Self-reported temporomandibular joint disorder symptoms, oral health, and quality of life of children in kindergarten through grade 5

Do sex, race, and socioeconomic background matter?

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ABSTRACT

Background. The authors' objectives were to determine the percentage of children in kindergarten through grade 5 who reported symptoms of temporomandibular joint disorder (TMJD); to assess whether sex, race, and socioeconomic background mattered; and to explore the relationships between TMJD and children's oral health and oral health–related quality of life (OHRQoL).

Methods. The research team conducted face-to-face interviews with 8,302 children in kindergarten through grade 5 (51% female, 49% male; 53% African American, 42% white). They conducted oral health screenings with 7,439 children.

Results. Overall, 23.6% of the children reported pain when chewing tough food, and 18.8% reported pain when opening their mouth wide; 23.2% reported hearing a sound (clicking) when opening their mouth wide. Female students were more likely than male students and African American children were more likely than white children to report TMJD symptoms. The prevalence of TMJD symptoms did not correlate with whether the children had a need for oral health care services or whether they had an abscess or carious teeth with pulpal involvement. TMJD symptoms were associated significantly with children's OHRQoL.

Conclusions. Considerable percentages of 4- to 12-year-old children reported TMJD symptoms, with girls and African American children being more likely than their counterparts to be affected. Experiencing TMJD symptoms was associated significantly with poorer OHRQoL.

Practical Implications. Dental practitioners need to be aware that substantial percentages of kindergarten and elementary school–aged children experience TMJD symptoms. Taking a dental history and conducting an oral examination, therefore, should include assessments of the signs and symptoms of TMJD; treatment recommendations should be provided for affected children.

Key Words. Temporomandibular joint; children; oral health; sex; socioeconomic factors; quality of life; oral health–related quality of life; dental care for children.

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Self-reported symptoms of temporomandibular joint disorder (TMJD) include reports of problems related to the masticatory system, such as pain when chewing tough food, limitations of mandibular movement, and joint sounds.[1] Although investigators have widely discussed and analyzed adult dental patients' TMJD issues since the early part of the 21st century,[2,3] fewer investigators have conducted studies about TMJD among children and adolescents. However, research results published as early as 1995 showed that considerable percentages of children and adolescents do indeed experience symptoms of TMJD.[4] For example, the results of studies with younger children showed that 16.5% of 3- to 5-year-old children had 1 or more signs of TMJD[5] and that 17% of 4- to 6-year-old children were affected by TMJD.[6] These percentages tended to be even higher in studies with older children. For example, Thilander and colleagues[7] showed that 25% of the 5- to 17-year-old children in their study had 1 or more signs of TMJD, and Feteih[8] found that 21.3% of their 12- to 16-year-old study participants exhibited at least 1 sign of TMJD. In 2014, Franco-Micheloni and colleagues[9] reported that 25.2% of 12- to 14-year-old children in their study had TMJD-related pain. Although the reported prevalence of TMJD

Supplemental material is available online.

in children has ranged considerably (7% in a study by List and colleagues[10] in 1999, 33% in a study by Moyaho-Bernal and colleagues in 2010,[11] and 35% in research conducted by Vierola and colleagues in 2012[12]), there is no doubt that TMJD in children deserves attention. One question is whether certain subgroups of children differ in how likely they are to report TMJD symptoms.

Among adult patients with TMJD, there is clear evidence that women are more likely than men to report TMJD symptoms.[13-18] The evidence for a sex difference in the prevalence of TMJD in children has been mixed. Although some authors found that girls were more likely than boys to experience TMJD,[4,5,8,19-25] the investigators of other studies found no sex differences[26-31] or inconclusive results.[32] Therefore, it is worthwhile to explore further whether girls and boys differ in the frequencies with which they report TMJD symptoms.

A second, less well-studied sociodemographic characteristic that investigators have found to be a risk factor for TMJD in adults is the patients' ethnicity or race.[33,34] For example, Slade and colleagues[34] found that Asian American participants had a lower incidence of TMJD and African American participants had a greater incidence compared with white participants. Among children, Widmalm and colleagues[4,26,35] found that African American children were more likely to report TMJD-related pain compared with white children. However, socioeconomic differences might play a role when comparing the prevalence of TMJD in black participants versus white participants.[36] Given that patients in all age groups in the United States are likely to experience more dental disease if they come from socioeconomically disadvantaged backgrounds,[37] it might be interesting to explore whether these differences also can be found regarding TMJD symptoms. More than 50 years ago, Franks[38] suggested to consider this relationship in adult patients, and in 1995, Widmalm and colleagues[4] proposed considering socioeconomic background as a contributing factor to TMJD in children. Helöe and colleagues[39] provided the first empirical evidence that there might be a relationship between socioeconomic status and the prevalence of TMJD in adult patients. Given these early considerations, it seems to be timely to explore the question of whether such a relationship exists in children.

