The Association of Temporomandibular Disorder Pain with History of Head and Neck Injury in Adolescents

Dena J. Fischer, DDS, MSD, MS
Lecturer
Department of Oral Medicine
School of Dentistry
University of Washington
Seattle, Washington

Beth A. Mueller, DrPH
Professor
Department of Epidemiology
School of Public Health and Community Medicine
University of Washington
Seattle, Washington
and
Program in Epidemiology
Division of Public Health Sciences
Fred Hutchinson Cancer Research Center
Seattle, Washington

Cathy W. Critchlow, PhD
Affiliate Professor
Department of Epidemiology
School of Public Health and Community Medicine
University of Washington
Seattle, Washington
and
Associate Director
Global Epidemiology
Amgen
Thousand Oaks, California

Linda LeResche, ScD
Professor
Department of Oral Medicine
School of Dentistry
University of Washington
Seattle, Washington

Correspondence to:
Dr Dena J. Fischer
Department of Oral Medicine
School of Dentistry
Box 356370
University of Washington
Seattle, WA 98195-6370
Fax: +206 685 8412
E-mail: denafis@u.washington.edu

Aims: *To evaluate the risk of self-reported temporomandibular disorder (TMD) pain among adolescents in relation to previous head and/or neck injury.* ***Methods:*** *3,101 enrollees (11 to 17 years of age) of a nonprofit integrated health-care system were interviewed by telephone. Two hundred four cases with self-reported TMD pain and 194 controls without self-reported TMD pain frequency-matched to the cases by age and gender completed standardized in-person interviews and physical examinations in which reports of previous head/neck injuries were recorded. Odds ratio (OR) estimates and 95% confidence intervals (CIs) of the relative risks of TMD pain associated with prior head and/or neck injuries were calculated using logistic regression.* ***Results:*** *A greater proportion of subjects reporting TMD pain (36%) than controls (25%) had a history of head and/or neck injuries (OR = 1.8, 95% CI, 1.1–2.8). In a separate analysis, the presence of TMD based upon the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) was assessed in relation to prior head and/or neck injury. Cases reporting TMD pain and meeting the RDC/TMD criteria for myofascial pain and/or arthralgia or arthritis were 2.0 (CI, 1.0–3.8) times more likely to have had a prior head injury than were controls with neither self-reported nor RDC/TMD pain diagnoses.* ***Conclusion:*** *The results suggest a modest association of prior head injuries with both self-reported and clinically diagnosed TMD pain in adolescents.*
J OROFAC PAIN 2006;20:191–198

Key words: adolescent, head injury, neck injury, orofacial pain, temporomandibular disorders

Injuries are the leading cause of death for children and young adults and a major cause of short- and long-term disability in the United States.[1] The incidence of medically attended injuries has been estimated to be approximately 32 per 100 person-years among 10- to 14-year-olds and 31 per 100 person-years among 15- to 19-year-olds.[2] Among adolescents, injuries to the head or neck account for approximately 18% of all medically attended injuries.[3]

Up to 15% of patients less than 16 years old with medically attended injuries have facial fractures.[4] One recent study reported that 16% of children with facial trauma presenting to emergency

or orofacial surgery departments had fractures; 48% of these fractures were mandibular and 29% were zygomatic. In the same study, the remainder of the injuries were soft tissue (73%) and dental (11%).[5] An estimated 29% to 76% of adolescents with facial fractures have concomitant injuries.[4,6] Maxillofacial injuries are more common in boys than girls, with facial fractures occurring in 54% to 80% of boys with maxillofacial injuries.[4] The most common causes of head and neck injury in adolescents are assault, motor vehicle accidents (MVAs), falls, and bicycle accidents.[4,5]

Head and neck injuries may have short- and long-term sequelae, including some affecting the face and jaw region and involving the temporomandibular joint (TMJ). Symptoms of temporomandibular disorders (TMD), such as TMJ dysfunction, headache, and/or head/neck pain following injuries have been documented in adults[7–10] and adolescents.[11] Based upon data obtained from a systematic review,[12] TMD pain is estimated to affect approximately 3.7% to 12% of the adult population and 0.7% to 18.6% of the pediatric population. However, the extent to which such symptoms in adolescents may be associated with prior injuries is unknown.

