treatment and prognosis. Patients might not respond to standard treatment and may need additional therapies [38].

We used the JFLS-20 in the follow-up assessment, which is a validated measure of jaw functional limitations. The four groups in the present study can be pooled into two distinct groups, those with TMD pain as young adults (the *new* and the *persistent TMD pain* groups), and those with no TMD pain (the *no* and the *previous TMD pain* groups). Individuals in the first pooled group, with TMD pain at the follow-up, reported substantially greater limitations in jaw function in all domains – mastication, mobility and verbal/emotional communication – than those without pain. Since this study is population-based, our data may serve as normative data for this jaw function scale in young adults.

Based on self-report surveys, TMD pain appears to triple the risk of TMD pain in young adulthood. Given that methods are now available to screen for TMD pain and predict persistence, and that effective treatment is available, secondary prevention should now be possible. For example, in Sweden, adolescents are checked regularly, and if screening is standardised, individuals with TMD pain can be identified and offered treatment according to the national guidelines for management of orofacial pain [39]. If risk factors, such as psychosocial distress, for new onset or persistent TMD pain can be modified, then TMD pain might not develop or, possibly only persist for a shorter time. Prevention of the development of chronic TMD pain in young people would be a substantial achievement for both the individual and society in the future.

Our conclusion is that TMD pain in adolescence carries a risk of persistent pain, and of attendant pain in different parts of the body, with affected jaw and overall functioning and psychosocial distress.

## Acknowledgments

We thank all study participants. We thank Dr. Marika Wenemark, Linköping, for fruitful discussions on surveys among young adults. We also thank dental nurses Gun Hector and Lotti Nierzwicki for making the telephone calls.

## Disclosure statement

The authors declare no conflicts of interests and have nothing to disclose in this study.

## Funding

The study was supported by the Faculty of Odontology, Malmö University, Malmö; and the Public Dental Service of Östergötland, Sweden [Dnr 2-12-11].

## ORCID

Ing-Marie Nilsson http://orcid.org/0000-0002-0550-8925

## Availability of data and materials

The dataset and materials can be accessed through direct contact with the first author (IMN).

## References

[1] Drangsholt M, LeResche L. Temporomandibular disorder pain. In: Crombie C, Linton, LeResche, editor. Epidemiology of pain. Seattle (WA): IASP Press; 1999. p. 203–233.
[2] Nilsson IM, List T, Drangsholt M. Prevalence of temporomandibular pain and subsequent dental treatment in Swedish adolescents. J Orofac Pain. 2005;19(2):144–150.
[3] Lövgren A, Häggman-Henrikson B, Visscher CM, et al. Temporomandibular pain and jaw dysfunction at different ages covering the lifespan–a population based study. Eur J Pain. 2016; 20:532–540.
[4] Nilsson IM, List T, Drangsholt M. Incidence and temporal patterns of temporomandibular disorder pain among Swedish adolescents. J Orofac Pain. 2007;21:127–132.
[5] Perquin CW, Hunfeld JA, Hazebroek-Kampschreur AA, et al. The natural course of chronic benign pain in childhood and adolescence: a two-year population-based follow-up study. Eur J Pain. 2003;7(6):551–559.
[6] Dunn KM, Jordan KP, Mancl L, et al. Trajectories of pain in adolescents: a prospective cohort study. Pain. 2011;152(1):66–73.
[7] Nilsson IM, Drangsholt M, List T. Impact of temporomandibular disorder pain in adolescents: differences by age and gender. J Orofac Pain. 2009;23(2):115–122.
[8] Nilsson IM, List T, Willman A. Adolescents with temporomandibular disorder pain-the living with TMD pain phenomenon. J Orofac Pain. 2011;25(2):107–116.
[9] Gatchel RJ, Garofalo JP, Ellis E, et al. Major psychological disorders in acute and chronic TMD: an initial examination. J Am Dent Assoc. 1996;127(9):1365–1370, 72, 74.
[10] Suvinen TI, Nystrom M, Evalahti M, et al. An 8-year follow-up study of temporomandibular disorder and psychosomatic symptoms from adolescence to young adulthood. J Orofac Pain. 2004; 18(2):126–130.
[11] LeResche L, Mancl LA, Drangsholt MT, et al. Predictors of onset of facial pain and temporomandibular disorders in early adolescence. Pain. 2007;129(3):269–278.
[12] Plesh O, Adams SH, Gansky SA. Temporomandibular joint and muscle disorder-type pain and comorbid pains in a national US sample. J Orofac Pain. 2011;25(3):190–198.
[13] Dominick CH, Blyth FM, Nicholas MK. Unpacking the burden: understanding the relationships between chronic pain and comorbidity in the general population. Pain. 2012;153(2):293–304.
[14] List T, John MT, Ohrbach R, et al. Influence of temple headache frequency on physical functioning and emotional functioning in subjects with temporomandibular disorder pain. J Orofac Pain. 2012;26:83–90.
[15] Sipila K, Suominen AL, Alanen P, et al. Association of clinical findings of temporomandibular disorders (TMD) with self-reported musculoskeletal pains. Eur J Pain. 2011;15:1061–1067.
[16] Ashraf J, Zaproudina N, Suominen AL, et al. Association between temporomandibular disorders pain and migraine: results of the health 2000 survey. J Oral Facial Pain Headache. 2019;33: 399–407.
[17] Rammelsberg P, LeResche L, Dworkin S, et al. Longitudinal outcome of temporomandibular disorders: a 5-year epidemiologic study of muscle disorders defined by research diagnostic criteria for temporomandibular disorders. J Orofac Pain. 2003;17(1):9–20.
[18] Fillingim RB, Slade GD, Greenspan JD, et al. Long-term changes in biopsychosocial characteristics related to temporomandibular disorder: findings from the OPPERA study. Pain. 2018;159(11): 2403–2413.
[19] Brattberg G. Do pain problems in young school children persist into early adulthood? A 13-year follow-up. Eur J Pain. 2004;8(3): 187–199.
[20] Fearon P, Hotopf M. Relation between headache in childhood and physical and psychiatric symptoms in adulthood: national birth cohort study. BMJ. 2001;322(7295):1145–1145.
[21] 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;54:337–342.
[22] Macfarlane TV, Blinkhorn AS, Davies RM, et al. Factors associated with health care seeking behaviour for orofacial pain in the general population. Community Dent Health. 2003;20(1):20–26.
[23] Yule PL, Durham J, Playford H, et al. OHIP-TMDs: a patient-reported outcome measure for temporomandibular disorders. Community Dent Oral Epidemiol. 2015;43(5):461–470.
[24] Sessle B. The societal, political, educational, scientific and clinical context of orofacial pain. In: Sessle B, editor. Orofacial pain: recent advances in assessment, management, and understanding of mechanisms. Washington (DC): IASP Press; 2014. p. 1–15.