To our knowledge, no researchers so far have explored whether there is a relationship between poor oral health and TMJD. This is not surprising because there is no reason to assume that TMJD would be related to the presence of caries or periodontal disease. However, one could make an argument that pain caused by abscesses or caries with pulpal involvement might radiate and thus lead to higher reports of TMJD symptoms. We therefore explored this question in our study. Although there is no empirical evidence so far that supports a relationship between poor oral health and TMJD, 2 groups of authors have explored whether children's experience of TMJD symptoms would be related to a poorer oral health–related quality of life (OHRQoL) overall. Both Jedel and colleagues[40] and Barbosa and colleagues[19] found that children with TMJD symptoms had a poorer OHRQoL than did children with no TMJD symptoms.

In summary, our objectives for this research study were to determine the percentages of children in kindergarten through grade 5 who reported TMJD symptoms and to assess whether male versus female children, African American versus white children, and students in schools with lower versus higher percentages of participants in the free school lunch program would be more likely to report TMJD symptoms. In addition, we explored the relationship between self-reports of TMJD symptoms and experiencing other oral health problems and between TMJD symptoms and having a poorer OHRQoL.

METHODS

The Institutional Review Board (IRB) for the Behavioral and Health Sciences at the University of Michigan, Ann Arbor, MI, and the IRB of C.S. Mott Children's Health Center, Flint, MI, approved this study.

Respondents. We collected data from 8,302 children in 35 different schools. On average, 339 children were enrolled in each school. Overall, 72% of the children returned a consent form signed by their parents, and we screened and enrolled 56% of the total number of students in the study. Approximately one-half of the children were boys (n = 4,099; 49%) and approximately one-half were girls (n = 4,193; 51%). Most of the children were African American (n = 4,414; 53%), and 42% were white (n = 3,518). On average, 72% of the children in these 35 schools participated in the free school lunch program.[41] Children from families with incomes at or below 130% of the federal poverty level[42] were eligible for free meals and milk and could participate in this program.

Procedure. Before the start of the school year, the parents of students in the 35 participating schools received information about the study and a consent form. The parents returned the completed consent form to the school by sending it along with their child. A total of 72% of the parents gave written consent for their child to participate in the study. Over the course of 2 school years, the research team visited each of the 35 schools twice and conducted oral health screenings and face-to-face interviews with students who had submitted parental consent that they could participate in the study, were present on the day of the school visit, and gave their assent to participate.

ABBREVIATION KEY. **IRB:** Institutional review board. **MOHRQoL-C:** Michigan Oral Health–Related Quality of Life Scale–Child Version. **OHRQoL:** Oral health–related quality of life. **TMJD:** Temporomandibular joint disorder.

We assessed the children's oral health during a screening examination conducted by 1 of 9 pediatric dentistry residents in year 1 and by 1 of 10 pediatric dentistry residents in year 2. At the beginning of each year, we calibrated the techniques of the residents in a 3-hour session to ensure that they were consistent in their screening examinations and that they used the scoring system consistently. We did not conduct actual clinical examinations with children during these calibration sessions. Instead, we used dental photographs. At the end of the calibration sessions, 100% of the pediatric dentistry residents knew in which sequence to score the students' teeth, and 90% or more of them gave correct answers concerning how they would record teeth that either were verbally described or depicted in dental photographs. At the end of the sessions, we asked the pediatric dentistry residents to describe situations in which they would feel uncertain regarding which score to use, and they only mentioned the situations of fractures, fracture restoration, and trauma or missing teeth. We then provided further instruction concerning those situations.

When the dental team arrived at each school, they set up a portable dental chair in either the gym or an empty classroom. A dental assistant accompanied each dentist and used a Microsoft Excel file on a laptop computer to record the dentist's findings. After each dental screening, a member of the dental team escorted the child to another part of the room and conducted a face-to-face interview. The interviewers were 2 dental hygienists whose techniques were calibrated to conduct the interviews in the same manner. They used laptops to record the children's answers in a Microsoft Access file.

TABLE 1

Overview of the childrens' background characteristics.

CHARACTERISTICS	NO. (%) OR MEAN (SD*), RANGE
School Characteristics	
Number of children	8,302 (100%)
Number of schools	35 (100%)
Number of enrolled students per school	339 (111.9), 163-572
Percentage of consent forms returned	72% (11.757), 42%-93%
Percentage screened of all students enrolled	56% (18), 23%-98%
Percentage of students with low family income†	72% (16.187), 32%-98%
Student Characteristics	
Grade	
Kindergarten	1,366 (17%)
1	1,724 (22%)
2	1,418 (18%)
3	1,213 (15%)
4	1,206 (15%)
5	1,032 (13%)
Sex	
Female	4,193 (51%)
Male	4,099 (49%)
Age (y)	7.66 (1.871), 4-12
Hispanic ethnicity	281 (3%)
Race	
African American	4,414 (53%)
White	3,518 (42%)
Other	370 (4%)

* SD: Standard deviation.
† The percentage of students with low family income was determined based on the percentage of students in each school that qualified for the free school lunch program. Children from families with incomes at or below 130% of the federal poverty level[42] were eligible for this program.