Prevalence estimates of TMD pain in adolescents vary depending upon the definition used. In a study of TMD pain among Swedish adolescents aged 12 to 18 years, the authors compared self-reports of TMD pain to clinical TMD pain diagnoses.[13] Of 862 subjects, 113 (13%) reported "pain once a week or more in the face, jaws, temporomandibular joints or temples." Of the 113 subjects reporting a history of TMD pain, 88 underwent a standardized head/neck research examination using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)[14] as well as the clinic's standard neurologic screening examination by a calibrated operator. Of these 88 subjects, 72% received an RDC/TMD diagnosis.

Because pain is the most troublesome symptom of TMD and is the overwhelming reason people seek care,[15] the investigators' primary aim was to evaluate the risk of self-reported TMD pain among adolescents in relation to previous head and/or neck injury. Data were obtained from a case-control study nested in a larger prevalence survey of TMD pain among adolescent enrollees at a large nonprofit integrated health-care system. In addition, a separate analysis was conducted to examine the association of previous head and/or neck injury with the presence of TMD pain meeting criteria for an RDC/TMD pain diagnosis.

Materials and Methods

Survey

Data for this study were drawn from a larger survey conducted between May 2000 and April 2001 of health status among adolescent enrollees of the Group Health Cooperative, a nonprofit integrated health-care system in the state of Washington. The purpose of the survey was to determine the prevalence of self-reported TMD pain, headache, back pain, and abdominal pain in adolescents and to identify risk factors for the onset of these common pain symptoms. Adolescents were identified from the rosters of current enrollees aged 11 to 17 years, and an age-stratified random sample of all 11-year-olds and 9.2% of 12- to 17-year-old children (n = 7,723) was selected. Eligible children (n = 6,349) included all currently enrolled adolescents in the Seattle metropolitan region. If more than 1 child from the same family was chosen, individuals were selected as follows to ensure that only 1 child per household was sampled: If 1 child of 2 or more potentially eligible children was 11 years old, he/she was given preference to participate; if all the children were ages 12 to 17, 1 child in this age group was randomly selected for study participation. Phone interviewers first spoke with parents or guardians to obtain permission to interview children. Assenting children (n = 3,101; 48.8% of eligible subjects; 88.5% of those with parental consent) completed a 15- to 20-minute telephone interview to ascertain basic demographic characteristics; the presence and characteristics of facial pain, headache, back pain, and abdominal pain; and potential risk factors for TMD and other pain conditions.

All subjects reporting problems with facial pain in the 3 months prior to the interview date (cases) were invited to participate in an in-person interview and to undergo a standardized examination. Controls were randomly selected from among survey participants who responded negatively concerning the presence of facial pain in the prior 3 months and also were invited to participate in the in-person interview and examination. All procedures were approved by the institutional review board of Group Health Cooperative.

Case and Control Identification

Potential cases were defined as the 244 adolescents in the initial survey who answered affirmatively to both of the following questions: "Have you ever had a problem with facial ache or pain in any of the

following places: the jaw muscles, the joint in front of the ear, or inside the ear, other than an ear infection?" and, "In the last 3 months, have you had a problem with facial pain?" Subjects were reminded to report only pains that occurred more than once in a year or lasted a whole day or more. All potential cases identified in the survey were recontacted by telephone and invited to participate in an in-person interview and standardized diagnostic examination of the head and neck using the RDC/TMD criteria. Of these 244 cases, 204 (83.6% of those eligible) completed the survey and diagnostic examination by a trained calibrated dental hygienist.