[25] Nilsson IM, List T, Drangsholt M. The reliability and validity of self-reported temporomandibular disorder pain in adolescents. J Orofac Pain. 2006;20(2):138–144.
[26] Lövgren A, Visscher CM, Häggman-Henrikson B, et al. Validity of three screening questions (3Q/TMD) in relation to the DC/TMD. J Oral Rehabil. 2016;43:729–736.
[27] Von Korff M, Ormel J, Keefe FJ, et al. Grading the severity of chronic pain. Pain. 1992;50(2):133–149.
[28] Dworkin SF, Sherman J, Mancl L, et al. Reliability, validity, and clinical utility of the research diagnostic criteria for Temporomandibular Disorders Axis II Scales: depression, non-specific physical symptoms, and graded chronic pain. J Orofac Pain. 2002;16(3):207–220.
[29] Ohrbach R, Larsson P, List T. The jaw functional limitation scale: development, reliability, and validity of 8-item and 20-item versions. J Orofac Pain. 2008;22(3):219–230.
[30] Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med. 2001;16(9): 606–613.
[31] Banafa A, Suominen AL, Sipila K. Factors associated with signs of temporomandibular pain: an 11-year-follow-up study on Finnish adults. Acta Odontol Scand. 2020;78:57–63.
[32] Murray GM, Svensson P, Arendt-Nilsson L. Musculoskeletal orofacial pain mechanisms: Insights from human experimental studies. In: Sessle B, editor. Orofacial pain: recent advances in assessment, management, and understanding of mechanisms. Washington (DC): IASP Press; 2014. p. 435–454.
[33] Tolonen H, Helakorpi S, Talala K, et al. 25-year trends and socio-demographic differences in response rates: Finnish adult health behaviour survey. Eur J Epidemiol. 2006;21(6):409–415.
[34] Arkhede S, Bové J, Bové K, et al. SOM-rapport 2017:34. Gothenburg: The SOM Institute, University of Gothenburg; 2017. Available from: www.som.gu.se
[35] Carey B, Stassen L. An audit comparing the discrepancies between a verbal enquiry, a written history, and an electronic medical history questionnaire: a suggested medical history/social history form for clinical practice. J Ir Dent Assoc. 2011;57(1): 54–59.
[36] Hunfeld JA, Perquin CW, Bertina W, et al. Stability of pain parameters and pain-related quality of life in adolescents with persistent pain: a three-year follow-up. Clin J Pain. 2002;18(2):99–106.
[37] Lim PF, Smith S, Bhalang K, et al. Development of temporomandibular disorders is associated with greater bodily pain experience. Clin J Pain. 2010;26(2):116–120.
[38] Kroenke K, Spitzer RL, Williams JB, et al. The Patient Health Questionnaire Somatic, Anxiety, and Depressive Symptom Scales: a systematic review. Gen Hosp Psychiatry. 2010;32(4):345–359.
[39] Wänman A, Ernberg M, List T. Guidelines in the management of orofacial pain/TMD: an evidence-based approach. Tandlaegebladet. 2015;11:828–838.