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## Tooth wear: prevalence and associated factors in general practice patients

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### Abstract

**Objectives**—To estimate the prevalence of tooth wear and to investigate factors associated with tooth wear in patients from general practices in the Northwest United States.

**Methods**—Data on the diagnosis and treatment of oral diseases during the previous year were collected in a survey with a systematic random sample of patients (n = 1530) visiting general dentists from the Northwest Practice-based REsearch Collaborative in Evidence-based DENTistry (PRECEDENT) (n = 80). Prevalence ratios (PRs) of moderate to severe occlusal and incisal tooth wear by patient characteristics were estimated using cluster-adjusted multiple binomial regression for adults (18+ years) and children/adolescents (3–17 years).

**Results**—For adults, the mean number of teeth with wear facets was 5.4 [95% confidence interval (CI) = 4.6–6.2] and 51% of the adults had four or more teeth with wear. Participants 45–64 and 65+ years old were 1.3 (95% CI = 1.1–1.6) and 1.4 (95% CI = 1.1–1.8) times as likely to have 4+ teeth with moderate to severe wear facets as participants 18–44 years old. Adult males had a 20% (PR = 1.2; 95% CI = 1.1–1.4) higher prevalence of wear than adult females. Adults who were using, or had ever used occlusal splints had higher prevalence of tooth wear compared to those who never used such appliances (PR = 1.3; 95% CI = 1.0–1.5). Adults with any periodontal bone loss also had a 20% higher prevalence of wear than adults without periodontal disease (PR = 1.2; 95% CI = 1.0–1.4). For children/adolescents, the mean number of teeth with moderate to severe wear facets was 1.6 (95% CI = 0.9–2.6) and 31% of the children had one or more teeth with wear facets. The adjusted prevalence ratio of tooth wear (1+ teeth with wear facets) for boys was 1.6 times as high (95% CI = 1.1–2.4) as compared with girls. The prevalence of wear for children 12+ years old was 50% (PR = 0.5; 95% CI = 0.3–0.8) lower than that of children <12 years old. Angle's class II was associated with higher tooth wear prevalence (PR = 1.8; 95% CI = 1.3–2.6) than class I. Children with posterior or anterior open bite had lower prevalence of wear than their counterparts (PR = 0.6; 95% CI = 0.3–1.0). No associations were observed between tooth wear and orthodontic treatment, missing teeth, and race/ethnicity.

**Conclusion**—Tooth wear is a prevalent condition in this population. Among adults, higher prevalences of tooth wear were observed among those who were older, males, had used occlusal splints and had periodontal disease. Among children, higher prevalences were associated with

younger age, male gender, class II malocclusion and the absence of open bite. Submitted on behalf of the Northwest PRECEDENT network, with support from NIDCR grants DE016750 and DE016752.

## Keywords

dental practice-based research; malocclusion; Northwest PRECEDENT; tooth attrition

Tooth wear is defined as loss of dental hard tissue by a chemical or mechanical process not involving bacteria (1). Tooth wear facets are characterized as flat, round or sharply angled and polished surfaces on the occlusal or incisal areas of the teeth and may be the result of excessive attrition of one tooth against the other. Abrasion and erosion can also contribute to the excessive wear of the occlusal and incisal surfaces.

The prevalence of tooth wear varies widely among populations (2). Tooth wear can be the result of a natural ageing process (3–5) and be imperceptible to the majority of the patients. However, some patients may have tooth hypersensitivity, and severe tooth wear may extend to the pulp. Severe tooth wear has an impact on oral pain levels, dental appearance and function (6).

Several studies have investigated dietary and other environmental factors contributing to tooth wear (7–12). Malocclusion and orthodontic treatment have been inconsistently associated with this condition (8, 13, 14). The way the mandibular teeth contact the maxillary teeth may influence tooth wear. For instance, Angle's Class II malocclusion has been associated with increased wear (10). In contrast, the absence of teeth contacts may prevent tooth wear, and the presence of an open bite or crossbite may decrease the risk of wear (10, 13). The objective of this study was to estimate the prevalence of tooth wear and to investigate factors associated with tooth wear including malocclusion and orthodontic treatment in general practices' patients.