Controls, frequency-matched by age and gender to the case distribution, were randomly selected from among survey participants who did not report the presence of facial pain in the prior 3 months. Controls had been interviewed within the same 2-week period as cases. One control was chosen per case. Of the 242 available controls who were invited to participate, 194 (80.2% of those eligible) completed the in-person interview and research examination. Reasons for case and control nonparticipation included refusal (7.4% cases, 9.5% controls), exceeding time window (6.6% cases, 5.4% controls), being out of the area (1.2% cases, 1.2% controls), inability of the researchers to contact (0.4% cases, 2.9% controls), being too ill (0.0% cases, 0.4% controls), and other (1.2% cases, 0.4% controls). No financial incentive was offered for this portion of the study.

Consenting cases and controls were administered standardized in-person interviews and physical examinations. Parents were allowed to be present during the interview and examination but were asked not to respond to the interview questions. Because the interview preceded the examination, the examiner was not blinded to pain status on the day of the examination. The clinical examiner conducted the RDC/TMD standardized examination, and diagnostic algorithms were applied to identify all RDC/TMD diagnoses present. Results of the physical examination were used to further identify subjects with a clinical RDC/TMD pain diagnosis based on the presence of myofascial pain and/or arthralgia.

Exposure

During the in-person interview, all subjects were asked, "Since you were 7, have you gone to a doctor, nurse, dentist, hospital, or other health-care provider because you were hurt in an accident or had an injury?" If subjects responded positively to the question, they were asked, "What kind of injury did you have?" and the body part and injury type were recorded. Injuries involving the head, eye, nose, over/above eye, forehead, cheek, face, chin, ear, tooth, jaw, gingiva, mucosa, lip, and tongue were defined as head injuries. Injuries involving the neck or collarbone were defined as neck injuries. The date of injury occurrence was also queried. Subjects whose injuries followed the onset of facial pain (n = 3) were recorded as having no prior injury.

Statistical Analysis

Dichotomous variables were created for prior head injury (yes/no), neck injury (yes/no), and either head and/or neck injuries (yes/no). Separate analyses were conducted to characterize the association between self-reported facial pain and prior *(1)* head or neck injury, *(2)* head injury only, *(3)* neck injury only, and *(4)* head and neck injury. A separate analysis was conducted in which the outcome of diagnosis of myofascial pain and/or arthralgia or arthritis (based on the RDC/TMD criteria) was assessed in relation to history of head and/or neck injury.

Logistic regression analyses were performed to estimate odds ratios (ORs) adjusted for the matching variables, age at baseline interview (11, 12 to 14, or 15 to 17 years) and gender, and other factors associated with both TMD pain and occurrence of prior head and/or neck injuries. The other factors assessed for their potential effects on the relationship between TMD pain and prior head and/or neck injuries included:

- Smoking (yes/no)
- Race (white/nonwhite)
- Parent education (≤ high school, trade school/some college, 4-year college graduate, professional/graduate degree)
- Self-reported school performance (better than average, average, below average)
- Pubertal development (Pubertal Development Scale,[16,17] continuous scale graded 1 through 4)
- Physical development (self-reported comparison to other boys/girls of the same age—much earlier, somewhat earlier, about the same, somewhat later, much later)
- Psychological distress (Youth Self Report [Achenbach] scales[18] for somatic complaints [9 questions], social problems [8 questions], withdrawn [7 questions], anxious/depressed [16 questions]; continuous scales graded 1 to 32; summary score of items graded from 0 to 2)
- Self-report of being physically active
- Number of hours engaged in vigorous activity/sports per week

- Height (short or tall, normal[19])
- Weight (underweight or obese, normal[19])
- Self-rated health status (excellent, very good, good, fair, poor)
- History of multiple body pains
- Self-reported TMD symptoms (clicking joint, locking joint, crepitus, tinnitus, abnormal bite)
- Bruxism (clenching/grinding habit)
- Self-reported habit of chewing gum, pencils, pens or fingernails
- Self-reported habit of holding the telephone between one's head and shoulder
- Whether the subject played a musical instrument
- Whether the subject had had third molars removed
- Past or current orthodontic treatment
- Hours/day of sedentary activities (hours/day of TV watching, video game playing, time on computer, time on telephone)
- Self-reported satisfaction with life (very satisfied, satisfied, neutral, unsatisfied)
- Prior injuries to other body parts