Materials. The interviewers used a survey that consisted of 3 sets of questions (see survey in the Appendix, available online at the end of this article). First, they recorded information about the children's age, sex, and grade level. Second, they measured the children's OHRQoL by using the Michigan Oral Health–Related Quality of Life Scale–Child Version (MOHRQoL-C).[43] This scale consists of yes-no format questions that ask the child about oral health–related pain and functioning and how the child's oral health affects his or her psychological and social well-being. The final part of the survey consisted of 3 questions concerning symptoms of TMJD. The interviewers asked the child to report whether his or her face hurt when chewing on tough food, whether the child heard a "noise" (clicking) when opening the mouth wide, and whether the child's face hurt when opening the mouth wide.

Statistical analysis. We analyzed the data with IBM SPSS software (Version 21). We computed descriptive statistics such as frequency distributions, percentages, means, standard deviations, and ranges to provide an overview of the responses. We used χ^2 tests to compare the categorical responses of different groups of children, and we used independent t tests to compare the average number of TMJD symptom–related responses. We assumed $P < .05$ as the level of significance.

RESULTS

Table 1 provides an overview of the characteristics of the schools and the students' backgrounds. A total of 8,302 children in 35 schools participated in this study. The number of children enrolled in these schools ranged from 163 to 572, and the percentages of children whose parents gave written consent ranged from 42% to 93%.

Overall, 23.6% of the children reported that their face hurt when they chewed on tough food, 23.2% reported that they heard a noise (clicking) when they opened their mouth wide, and 18.8% reported that their face hurt when they opened their mouth wide. However, Figure 1 shows that there were significant differences in the percentages of children in different age groups who reported each of these 3 symptoms. Although children in grades 2 and 3

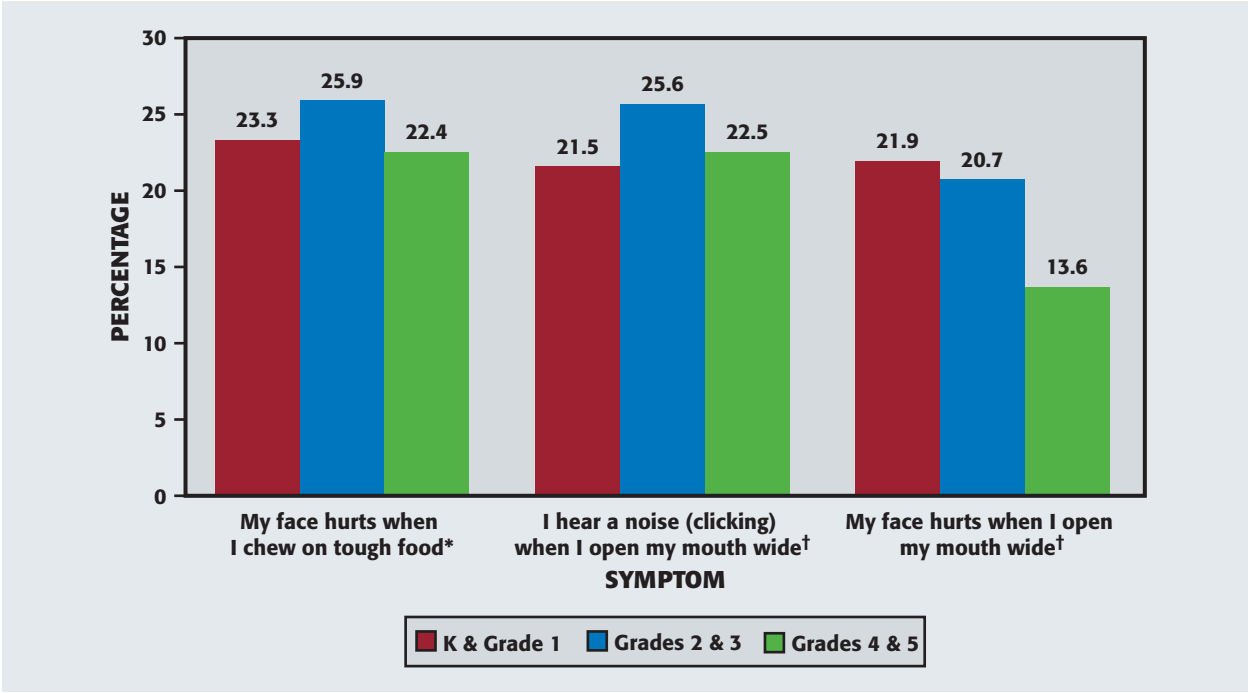

Figure 1. Percentages of children in kindergarten (K) and grade 1, grades 2 and 3, and grades 4 and 5 who reported 3 different symptoms of temporomandibular joint disorder. * $P \leq .01$. † $P \leq .001$.

were most likely to report that their face hurt when they chewed on tough food and that they heard a noise (clicking) when they opened their mouth wide, the children in kindergarten and grade 1 were most likely to indicate that their face hurt when they opened their mouth wide.