## Materials and methods

A cross-sectional study of the oral health conditions of the patients and the treatments performed by 80 general dentists was conducted from September 2006 to June 2008 in the Northwest Practice-based REsearch Collaborative in Evidence-based DENTistry (PRECEDENT), a dental practice-based research network. The study settings were the practices of the general dentists, with 96% being private practices and 4% community clinics.

Participants were selected using a systematic random sampling scheme where each office was assigned a starting date and a sampling interval. The sampling interval was adjusted for each practice based on patient volume, so that each practitioner was expected to sample approximately one, and no more than two, study participants per day. Every *n*th patient visiting the office in the study period was invited to participate until 20 participants within each practice were enrolled in the study. The purpose and procedures of the study were explained to the participants and informed consent was obtained. The study protocol was approved by the Institutional Review Board of the Oregon Health & Science University.

Dentist members performed a clinical examination. Information on diagnosis and treatments of several oral conditions was collected from the patients' dental charts. Training for this study included the review of the manual of operations and data collection forms by the dentist and dental practice staff and participation in telephone training sessions given by research coordinators on the study-specific methods and the electronic, web-based data entry system. Detailed instructions for the clinical measures were given in the data collection form

and research coordinators were available by telephone to answer any queries from the dentists, but no attempts were made to standardize the clinical measurements.

Data on occlusal/incisal tooth wear was collected during the clinical examination using the following question: 'How many teeth exhibit wear facets? (include moderate to severe wear only)' and instructions were given to consider tooth wear as the loss of 1 mm or more of tooth structure, regardless of being primary or permanent tooth. Information on Angle's malocclusion Class, open bite, and orthodontic treatment were collected through a clinical examination and patient interview. Participants were classified as having (i) Angle's class I if the right and left permanent molar relationship were class I, (ii) Angle's class II if the right and/or left permanent molar relationship was a class II and (iii) Angle's class III if the right and/or left permanent molar relationship was a class III and neither side was class II. Open bite was considered present when anterior (cuspid/anterior region) or posterior (molar/premolar region) open bite was observed. Either any tooth movement ever performed or an intraoral appliance made for orthodontic reasons mentioned by the participant were considered evidence of orthodontic treatment. Reported use of intraoral appliances made for bruxism, grinding, clenching and musculoligamentous pain whether associated or not with temporomandibular disorders were referred to as occlusal splint use. Participants were also asked about their age, gender, and race/ethnicity during the clinical examination. The following age groups were defined: 3–11, 12–17, 18–44, 45–64 and 65 or more years old. Participants were queried about their ethnicity (Hispanic or Latino and not Hispanic or Latino) and their race (White, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Pacific Islander and other races) and race/ethnicity was then categorized as Non-Hispanic White and other.

Information on periodontal disease and number of missing permanent teeth was collected during a chart review. Periodontal disease was considered present if the chart had any record of bone loss in the past 12 months. The number of missing permanent teeth was categorized as 0–4 versus 5 or more missing teeth excluding the third molars for adults and as 0 versus 1 or more missing teeth for children/adolescents.

### Statistical analysis

The distribution of tooth wear and the other patients' characteristics were examined using descriptive statistics. Design-adjusted chi-square tests were used to test for differences between participants with and without tooth wear (15). Prevalence ratios (PR) were estimated to relate tooth wear to the patients' characteristics using GEE multiple binomial regressions. Generalized estimating equations were used to take into account the clustering of participants within practices (16). Separate results were presented for adults and children/adolescents. The outcome was a binary variable calculated by dichotomizing the number of teeth with wear facets using the median as the cutoff, which was four or more teeth with moderate to severe wear facets for adults. Since for children/adolescents the median was 0, the next highest value was used as the cutoff and the outcome was defined as 1 or more teeth with moderate to severe wear facets. Analyses were performed using SAS 9.2 for Windows software (SAS Institute Inc., Cary, NC, USA).