Age, gender, and those variables that meaningfully altered ORs (generally by at least 10%) were adjusted for in the analyses. Obesity was defined as: ≥ 95th percentile for US Centers for Disease Control (CDC) growth charts for body mass index (BMI) by age and gender.[19] Statistical analyses were performed using STATA, version 8.

Results

Characteristics of the Study Population

Of the 204 cases, the mean age was 12.8 ± 2.3 years, and 51% were female (Table 1a). The mean age of the 194 controls was 12.6 ± 2.3 years, and 53% were female. Seventy-six percent of the cases and 75% of the controls were white. Other painful body sites (back, stomach, head) were reported by 73% of the cases and 43% of the controls. Other characteristics of the study population are listed in Tables 1a and 1b.

Association of Head and/or Neck Injuries with Self-Reported Facial Pain

A greater proportion of subjects reporting TMD pain (36%) than controls (25%) had a history of head and/or neck injuries (OR = 1.8; 95% CI, 1.1–2.8; Table 2). (Unless otherwise indicated, all estimates are adjusted for age at interview, gender, number of other painful body sites, weight category, height category, total score for anxiety plus depression, and daytime bruxism.) The OR for facial pain associated with a history of head injuries only was 1.8 (95% CI, 1.1–2.9), whereas that for facial pain associated with neck injury only was 1.2 (95% CI, 0.6–2.6). The odds of TMD pain increased as the number of head and/or neck injuries increased, although this trend was not statistically significant. The OR associated with having a head injury involving a concussion or fracture was 2.2 (95% CI, 0.9–4.9); the OR associated with head injury without concussion or fracture was 1.6 (95% CI, 1.0–2.8).

RDC Diagnosis of TMD in Relation to Head and Neck Injury

A separate analysis was conducted in which the outcome of diagnosis of myofascial pain and/or arthralgia or arthritis based on the RDC/TMD criteria was assessed in relation to history of head and/or neck injury. Of the 204 cases who self-reported TMD pain, 83 (41%) also met the RDC criteria for 1 or more TMD pain diagnoses, and of the 194 control subjects who did not report TMD pain, 170 (88%) did not meet criteria for a TMD pain diagnosis according to the RDC. Cases reporting TMD pain and meeting the RDC/TMD criteria were 2.0 times more likely (95% CI, 1.0–3.8) to have had a prior head and/or neck injury than were controls with neither self-reported pain nor an RDC/TMD pain diagnosis (adjusted for age at interview, gender, parents' education, number of other painful body parts, weight category, height category, and total score for anxiety plus depression). The OR for having had a prior head injury only was 1.8 (95% CI, 0.9–3.7). The OR for neck injury only was 1.6 (95% CI, 0.6–3.9). Cases who self-reported TMD pain but did not meet the RDC/TMD criteria (n = 121) were 1.7 times more likely (95% CI, 0.9–2.8) to have previously experienced a head and/or neck injury as compared to the 170 controls without self-reported or RDC/TMD pain. The 24 controls who did not self-report TMD pain but who met RDC/TMD criteria were 0.8 times as likely (95% CI, 0.3–2.7) to have a history of head and/or neck injury as the 170 controls without self-reported or RDC/TMD pain.