Although we found that the age-related prevalence of the 3 symptoms was not consistent, Figure 2 shows that we did find consistent differences related to the sex of the participants. Higher percentages of girls than boys reported that they had each of these 3 symptoms. For example, whereas 25.9% of girls indicated that their face hurt when they chewed on tough food, only 21.2% of the boys reported this symptom ($P < .001$), and whereas 20.4% of girls indicated that their face hurt when they opened their mouth wide, only 17.1% of boys reported this symptom ($P < .001$).

The differences in the percentages of African American children versus white children who reported TMJD symptoms also were consistent. The percentages of African American children who reported that their face hurt when they chewed on tough food (28.1% versus 18.4%; $P < .001$) and opened their mouth wide (21.5% versus 16.2%; $P < .001$) and that they heard a noise (clicking) when they opened their mouth wide (25.4% versus 20.6%; $P < .001$) were significantly higher than the percentages of white children who indicated these symptoms (Figure 3).

In addition, we compared the percentages of children reporting the 3 TMJD symptoms who were enrolled in schools in which fewer than 50% of the students participated in the free school lunch program with the percentages of children in schools in which 50% to 75% of students were enrolled in this program and in schools in which more than 75% of students were enrolled in this program. Figure 4 shows that children in schools in which fewer than 50% of children were enrolled in the free school lunch program were the least likely to respond "yes" to the 2 questions "Does your face hurt when you chew on tough food?" and "Does your face hurt when you open your mouth wide?" However, the children in this group were not the least likely to respond affirmatively to the question "Do you hear a noise (clicking) when you open your mouth wide?"

In addition to exploring whether certain subgroups of children such as boys versus girls and African American children versus white children differed in the prevalence of experiencing each of the 3 TMJD symptoms separately, we considered whether these subgroups of children also differed in how likely they were to report no symptoms versus 1, 2, or all 3 of the TMJD symptoms (Table 2). We found that 4,848 children reported no TMJD symptoms, 1,923 children reported 1 symptom, 1,029 children reported 2 symptoms, and 502 children reported all 3 symptoms. Concerning differences in the percentages of reported symptoms by subgroups, Table 2 shows that a higher

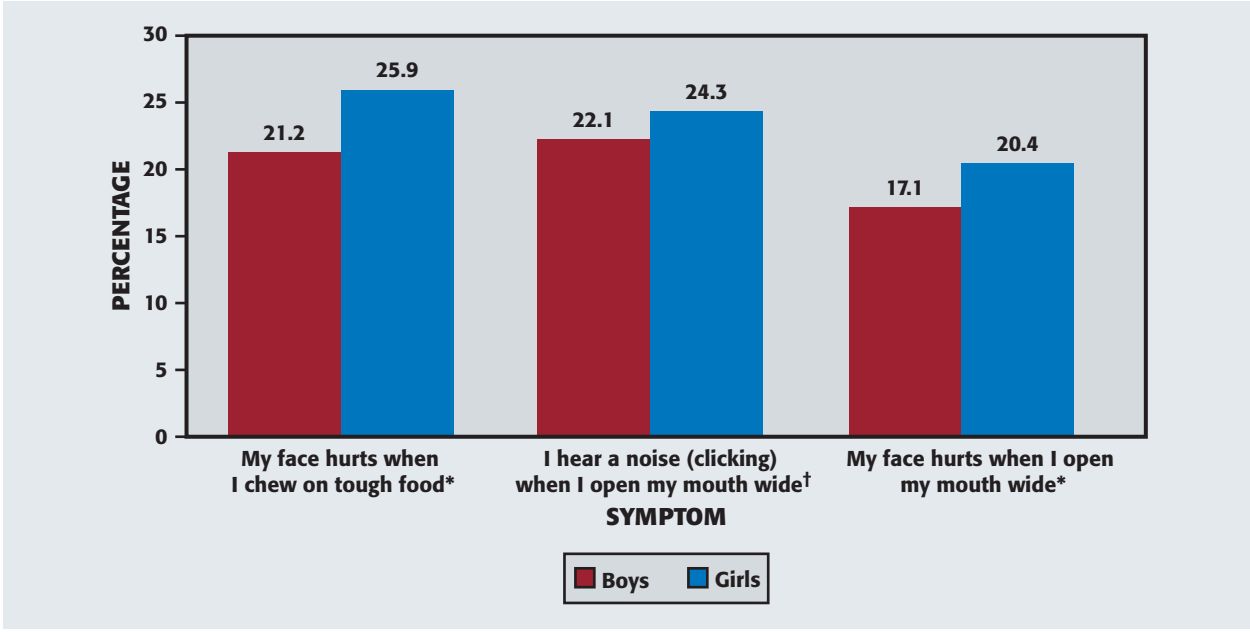

Figure 2. Percentages of boys and girls who reported 3 different symptoms of temporomandibular joint disorder. * $P < .001$. † $P < .05$.