### Results

After excluding nine edentulous patients, the number of adults enrolled was 1 295. Adult participants were 18–93 years old (mean = 49), 43% were males, and 84% were non-Hispanic white race/ethnicity. Sixty-two per cent of the adults had a class I molar relationship, 12% had anterior or posterior open bite, and 30% had orthodontic treatment. Seven per cent had used occlusal splints. Bone loss in the past 12 months was recorded in

37% of the charts and five or more teeth were missing in 17% of the adults. Data was missing on one or more variables for 210 adults (16%).

For adults, the mean number of teeth with moderate to severe wear facets was 5.4 [95% confidence interval (CI) = 4.6–6.2]. Fifty-one per cent of the participants had four or more teeth with moderate to severe wear facets. Prevalences of four or more teeth with moderate to severe wear facets were higher among adults of older age, male gender, who ever used occlusal splints and who had periodontal bone loss than among their adult counterparts (Table 1).

The number of children and adolescents enrolled was 225. Children and adolescent participants were 3–17 years old (mean = 11.2), 51% were males, and 70% were non-Hispanic white race/ethnicity. Sixty-one percent of the children/adolescents had a class I molar relationship, 16% had anterior or posterior open bite and 26% had orthodontic treatment. One or more permanent teeth were missing in 8% of the children/adolescents.

For children and adolescents, the mean number of teeth with moderate to severe wear facets was 1.5 (95% CI = 0.8–2.2). Thirty-one per cent of the children had one or more teeth with moderate to severe wear facets. The prevalence of 1+ teeth with wear facets was higher among male children/adolescents than among females (Table 2).

In the adjusted model with all variables included, except missing teeth, participants 45–64 and 65+ years old were 1.3 (95% CI = 1.1–1.6) and 1.4 (95% CI = 1.1–1.8) times as likely to have 4+ teeth with moderate to severe wear facets as participants 18–44 years old. Adult males had a 20% (PR = 1.2; 95% CI = 1.1–1.4) higher prevalence of tooth wear compared to adult females. Adults who were using, or ever used occlusal splints had a 30% higher prevalence of tooth wear compared to those who never used such appliances (PR = 1.3; 95% CI = 1.0–1.5). Participants with any periodontal bone loss also had a 20% higher prevalence of tooth wear than participants without periodontal disease (PR = 1.2; 95% CI = 1.0–1.4). No associations were observed between tooth wear and Angle malocclusion, posterior or anterior open bites, orthodontic treatment, missing teeth, and race/ethnicity (Table 3).

In the adjusted model with all variables included, except missing teeth, the prevalence of tooth wear for children 12+ years old was 50% lower than that of children <12 years old (PR = 0.5; 95% CI = 0.3–0.8). Boys were 1.6 (95% CI = 1.1–2.4) times as likely to have one or more teeth with wear facets as girls. Angle class II was associated with higher tooth wear prevalence (PR = 1.8; 95% CI = 1.3–2.6) than class I. Posterior or anterior open bite was associated with a 40% lower prevalence of tooth wear when compared to children/adolescents without open bite (PR = 0.6; 95% CI = 0.3–1.0). Race/ethnicity, orthodontic treatment and missing teeth were not associated with the prevalence of tooth wear among children and adolescents (Table 4).

## Discussion

Tooth wear was a prevalent condition in this patient population: one in two adult patients had four or more teeth with moderate to severe wear, and one in three children had one or more teeth with moderate to severe wear. Tooth wear may be considered a physiological process with an expected annual rate of wear of approximately 11  $\mu\text{m}$  (17). Moderate to severe wear facet was defined in this study as the loss of 1 mm or more of tooth structure. Under physiological 'normality', 91 years of natural masticatory functioning would be necessary to achieve the minimal level of tooth wear defined for this study. Since the oldest patient in this study was 93 years old (and the first permanent teeth erupted at approximately 6 years of age), virtually all of the wear identified in this study would be considered nonphysiological. Among adults, periodontal disease, occlusal splint use, older age and male

gender were associated with increased tooth wear, while malocclusion, orthodontic treatment and other factors were not. Among children, class II malocclusion and absence of open bite was associated with increased tooth wear as well as younger age and male gender.