Stratified Analysis

When stratified by race, the OR for the association of self-reported TMD pain in relation to head and/or neck injury was 1.3 (95% CI, 0.8 to 2.2) for white adolescents, while the OR was 6.9 (95%

Table 1a Numbers and Percentages of Adolescents With and Without Self-reported Facial Pain

Characteristic	Facial pain (n = 204) n	Facial pain (n = 204) %	No facial pain (n = 194) n	No facial pain (n = 194) %
Female	103	51	102	53
Age (y)				
11	113	55	117	60
12 to 14	34	17	29	15
15 to 17	57	28	48	25
Smoker	16	8	7	4
Nonwhite race*	49	24	49	25
Hispanic	22	11	23	12
Parent education†				
≤ High school graduate	38	19	27	14
Trade school/ some college	78	38	73	38
College graduate	52	26	47	24
Professional/ graduate degree	30	15	46	24
Self-reported school performance				
Better than average	87	43	85	44
Average	99	49	103	53
Below average	13	6	5	3
Self-reported physical development‡				
Much earlier	20	10	9	5
Somewhat earlier	30	15	32	16
About the same	114	56	122	63
Somewhat later	27	13	26	13
Much later	13	6	5	3
Physically active	191	94	163	84
Short/tall§				
Short	5	3	4	2
Tall	44	22	65	34
Underweight/obese"				
Underweight	2	1	3	2
Obese	48	24	33	17
Self-rated health status				
Excellent	34	17	41	21
Very good	81	40	92	48
Good	69	34	48	25
Fair	18	9	13	7
Poor	2	1	0	0
Reported history of medically-attended injuries to other body parts	109	53	91	47
No. of other painful body sites (self-reported)¶				
0	54	26	111	57
1	74	36	59	31
2	43	21	18	9
3	33	16	6	3
RDC/TMD pain diagnosis	83	41	24	12
Sought care for TMD treatment	35	17	8	4
Self-reported TMD symptoms				
Clicking joint	131	64	83	43
Locking joint	45	22	17	9
Crepitus	63	31	36	19
Tinnitus	25	12	10	5
Abnormal bite	75	37	29	15
Jaw/muscle parafunction				
Bruxism—day	143	70	111	57
Bruxism—night	57	28	43	22
Chewing gum	193	95	181	93
Biting pencils/pens	85	42	81	42
Biting nails	120	59	105	54
Holding telephone with shoulder	147	72	132	68
Playing a musical instrument	83	41	91	47
History of third molar extractions	11	6	5	3
Past or current orthodontic treatment	62	31	78	40
History of headaches/migraines	89	44	34	18
Sedentary activities (h/d)#				
< 1	20	10	19	10
1 to 2	101	49	106	55
3+	83	41	69	35
Self-reported satisfaction with life				
Very satisfied	56	27	79	41
Satisfied	110	54	92	47
Neutral	30	15	15	8
Dissatisfied	8	4	8	4

*Nonwhite race category included African Americans, Asians/Pacific Islanders, Native Americans, and persons of other races.
†Highest level completed by parent.
‡Self-reported comparison to other boys/girls of the same age.
§At or above the 95th percentile or at or below the 5th percentile for CDC growth charts for stature by age and gender.[19]
"At or above the 95th percentile or at or below the 5th percentile for CDC growth charts for BMI by age and gender.[19]
¶Back pain, stomach pain, headache.
#TV watching, video game play, time on computer, time on telephone.

Table 1b Further Selected Characteristics of Adolescents With and Without Self-reported Facial Pain With Selected Characteristics

Characteristic	Facial pain (n = 204) Mean	Facial pain (n = 204) SD	No facial pain (n = 194) Mean	No facial pain (n = 194) SD
Pubertal development*	2.60	0.74	2.48	0.78
Physical activity†	3.93	4.54	3.25	2.81
Psychological distress‡				
Somatization	5.61	3.08	3.75	2.93
Social problems	2.81	2.56	2.52	2.50
Withdrawing	3.00	2.60	2.44	2.25
Anxiety disorder	6.15	5.37	4.80	4.96

*Mean (SD) score on the Pubertal Development Scale, a continuous scale graded from 1 to 4.[16,17]
†Mean (SD) hours per week.
‡Mean (SD) scores on the Achenbach scales[18] for somatization, social problems, withdrawing, anxiety disorder; continuous scales graded 1 to 32.