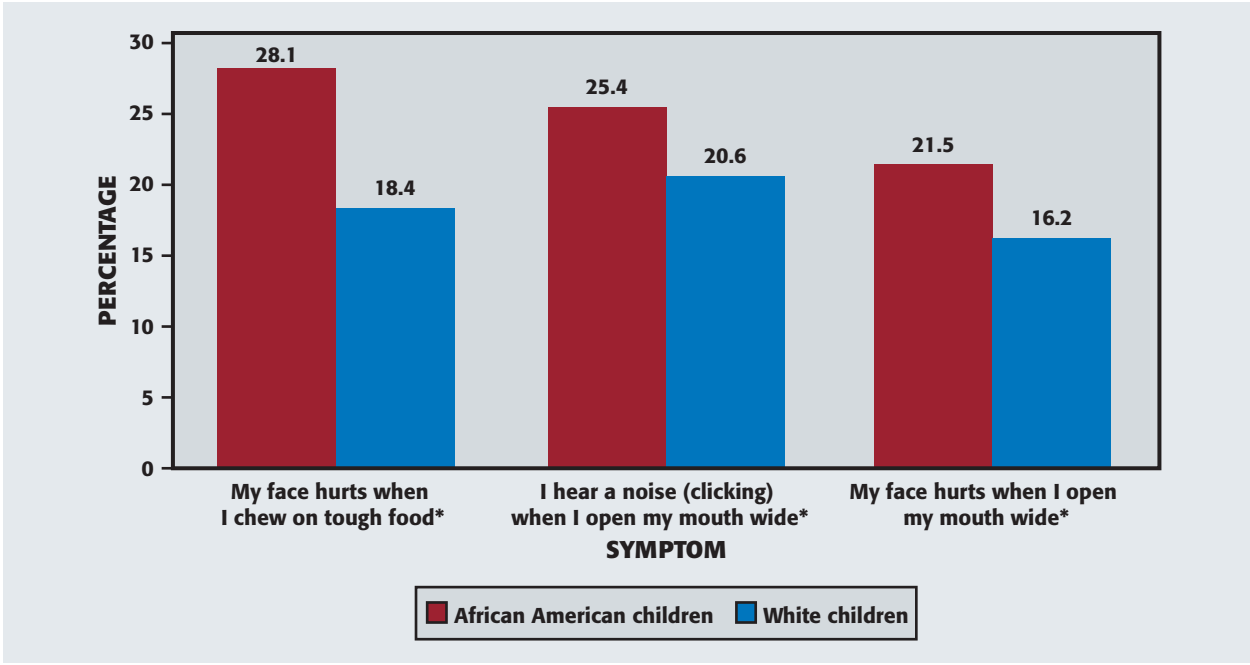

Figure 3. Percentages of African American versus white children who reported temporomandibular joint disorder symptoms. * $P < .001$.

percentage of boys than girls did not report any TMJD symptoms (61% versus 56%) and that higher percentages of girls reported 2 symptoms (14% versus 11%) or all 3 TMJD symptoms (7% versus 5%; $P < .001$) than boys. African American children had consistently higher percentages than white children when reporting whether they had 1, 2, or 3 TMJD symptoms ($P < .001$). Children in schools in which 50% or more students were enrolled in the free school lunch program were less likely to report no TMJD symptoms and more likely to report 1, 2, or all 3 symptoms

