Prevalence of dental attrition and its relationship with dental erosion and salivary function in young adults

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Objectives: The aim of this study was to estimate the prevalence of dental attrition in a young adult population and to explore associated factors. **Method and materials:** Dental students aged 18 to 40 years old with a minimum of 24 natural teeth were invited to take part in this cross-sectional study. Their demographic information, medical history, perceived stress, frequency of dietary acid intake, and frequency of oral habits were obtained through several questionnaires. Assessment of each type of tooth wear (erosion, attrition, and abrasion) was performed according to the tooth wear evaluation system (TWES 1.0). All participants underwent salivary tests. Statistical analysis was performed by chi-squared or Mann–Whitney tests and logistic regression models. **Results:** In total, 178 participants (88 women and 90 men) with a median age of 22 years were included and of those 74.7% (95% confidence interval [CI], 68% to 81%) had dental attrition. Univariate analysis revealed positive associations for male sex, age, body mass index, awake bruxism frequency, and erosive tooth wear with the presence of dental attrition. Multivariable logistic regression (Nagelkerke $r^2 = 0.31$) indicated that dental attrition was associated with erosive tooth wear (adjusted odds ratio [aOR], 6.3; 95% CI, 2.8 to 14.2), body mass index (aOR, 1.3; 95% CI, 1.1–1.5), and age (aOR, 1.2; 95% CI 1.0 to 1.3). **Conclusion:** Dental attrition is present in most young adults of Catalonia. The associated factors were erosive tooth wear, body mass index, and age. Slight alterations of salivary parameters do not seem to predict dental attrition.
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Key words: prevalence, tooth attrition, tooth erosion, tooth wear, young adult

Tooth wear refers to the loss of tooth substance by means other than dental caries, dental trauma, or development disorders.[1] More than 85% of the adult population have some degree of tooth wear,[2,3] with moderate and severe issues affecting 35% and ≤ 10% of the population, respectively.[4,5] It is a multifactorial condition that involves an interplay between erosion (acid exposure), attrition (tooth-to-tooth contact), and abrasion (wear by objects other than teeth).[1,4] Unfortunately, few studies have distinguished the prevalence values between erosion, attrition, and abrasion,[6] though a recent study estimated that erosion, attrition, and abrasion were present in 80%, 90%, and 28% of Swedish adults, respectively.[3] Differentiation is important because, although all three processes often occur concurrently, one usually predominates. Research has also uncovered different in vitro microwear characteristics[7,8] and different clinical signs for each type of tooth wear.[9,10] Prevention measures should clearly target the predominant cause of tooth wear.

Several risk factors have been reported for dental attrition or occlusal/incisal wear, including male sex,[3,11-17] age,[3,11-16,18,19] body mass index (BMI), weight, and occlusal force.[11,16,17,20] Dental attrition was also positively associated with self- or partner-reported sleep and awake bruxism.[2,18,21-27] Although research has found a positive association between stress symptoms and sleep bruxism,[28] none has found a relationship between perceived stress and dental attrition.[22] Animal and in vitro studies indicate that erosion and abrasion predispose a person to attrition,[29-31] yet no clinical study has demonstrated the magnitude of this association. Research has uncovered several risk factors for erosive tooth wear, including history of gastric reflux,[32] eating disorders, acidic diet, and the quality and quantity of saliva.[4,33-38] Disease, medication, and regular sport may also affect the saliva and indirectly affect tooth wear.[5,35] Toothbrushing frequency and technique can promote abrasive tooth wear lesions.[39] Because of the interrelationship between these factors, tooth wear evaluation should be done by using multivariate techniques.[40,41] However, the few studies that have used multivariate techniques have reported several key factors that could explain up to 60% of the presence of occlusal wear.[11,12,14,18]

The human body cannot repair tooth wear, meaning that dental practitioners must rely on complex and expensive treatments for which technical complications are relatively frequent, and lifelong success cannot be guaranteed.[42,43] Hence, it would be preferable to detect tooth wear and apply appropriate preventive measures as early as possible.[4] The detection of risk factors for each type of tooth wear could be easier in the young population because they are more likely to coincide temporarily with clinical signs. This study aimed to estimate the prevalence of dental attrition in a young adult population in Catalonia and to explore the magnitude of association between the presence of dental attrition and erosive tooth wear, dental abrasion, salivary function, and other risk factors. The research hypothesis tested was that local or salivary factors are unrelated to dental attrition.