Table 2 Self-reported Facial Pain Among Adolescents in Relation to History of Head and Neck Injury

Injury history	Facial pain (n = 204) n	Facial pain (n = 204) %	No facial pain (n = 194) n	No facial pain (n = 194) %	OR* (95% CI)
Head and/or neck injury	72	36	48	25	1.8 (1.1–2.8)
Type of head and/or neck injury					
None	131	64	146	75	1.0 (ref)
Head injury only	49	24	32	17	1.8 (1.1–2.9)
Neck injury only	16	8	10	5	1.2 (0.6–2.6)
Head and neck injury	7	3	6	3	1.1 (0.3–3.6)
No. of head and/or neck injuries					
None	131	64	146	75	1.0 (ref)
1	45	22	33	17	1.8 (1.0–3.0)
2	19	9	12	6	1.4 (0.6–3.1)
≥ 3	8	4	3	2	3.1 (0.8–11.5)
Severity of head and/or neck injury					
No head and/or neck injury	131	64	146	75	1.0 (ref)
Injury w/o concussion or fracture	53	26	37	19	1.6 (1.0–2.8)
Injury with concussion or fracture	19	10	11	6	2.2 (0.9–4.9)

*Adjusted for age at interview, gender, number of other painful body sites, weight, height, total score for anxiety plus depression, and daytime bruxism.
(ref) indicates reference or baseline OR.

CI, 1.7 to 20.5) for nonwhite adolescents. The odds of having self-reported TMD pain in adolescents with previous head and/or neck injury were 36.6 (95% CI, 4.1–323) in obese subjects, while the OR for this association in normal-weight subjects was 1.2 (95% CI, 0.7–2.0).

Discussion

The relationship between head and/or neck injuries and TMD pain has been studied in the adult population. TMD symptoms have reportedly resulted from injuries, most commonly as a result of MVAs.[8,20,21] Jaw pain and dysfunction, including persistence of symptoms and limitation of function and daily activities, reportedly affected the majority of post-MVA treatment-seeking TMD patients; in that study, the TMD patients were, on average, more than 4 years post-MVA.[21] Chronic facial pain following head and neck trauma may be a direct or indirect result of the injury.[22] In adolescents, however, the relationship between injury and TMD pain has not been extensively investigated. While previous studies have documented TMD symptoms following injuries in adolescents,[11] this controlled study sought to determine the strength of this association.

The present results suggest a moderate but consistent association among adolescents between TMD pain and prior head, but not neck, injury, after controlling for other relevant risk factors. The association between head and neck injuries and TMD pain increased, albeit nonsignificantly, with number of head and/or neck injuries, as well as with severity of injury.

Previous researchers have found a higher prevalence of TMD pain in adolescents when a definition of self-reported pain was used compared to a definition based on an RDC diagnosis of TMD.[13] In the present study, 41% of adolescents with self-reported TMD pain also had an RDC/TMD pain diagnosis. This discrepancy may be due to the fact that adolescents misunderstood the question regarding TMD pain and consequently answered incorrectly. Alternatively, TMD pain in adolescents has been reported to be transient in nature. Kitai and colleagues[23] performed a longitudinal study of 361 female adolescents between the ages of 12 and 16. Throughout the 4-year follow-up, the authors found that TMD pain was not persistent but rather appeared and disappeared repeatedly. In addition, the present study included 24 control subjects who did not report the presence of facial pain in the telephone interview but met RDC/TMD criteria for facial pain during the in-person examination. These subjects may be "false positives," presenting with signs only of TMD pain, or these individuals may have undergone a recent onset of TMD pain, as there was a time lag between the telephone interview and in-person examination. Regardless, it was decided to eliminate these subjects from the analysis.