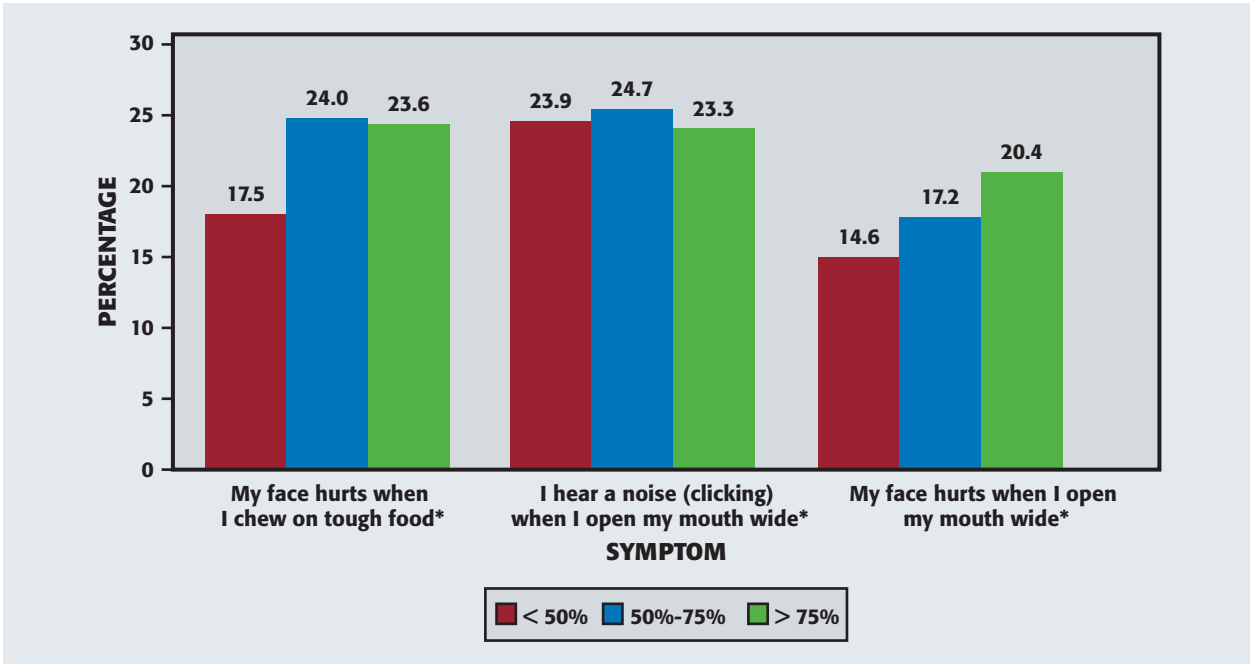

Figure 4. Percentages of children in schools with less than 50%, 50% to 75%, and more than 75% of the students enrolled in the free school lunch program who reported 3 different symptoms of temporomandibular joint disorder. * $P \leq .001$.

than students in schools in which fewer than 50% of the students were enrolled in this program ($P < .001$).

Table 3 shows the relationship among reported TMJD symptoms and 2 oral health indicators (the presence or absence of abscess and caries with pulpal involvement) and whether children needed oral health care. The data show that whether children reported specific TMJD symptoms or had increasing numbers of reported TMJD symptoms did not affect the likelihood of having an abscess or caries with pulpal involvement. Concerning the relationships between children's need for dental treatment and the data regarding TMJD, the results showed that children who needed treatment were more likely to report that they heard a noise (clicking) when they opened their mouth wide compared with children who did not need treatment (24% versus 22% $P < .05$).

Table 4 provides an overview of the percentages of children with no TMJD symptoms and of children with 1, 2, or 3 self-reported TMJD symptoms who reported impaired OHRQoL. The data show that children with 3 TMJD symptoms consistently had the highest percentages of reported symptoms and thus the poorest OHRQoL, and that children with no TMJD symptoms had the lowest percentages of reported symptoms and thus the best OHRQoL. For example, whereas 44% of children with 3 symptoms answered that their teeth hurt them at the time of the face-to-face interview, only 29% children with 2 TMJD symptoms, 18% of the children with 1 TMJD symptom, and 11% of children with no TMJD symptoms responded affirmatively to this question. In addition, when we compared the average sum score of reported OHRQoL impairments for the 4 groups of children, the data showed that the children with no TMJD symptoms had an excellent OHRQoL (on a scale from 0 = optimal OHRQoL to 13 = worst OHRQoL; mean = 1.44), whereas the children with 3 self-reported TMJD symptoms had the poorest OHRQoL (mean = 4.84; $P < .001$).

DISCUSSION

The prevalence of self-reported TMJD symptoms in this study ranged from 23.6% of children reporting that their face hurt when they chewed on tough food to 18.8% reporting that their face hurt when they opened their mouth wide. These percentages are between the prevalence data previously reported, which ranged from 7% among 12- to 18-year-old children in a study by List and colleagues[10] to 35% in a study by Vierola and colleagues[12] with children aged 6 to 8 years. Other authors found percentages of TMJD symptoms and signs between 10% and 25% among the children in their studies.[4-8,26,32] These percentages were closer to the percentages we found in our study. This range of prevalence data raises the question whether a child's age might be an explanatory factor. The findings in this study showed that although the percentages of children with self-reported TMJD symptoms differed for the 3 age groups we considered (group 1, children in kindergarten and grade 1 [mostly

TABLE 2

Percentages of self-reported TMJD* symptoms among different subgroups of children.

BACKGROUND CHARACTERISTICS	NO. (%) OF CHILDREN REPORTING NO TMJD SYMPTOMS (N = 4,848)	NO. (%) OF CHILDREN REPORTING 1 TMJD SYMPTOM (N = 1,923)	NO. (%) OF CHILDREN REPORTING 2 TMJD SYMPTOMS (N = 1,029)	NO. (%) OF CHILDREN REPORTING 3 TMJD SYMPTOMS (N = 502)	*P* VALUE
Grade					
Kindergarten and grade 1	1,852 (60)	653 (21)	349 (11)	236 (8)	< .001
Grade 2 and 3	1,445 (55)	642 (24)	375 (14)	169 (6)	
Grade 4 and 5	1,354 (51)	536 (24)	269 (12)	79 (4)	
Sex					
Male	2,482 (61)	956 (23)	445 (11)	216 (5)	< .001
Female	2,361 (56)	965 (23)	583 (14)	284 (7)	
Race					
African American	1,342 (54)	618 (24)	330 (15)	171 (7)	< .001
White	1,217 (64)	461 (22)	173 (9)	102 (5)	
Socioeconomic Background					
< 50% of students enrolled in free school lunch program	339 (60)	132 (23)	61 (11)	33 (6)	< .001
50%-75% of students enrolled in free school lunch program	932 (60)	369 (24)	180 (12)	83 (5)	
> 75% of students enrolled in free school lunch program	1,393 (56)	630 (24)	289 (12)	168 (7)	

* TMJD: Temporomandibular joint disorder.

TABLE 3

Oral health indicators and self-reported temporomandibular joint disorder symptoms.