Periodontal disease may contribute to tooth wear by increasing tooth mobility and migration, and thereby modifying the interocclusal contacts. Occlusal trauma may be a co-factor aggravating an existing periodontal problem (18), but there is no evidence that occlusal trauma causes periodontal disease. We observed an increased prevalence of tooth wear among patients with evidence of bone loss. However, the causative mechanisms contributing to the observed association of tooth wear and periodontal disease cannot be further elucidated in this cross-sectional study.

Another factor associated with tooth wear was the use of occlusal splints. Occlusal splints are used for the treatment of bruxism, clenching and grinding as well as temporomandibular joint disorders (TMJD). According to the literature, tooth wear is more likely to be associated with bruxism, clenching and grinding than with TMJD. Although an association between tooth wear and TMJD has been reported (19, 20), most studies indicate that TMJD is not a risk factor for tooth wear (13, 21–26). Bruxism, on the other hand, has been consistently implicated in tooth wear etiology (13, 27–29), with tooth wear even being used as a proxy for bruxism by some investigators (21, 30). In our study, we could not determine the indications for the different uses of occlusal splints, but participants who had at some time used occlusal splints had a higher prevalence of occlusal wear facets.

Class II malocclusion and absence of posterior or anterior open bite was associated with tooth wear in children, but not in adults. These findings are corroborated by other studies in which the association of malocclusion was observed in children (10), but not in adults (13, 30). It may be that a class II malocclusion precludes anterior disclusion during lateral and protrusive mandibular excursions, resulting in greater contact of posterior teeth during episodes of parafunction. Likewise, class II division 2 malocclusion is associated with increased anterior vertical overlap that could result in increased contact of anterior teeth during parafunction. However, we did not collect data on the specific teeth that demonstrated wear, nor did we collect information on the sub classification of class II malocclusions. On the other hand, the absence of tooth contacts present in an open bite may prevent the development of tooth wear. It is therefore tempting to blame the association of increased wear prevalence with class II malocclusion and absence of open bite observed in this study on those factors. However, this fails to explain why there were no associations in adults.

In addition to periodontal disease and occlusal splint use in adults and class II malocclusion and absence of open bite in children, age and gender were associated with tooth wear for both adults and children. Contrasting relations were observed for age among adults and children. While the older the adult the higher the prevalence of tooth wear, the younger the children the higher the prevalence of tooth wear. For children, both primary and permanent teeth were considered for the estimates of the number of wear facets. High wear of primary teeth has been observed previously with 82% of children showing dentin exposure (9). The higher number of primary teeth among children younger than 12 years old and the higher natural wear of these teeth compared to permanent teeth in children (31) may be the reason for the higher prevalence of tooth wear in young children. Among adults, the opposite is occurring because of the natural wear of the permanent teeth. Males among children and also among adults had an increased prevalence of tooth wear, probably reflecting the higher bite force of males compared to females (28).

Strengths of this study include the systematic sample which permits us to generalize the findings to the population of patients visiting general dentist's practices in Northwest PRECEDENT. However, the results should not be extrapolated to the general population of patients or to all patients of general dentists, because the study sample included only active patients of Northwest PRECEDENT members. Other limitations of this study include the lack of standardization of the tooth wear measurements, of a clear definition of open bite and the inability to ascertain nonresponse rate and causal relationships. While the practice-based research permit us to include different practitioners and real life circumstances, the agreement of the practitioner–investigators on the assessment of tooth wear was not evaluated. Finally, an additional limitation of this study is that diet, oral hygiene and other habits that may contribute to tooth wear were not considered in this study.

An improved understanding of the factors associated with tooth wear may lead to more effective interventions. In conclusion, moderate to severe tooth wear is a prevalent condition in the adult population and older age, male gender, occlusal splint use and periodontal disease were associated with occlusal and incisal wear facets, while malocclusion and other factors were not. Among children, tooth wear was less prevalent and only class II malocclusion, absence of open bite, age and gender were associated with occlusal and incisal wear facets.