Similar to the findings for self-reported pain only, a modest association between prior head and/or neck injury and TMD pain was observed when TMD pain was defined as the occurrence of both self-reported pain and a clinical (RDC) diagnosis of TMD pain. As with the outcome of self-reported TMD pain only, the suggestion of an association appears to be mostly related to prior head, but not neck, injuries.

While population-based studies have found the female-to-male ratio of TMD pain in adults to be about 2:1,[12] the gender ratio was approximately equal in the present study. This finding may be due to the fact that 58% of the subjects were 11 years old, and it has been reported that the prevalence of TMD pain is similar in younger adolescent boys and girls.[24] Furthermore, since cases and controls were frequency-matched by gender in this study, gender could not be evaluated as a risk factor.

A greater OR was documented in the present study in nonwhite adolescents compared to white adolescents for the association of self-reported TMD pain in relation to head and/or neck injury. The nonwhite sample was composed of African Americans, Asians/Pacific Islanders, Native Americans, and persons of other races. Although some studies have indicated that facial pain is less prevalent in certain nonwhite populations,[25,26] the findings of the present study suggest that head/neck injuries may be an important risk factor for TMD pain in the African-American group. An unexpected discovery was the greater odds of having self-reported TMD pain in obese adolescents with previous head and/or neck injury compared to nonobese subjects, and this warrants further investigation.

The association between head and/or neck injuries and TMD pain observed in the study may be affected by unmeasured confounding variables. However, the authors are not aware of any obvious factors that were not assessed that would substantially alter the reported association. In addition, the self-reports of head and/or neck injuries may be subject to differential exposure measurement error due to recall of injury. This differential misclassification bias may have affected the OR. A study evaluating the validity of self-reported injuries found that football players were able to correctly indicate their injury status (injured/not injured) in the previous 12 months, while 78.6% could accurately describe the number of injuries and body region injured.[27] A tendency toward underreporting of injuries was also found in the same study.[27] Although the present study used a longer recall period, the focus was on medically attended injuries, and it can be assumed that the injury status is likely to be reasonably accurate. Furthermore, the study was limited by sample size. Although 398 subjects were analyzed, samples were small when subgroups were examined. Nonetheless, since the results showed a modest association of TMD pain with prior head injury, the effect could be more robust if a larger sample size were used. In addition, data pertaining to the mechanism of injury (eg, MVA, fall) were not available. Therefore, the effect of mechanism of injury upon the association between head and/or neck injury and TMD pain could not be explored. Finally, data concerning clinical diagnosis or specific prior treatments were unavailable in this population-based study.

The present data suggest a modest association between prior head injuries and both self-reported and clinically diagnosed TMD pain in adolescents. In addition to being associated with other recognized and more widely publicized sequelae, such as brain injury, head injuries may also result in TMD pain. Chronic TMD pain shares features such as psychological distress and the sometimes marked levels of morbidity common to other chronic pain conditions.[15] Measures to prevent head injury and thus incidence of TMD pain in adolescents may help reduce related adverse effects such as time away from school, restriction of activities, or other eventual morbidity.

Acknowledgments

This study was supported by NIH grants K16 DE00161 and P01 DE08773. The authors thank Dr Mark Drangsholt for helpful comments on the manuscript. This research was conducted in partial fulfillment of the MS degree in epidemiology at the University of Washington.

References

1. Baker S, O'Neill B, Karpf R. The Injury Fact Book. Lexington, MA: Lexington Books, 1984.
2. Rivara FP, Calonge N, Thompson RS. Population-based study of unintentional injury incidence and impact during childhood. Am J Public Health 1989;79:990–994.
3. Brudvik C. Child injuries in Bergen, Norway. Injury 2000;31:761–767.
4. Haug RH, Foss J. Maxillofacial injuries in the pediatric patient. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;90:126–134.
5. Shaikh ZS, Worrall SF. Epidemiology of facial trauma in a sample of patients aged 1–18 years. Injury 2002;33:669–671.
6. McGraw BL, Cole RR. Pediatric maxillofacial trauma. Age-related variations in injury. Arch Otolaryngol Head Neck Surg 1990;116:41–45.