SYMPTOM	ABSCESS		PULPAL INVOLVEMENT		TREATMENT NEEDED	
	Yes	No	Yes	No	Yes	No
"Does it hurt when you chew on tough food?" (No. [%])	58 (25)	1,532 (23)	120 (25)	1,470 (23)	970 (25)	813 (23)
"Do you hear a noise when you open your mouth wide?" (No. [%])	46 (23)	1,538 (20)	106 (22)	1,478 (23)	944 (24)	771 (22)*
"Does it hurt when you open your mouth wide?" (No. [%])	48 (21)	1,237 (19)	1,185 (19)	100 (21)	685 (20)	753 (19)
Self-Reported Temporomandibular Joint Disorder Symptoms (%)						
0 (N = 4,346)	2.5	97.5	8.7	91.3	52.0	48.0
1 (N = 1,712)	3.2	96.8	8.8	91.2	53.6	46.4
2 (N = 919)	2.3	97.7	9.5	90.5	54.4	45.6
3 (N = 462)	3.0	97.0	8.6	91.4	54.1	45.9

* $P < .05$.

5 and 6 years old]; group 2, children in grades 2 and 3 [mostly 7 and 8 years old]; and group 3, children in grades 4 and 5 [mostly 9 and 10 years old]) (Figure 1), we noted no consistent changes over time. This finding is consistent with a report by Emodi-Perlman and colleagues[44] whose results also showed that in a group of 5- to 12-year-old children, age was not related to the prevalence of TMJD symptoms. However, some authors have argued that TMJD symptoms might increase with age among older children[45] and that this might be owing to pubertal development and increased self-awareness among these older children.[21] Although future researchers should explore the way children's developmental changes might affect the prevalence of TMJD, overall there is consensus that TMJD is a serious issue among children.

TABLE 4

Oral health–related quality of life of children who reported no symptoms or 1, 2, or 3 symptoms of TMJD.*

ORAL HEALTH–RELATED QUALITY OF LIFE QUESTIONS	CHILDREN REPORTING NO TMJD SYMPTOMS (N = 4,848)	CHILDREN REPORTING 1 TMJD SYMPTOM (N = 1,923)	CHILDREN REPORTING 2 TMJD SYMPTOMS (N = 1,029)	CHILDREN REPORTING 3 TMJD SYMPTOMS (N = 502)	*P* VALUE
"Do your teeth hurt you now?" (No. [%] responding "yes")	527 (11)	349 (18)	295 (29)	219 (44)	< .001
"Do your teeth hurt when you eat hot or cold food?" (No. [%] responding "yes")	1,330 (27)	776 (40)	572 (56)	329 (66)	< .001
"Do your teeth hurt when you eat sweet food?" (No. [%] responding "yes")	808 (17)	530 (28)	379 (37)	251 (50)	< .001
"Do your teeth hurt when you chew or bite?" (No. [%] responding "yes")	1,058 (22)	686 (36)	513 (50)	352 (70)	< .001
"Does a toothache wake you up at night?" (No. [%] responding "yes")	695 (14)	454 (24)	388 (38)	282 (56)	< .001
"Does a toothache stop you from playing?" (No. [%] responding "yes")	501 (10)	371 (19)	333 (32)	227 (45)	< .001
"Does a tooth hurt in school?" (No. [%] responding "yes")	697 (15)	482 (25)	426 (42)	257 (53)	< .001
"Does a toothache keep you home from school?" (No. [%] responding "yes")	334 (7)	226 (12)	211 (21)	172 (36)	< .001
"Does a toothache keep you from learning in school?" (No. [%] responding "yes")	228 (5)	153 (8)	150 (15)	121 (25)	< .001
"Does a toothache keep you from paying attention in school?" (No. [%] responding "yes")	259 (5)	187 (10)	180 (18)	134 (28)	< .001
"Do you have a nice smile?" (No. [%] responding "no")	265 (6)	145 (8)	66 (6)	41 (8)	.003
"Are you happy with your teeth?" (No. [%] responding "no")	235 (5)	116 (6)	87 (9)	41 (8)	< .001
Oral health–related sum score (mean [standard deviation])†	1.44 (1.81)	2.33 (2.24)	3.50 (2.51)	4.84 (2.85)	< .001

* TMJD: Temporomandibular joint disorder.
† The oral health–related quality of life (OHRQoL) sum score was computed by adding 1 point for a "yes" response to the first 10 items and 1 point for a "no" response to the last 2 items. The scores ranged from 0 (best OHRQoL) to 13 (worst OHRQoL).

Concerning whether boys versus girls in kindergarten through grade 5 are more likely to self-report TMJD symptoms, our findings were consistent with the findings of investigators of other studies that also showed that a higher percentage of girls than boys experienced TMJD.[4,5,8,19-25] However, the fact that the investigators of some studies did not find differences related to sex in the prevalence of TMJD symptoms deserves attention.[26-31] It seems important to gain a better understanding of the reasons for these contradictory findings. For example, researchers should rule out whether response biases—such as girls finding it more acceptable to report pain compared with boys—might explain these findings.