Method and materials

This cross-sectional study was performed from February 2020 to December 2020 in the Bellvitge Campus of the University of Barcelona, Catalonia. White European undergraduate and postgraduate dental students aged 18 to 40 years old with a minimum of 24 natural teeth were invited to participate in this study. Those with removable prostheses or more than two units of fixed implant- or dental-supported prosthesis were excluded. Most individuals took part in a previous investigation.[44] All participants provided informed consent.

The sample size (196) was determined to estimate the prevalence of dental attrition with 95% confidence and ± 5% precision, given a prevalence of 85% in the population.[6] The study was approved by the local ethics committee (2019-41; 5 February 2020), conducted in accordance with the principles of the Helsinki Declaration, and reported according to the STROBE guidelines.

All participants answered several questionnaires and underwent both clinical examination and salivary testing. Demographic information was collected, including age, sex, weight, and height, and the BMI was calculated as body weight divided by height squared.[45] The questionnaire also included questions on medical history, including gastric reflux, eating disorders, and medication, together with questions about diseases related to hyposalivation, such as Sjögren syndrome, asthma, depression, diabetes mellitus, and hypertension.

Perceived stress was assessed using the European Spanish version of the 10-item perceived stress scale.[46] This consists of 10 items rated on five-point Likert scales with four items reversed coded. The total score can range from 0 to 40 and is interpreted as low (0 to 13), moderate (14 to 26), and high (27 to 40) perceived stress. The frequency of dietary acid intake was assessed by asking the participants four questions:

- How many times per week do you eat fruit?
- Do you drink carbonated or soft beverages?
- Do you drink fruit juices?
- Do you consume vinegar?

Each question was rated using a five-point ordinal scale:

- 0, never
- 1, once or twice a week
- 2, three or four times a week
- 3, five or six times a week
- 4, daily.[47]

A new variable named "acid diet" was calculated as the sum of these four scores (range 0 to 16). Frequency of toothbrushing per day was also recorded.

The questionnaire also included the frequency of different habits, such as sport activities and oral habits. The oral behavior checklist comprises 21 items with five frequency options (0 to 4, for none to all the time). Among these 21 items, two are related to sleep activities and 19 are related to waking activities.[48] The first item "clench or grind teeth when asleep" represented the perceived frequency of sleep bruxism. The sum of the third and fourth items "grind teeth together during waking hours" and "clench teeth together during waking hours" represented the perceived frequency of awake bruxism. The oral behavior checklist sum score (range 0 to 84) represented the frequency of parafunctional behaviors.

Two researchers performed the tooth wear assessment according to the tooth wear evaluation system (TWES 1.0). They recorded dental attrition as present if an individual showed a plane facet in the occlusal/incisal surface of at least one tooth that matched a plane facet in an antagonistic tooth.[9] They recorded erosive tooth wear as present if an individual had at least one of the following features: wear on non-occlusal surfaces; flattening of convex areas; cupping, cratering, or grooving of