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**Table 1**

Prevalence of tooth wear by characteristics of adults

|                                 | <b>4 + teeth with wear facets</b> |          | <b>Total</b> | <b>P-value</b> |
|---------------------------------|-----------------------------------|----------|--------------|----------------|
|                                 | <b>N</b>                          | <b>%</b> | <b>N</b>     |                |
| All                             | 655                               | 51       | 1288         |                |
| Age                             |                                   |          |              | <0.01          |
| 18–44 years                     | 211                               | 41       | 515          |                |
| 45–64 years                     | 311                               | 56       | 552          |                |
| 65 + years                      | 133                               | 60       | 221          |                |
| Gender                          |                                   |          |              | <0.01          |
| Female                          | 339                               | 46       | 737          |                |
| Male                            | 316                               | 57       | 551          |                |
| Race/Ethnicity                  |                                   |          |              | 0.91           |
| Non-Hispanic White              | 552                               | 51       | 1087         |                |
| Other                           | 98                                | 50       | 195          |                |
| Unreported                      | 5                                 | 83       | 6            |                |
| Angle's malocclusion            |                                   |          |              | 0.60           |
| Class I                         | 398                               | 50       | 795          |                |
| Class II                        | 150                               | 54       | 277          |                |
| Class III                       | 55                                | 52       | 106          |                |
| Unreported                      | 52                                | 47       | 110          |                |
| Posterior or anterior open bite |                                   |          |              | 0.17           |
| No                              | 558                               | 50       | 1107         |                |
| Yes                             | 84                                | 57       | 148          |                |
| Unreported                      | 13                                | 39       | 33           |                |
| Orthodontic treatment           |                                   |          |              | 0.08           |
| No                              | 467                               | 53       | 886          |                |
| Yes                             | 182                               | 47       | 390          |                |
| Unreported                      | 6                                 | 50       | 12           |                |
| Occlusal splint                 |                                   |          |              | 0.03           |
| No                              | 593                               | 50       | 1192         |                |
| Yes                             | 62                                | 65       | 96           |                |
| Periodontal bone loss           |                                   |          |              | <0.01          |
| No                              | 328                               | 45       | 733          |                |
| Yes                             | 281                               | 60       | 470          |                |
| Unreported                      | 46                                | 54       | 85           |                |
| Missing permanent teeth         |                                   |          |              | 0.72           |
| <5 teeth                        | 543                               | 51       | 1073         |                |
| 5 + teeth                       | 112                               | 52       | 215          |                |



**Table 2**

Prevalence of tooth wear by characteristics of children and adolescents

|                                 | <u>1 + teeth with wear facets</u> |     | <u>Total</u> | <i>P</i> -value |
|---------------------------------|-----------------------------------|-----|--------------|-----------------|
|                                 | N                                 | %   | N            |                 |
| All                             | 69                                | 31  | 225          |                 |
| Age                             |                                   |     |              | 0.09            |
| <12 years old                   | 43                                | 36  | 118          |                 |
| 12 + years old                  | 26                                | 24  | 107          |                 |
| Gender                          |                                   |     |              | 0.02            |
| Female                          | 26                                | 24  | 110          |                 |
| Male                            | 43                                | 37  | 115          |                 |
| Race/Ethnicity                  |                                   |     |              | 0.90            |
| Non-Hispanic White              | 49                                | 31  | 158          |                 |
| Other                           | 20                                | 30  | 67           |                 |
| Angle's malocclusion            |                                   |     |              | 0.12            |
| Class I                         | 40                                | 29  | 137          |                 |
| Class II                        | 18                                | 46  | 39           |                 |
| Class III                       | 4                                 | 31  | 13           |                 |
| Unreported                      | 7                                 | 19  | 36           |                 |
| Posterior or Anterior open bite |                                   |     |              | 0.61            |
| No                              | 58                                | 33  | 176          |                 |
| Yes                             | 10                                | 29  | 35           |                 |
| Unreported                      | 1                                 | 7   | 14           |                 |
| Orthodontic treatment           |                                   |     |              | 0.36            |
| No                              | 52                                | 32  | 164          |                 |
| Yes                             | 15                                | 25  | 59           |                 |
| Unreported                      | 2                                 | 100 | 2            |                 |
| Missing permanent teeth         |                                   |     |              | 0.42            |
| No                              | 65                                | 31  | 207          |                 |
| Yes                             | 4                                 | 22  | 18           |                 |