Future research also is needed to gain a better understanding about why we found differences in the percentages of children with African American backgrounds versus white children. Only Widmalm and colleagues,[4,26,35] who conducted research studies with children, found such differences. However, this could be owing to the fact that the investigators of nearly all of the other reported studies concerning TMJD in children did not consider race. Research results of studies with adults showed some support for the hypothesis that African American adults might be more likely to experience TMJD than white adults.[33,34] However, other authors argued that these racial differences might disappear if investigators would control for socioeconomic differences.[36] We found that this argument was not completely supported in our research study. Although children in schools that had fewer than 50% of the students enrolled in a free school lunch program consistently had the lowest prevalence of TMJD symptoms, the children in

schools that had 50% to 75% of the students enrolled in a free school lunch program and the children in schools that had more than 75% of the students enrolled in a free school lunch program did not differ in a consistent fashion. This finding could be owing to the fact that in our study, we indirectly determined socioeconomic status by grouping the children according to the rate of free school lunch participants in each school. Future researchers should analyze the role of socioeconomic background factors more precisely by including individual assessments of this variable in the design of their studies.

Although there is no reason to assume that TMJD would be related to the presence of caries or periodontal disease, one could make an argument that pain caused by abscesses or caries with pulpal involvement might radiate and thus lead to higher reports of TMJD symptoms. However, we did not find this expected relationship in our study. In addition, there was only 1 significant relationship between having versus not having a need for dental treatment and reporting a TMJD symptom. Although this relationship was significant, one might argue that the difference was not highly clinically relevant (22% versus 24%; $P < .05$). One could conclude, therefore, that there is no relationship between oral disease and TMJD in children.

However, the connections between TMJD symptoms and children's OHRQoL were strong. Children without any TMJD symptoms had excellent OHRQoL, whereas children reporting 3 symptoms had the poorest OHRQoL. These findings are consistent with findings by Barbosa and colleagues[19] and Jedel and colleagues.[40]

The results of our study have 3 major limitations. First, we assessed TMJD only by gathering the answers to self-reported interview questions and not by conducting clinical examinations. Not using the diagnostic criteria for temporomandibular disorders[45] for this research study was clearly a limitation because it made it difficult to compare these findings with the results in the existing literature regarding TMJD. However, other researchers who have collected both clinical examination and survey questionnaire data have found a rather impressive level of consistency between the 2 sets of data.[8,10,19,24,28,46]

The second limitation was the fact that we only assessed socioeconomic background on a group level by considering the percentages of students who were enrolled in free school lunch programs in each of the 35 schools. More precise individual assessments definitely would have contributed to a more accurate assessment of the role of children's socioeconomic background regarding their reported TMJD symptoms. In addition, it would have been helpful to include the assessment of etiologic factors such as trauma, oral habits, and stressors that would have helped with a discussion of etiology.

Finally, it would have been valuable to also ask the children whether their face hurt at rest and to determine whether they had earaches, headaches, and neck pain, because these conditions often overlap with TMJD pain. This information could have been valuable when considering that interprofessional collaborations with pediatricians might be helpful when providing care for these children.

CONCLUSION

Our results clearly show that significant percentages of kindergarten through grade 5 elementary school students reported TMJD symptoms related to the masticatory system (such as pain when chewing tough food), limitations of mandibular movement (such as when opening the mouth wide), and joint sounds. Although we did not find conclusive data concerning age differences, we did find consistent results related to the role of sex and race and preliminary indications for the role of socioeconomic factors. Girls were more likely to report TMJD symptoms than were boys, and children from African American backgrounds were more likely to report TMJD symptoms than were white children. However, although children in schools in which fewer than 50% of the students were enrolled in the free lunch program were consistently the least likely to report TMJD symptoms, the relationships were not as straightforward for students in schools in which 50% to 75% of the students were enrolled in this program versus schools in which more than 75% of the students were enrolled in this program.

In addition, we found no relationships between the prevalence of TMJD and the presence or absence of abscesses and caries with pulpal involvement. However, we found that the presence of TMJD symptoms is related strongly with poorer OHRQoL.

There are 3 sets of practical implications of these findings for dental and dental hygiene educators, for practicing clinicians, and for researchers. First, coordinators of dental and dental hygiene education and continuing education for dental care providers have to incorporate education about how to diagnose TMJD in children and adolescents and how to provide treatment recommendations (see also Castelo and colleagues,[47] Greene and colleagues,[48] and Tegelberg and colleagues[49,50]). Second, clinicians need to include questions about TMJD in their medical and dental history forms and be skilled in conducting clinical examinations for diagnosing TMJD in children. Once a child's TMJD is diagnosed, it is crucial that practitioners are aware which treatment recommendations need to be provided. Third, given the prevalence of TMJD among children and the degree to which TMJD affects children's well-being and quality of life, researchers need to focus on gaining a better understanding of how to prevent TMJD and how to provide optimal treatment when children are diagnosed with TMJD. ■

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at: http://dx.doi.org/10.1016/j.adaj.2015.10.001.

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