7. Pullinger AG, Seligman DA. Trauma history in diagnostic groups of temporomandibular disorders. Oral Surg Oral Med Oral Pathol 1991;71:529–534.
8. Spitzer WO, Skovron ML, Salmi LR, et al. Scientific monograph of the Quebec Task Force on Whiplash-Associated Disorders: Redefining "whiplash" and its management. Spine 1995;20(8 suppl):1S–73S.
9. Kolbinson DA, Epstein JB, Senthilselvan A, Burgess JA. A comparison of TMD patients with or without prior motor vehicle accident involvement: Treatment and outcomes. J Orofac Pain 1997;11:337–345.
10. Plesh O, Gansky SA, Curtis DA, Pogrel MA. The relationship between chronic facial pain and a history of trauma and surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;88:16–21.
11. Egermark I, Carlsson GE, Magnusson T. A 20-year longitudinal study of subjective symptoms of temporomandibular disorders from childhood to adulthood. Acta Odontol Scand 2001;59:40–48.
12. Drangsholt M, LeResche L. Temporomandibular disorder pain. In: Crombie I, Croft PR, Linton SJ, LeResche L, Von Korff M (eds). Epidemiology of Pain. Seattle: IASP Press, 1999:203–233.
13. List T, Wahlund K, Wenneberg B, Dworkin SF. TMD in children and adolescents: Prevalence of pain, gender differences, and perceived treatment need. J Orofac Pain 1999;13:9–20.
14. Dworkin SF, LeResche L. Research Diagnostic Criteria for Temporomandibular Disorders: Review, criteria, examinations and specifications, critique. J Craniomandib Disord 1992;6:301–355.
15. Dworkin SF. Personal and Societal Impact of Orofacial Pain. New York: Raven Press, 1995.
16. Brooks-Gunn J, Warren MP, Rosso J, Gargiulo J. Validity of self-report measures of girls' pubertal status. Child Dev 1987;58:829–841.
17. Peterson A, Crockett L, Richards M, Boxer A. A self-report measure of pubertal status: Reliability, validity, and initial norms. J Youth Adolesc 1988;17:117–133.
18. Achenbach T. Manual for the Youth Self-Report and 1991 Profile. Burlington, VT: University of Vermont Department of Psychiatry, 1991.
19. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al. CDC growth charts: United States. Adv Data 2000(314):1–27.
20. Barnsley L, Lord S, Bogduk N. Whiplash injury. Pain 1994;58:283–307.
21. Kolbinson DA, Epstein JB, Burgess JA, Senthilselvan A. Temporomandibular disorders, headaches, and neck pain after motor vehicle accidents: A pilot investigation of persistence and litigation effects. J Prosthet Dent 1997;77:46–53.
22. Elkind AH. Headache and facial pain associated with head injury. Otolaryngol Clin North Am 1989;22:1251–1271.
23. Kitai N, Takada K, Yasuda Y, Verdonck A, Carels C. Pain and other cardinal TMJ dysfunction symptoms: A longitudinal survey of Japanese female adolescents. J Oral Rehabil 1997;24:741–748.
24. Nilsson IM, List T, Drangsholt M. Prevalence of temporomandibular pain and subsequent dental treatment in Swedish adolescents. J Orofac Pain 2005;19:144–150.
25. Lipton JA, Ship JA, Larach-Robinson D. Estimated prevalence and distribution of reported orofacial pain in the United States. J Am Dent Assoc 1993;124:115–121.
26. Plesh O, Crawford PB, Gansky SA. Chronic pain in a biracial population of young women. Pain 2002;99:515–523.
27. Gabbe BJ, Finch CF, Bennell KL, Wajswelner H. How valid is a self reported 12 month sports injury history? Br J Sports Med 2003;37:545–547.