**Table 3**

Association of tooth wear and patient characteristics in the adult population ( $n = 1085$ ): crude and adjusted prevalence ratios (PR) and 95% confidence intervals

|                                 | Crude PR | 95%CI       | Adjusted PR <sup>a,b</sup> | 95% CI      |
|---------------------------------|----------|-------------|----------------------------|-------------|
| 45–64 years old <sup>c</sup>    | 1.4      | (1.2–1.6) * | 1.3                        | (1.1–1.6) * |
| 65+ years old                   | 1.6      | (1.3–1.9) * | 1.4                        | (1.1–1.8) * |
| Male gender                     | 1.2      | (1.1–1.4) * | 1.2                        | (1.1–1.4) * |
| Non-Hispanic White              | 1.1      | (0.9–1.3)   | 1.0                        | (0.8–1.2)   |
| Class II                        | 1.1      | (0.9–1.3)   | 1.0                        | (0.8–1.1)   |
| Class III                       | 1.0      | (0.8–1.3)   | 0.9                        | (0.8–1.2)   |
| Posterior or Anterior Open bite | 1.1      | (1.0–1.3)   | 1.1                        | (1.0–1.3)   |
| Orthodontic treatment           | 0.9      | (0.8–1.0)   | 1.0                        | (0.9–1.2)   |
| Occlusal Splint                 | 1.3      | (1.1–1.6) * | 1.3                        | (1.0–1.5) * |
| Periodontal bone loss           | 1.4      | (1.2–1.5) * | 1.2                        | (1.0–1.4) * |
| 5+ missing permanent teeth      | 1.0      | (0.8–1.3)   |                            |             |

<sup>a</sup>Binomial model with all variables in the table, except missing teeth.

<sup>b</sup>Missing teeth was excluded from final model because convergence could not be achieved.

<sup>c</sup>Reference groups were 18–44 years old for age, and class I for malocclusion.

\*  $P < 0.05$ .

**Table 4**

Association of tooth wear and patient characteristics in the children/adolescent population ( $n = 184$ ): crude and adjusted prevalence ratios (PR) and 95% confidence intervals

|                                 | Crude PR | 95% CI      | Adjusted PR <sup>a,b</sup> | 95% CI      |
|---------------------------------|----------|-------------|----------------------------|-------------|
| 12+ years old <sup>c</sup>      | 0.5      | (0.3–0.9) * | 0.5                        | (0.3–0.8) * |
| Male gender                     | 1.5      | (1.0–2.3)   | 1.6                        | (1.1–2.4) * |
| Non-Hispanic White              | 1.0      | (0.6–1.7)   | 1.0                        | (0.6–1.7)   |
| Class II                        | 1.7      | (1.1–2.5) * | 1.8                        | (1.3–2.6) * |
| Class III                       | 1.1      | (0.5–2.4)   | 1.5                        | (0.9–2.4)   |
| Posterior or anterior Open bite | 0.8      | (0.4–1.5)   | 0.6                        | (0.3–1.0) * |
| Orthodontic treatment           | 0.7      | (0.4–1.1)   | 0.9                        | (0.6–1.2)   |
| 1+ missing permanent teeth      | 0.7      | (0.3–1.6)   |                            |             |

<sup>a</sup>Binomial models with all variables in the table, except missing teeth.

<sup>b</sup>Missing teeth was excluded from final model because convergence could not be achieved.

<sup>c</sup>Reference groups were < 12 years old for age, and class I for malocclusion.

\*  $P < 0.05$ .