Table 1 Univariate analysis results for factors associated with dental attrition

Variable (risk factor)	n	Dental attrition: Absent (n = 45)	Dental attrition: Present (n = 133)	Significance (*P*)
Gender, n (%) of men	178	13 (28.9%)	77 (57.9%)	.001†
Age, mean (SD) years	178	22.1 (2.8)	24.0 (4.2)	.005‡
Body mass index, mean (SD), kg/m^2	178	21.0 (2.6)	23.0 (3.1)	<.001‡
History of gastric reflux, n (%)	177	6 (13.3%)	21 (15.9%)	.678†
History of eating disorders, n (%)	177	0 (0.0%)	5 (3.8%)	.226†
Perceived Stress Scale, mean (SD), Sum Score	178	15.9 (6.0)	15.2 (7.3)	.427‡
Acidic diet, mean (SD) Sum Score	177	3.5 (2.1)	4.2 (2.4)	.164‡
Frequency of tooth brushing, mean (SD) times daily	178	2.7 (0.6)	2.5 (0.6)	.058‡
Regular practice of sport, n (%)	177	24 (53.3%)	69 (52.3%)	.908†
Frequency of sleep bruxism, mean (SD), score 0–4	178	1.41 (1.5)	1.91 (1.6)	.074‡
Frequency of awake bruxism, mean (SD), score 0–8	178	1.24 (1.2)	1.90 (1.5)	.009‡
Oral Behavior Checklist, mean (SD), Sum Score	178	24.2 (7.1)	23.9 (7.3)	.960‡
Increased resting salivary viscosity, n (%)	178	6 (13.3%)	21 (15.8%)	.691†
Acidic resting saliva, n (%)	178	11 (24.4%)	24 (18.0%)	.350†
Reduced stimulated salivary flow, n (%)	177	8 (17.8%)	30 (22.7%)	.485†
Reduced buffering capacity stimulated saliva, n (%)	177	24 (53.3%)	48 (36.4%)	.050†
Presence of dental abrasion, n (%)	178	2 (4.4%)	7 (5.3%)	.593§
Presence of dental erosion, n (%)	178	21 (46.7%)	111 (83.5%)	<.001†

†Chi-square test.
‡Independent samples Mann–Whitney U test.
§Fisher Exact test (1-sided).

cusps; or a dull appearance.[9] Abrasive tooth wear was recorded in those who showed wear lesions in the cervical areas of canines and/or premolars exposed to toothbrushing.[9,10] Severity of tooth wear was assessed using a five-point ordinal occlusal/incisal grading scale according to the TWES 1.0 screening module. Examiners were blind to each other's findings, and at the end of the examination, a consensus was achieved for every diagnosis followed by reexamination when discrepancies persisted.

All salivary tests were performed between 09:00h and 13:00h, using the Saliva-Check Buffer system (GC Europe) according to the manufacturer's instructions. Resting salivary consistency was evaluated visually and assessed as having normal or increased viscosity. Salivary pH was measured by placing a pH test strip into a saliva sample for 10 seconds, and the result was classified as normal (pH 6.8 to 7.8) or acidic (pH < 6.8). Participants were instructed to chew a piece of wax for 30 seconds to stimulate salivation and the saliva was collected into a cup for 5 minutes. The stimulated flow rate was categorized as normal (≥ 5 mL/5 minutes) or reduced (< 5 mL/5 minutes). These cut-offs were chosen according to the manufacturer's instructions. One drop of saliva was placed onto each of three test pads and a change of color indicated the buffering ability of the saliva. The buffer capacity was categorized as normal (10 to 12) or low (0 to 9). This test and the methods used have acceptable reliability.[49]

A weighted kappa coefficient was used to determine the interobserver agreement for the presence of each type of tooth wear. Cohen-weighted Kappa of 0.57 (95%CI 0.42 to 0.71), 0.60 (95%CI 0.46 to 0.74), and 0.69 (95%CI 0.44 to 0.95) were obtained for the presence of attrition, erosion, and abrasion, respectively. Results for some variables related to medical history, medication, and toxic habits had low frequencies and were excluded from the analysis. The chi-square and Fisher exact tests were performed to assess the relationship between the presence of attrition and categorical variables, while the Mann–Whitney U test was used for ordinal and quantitative variables. Factors that could be related to the presence of dental attrition were analyzed by logistic regression, using a forward selection strategy with the likelihood ratio statistic. Potential risk factors were selected because they either showed a significant relationship in the bivariate analysis or other studies had reported them as significant. Specifically, the following independent factors were included: sex, age, BMI, history of gastric reflux, history of eating disorders, perceived stress, acidic diet, toothbrushing frequency, sport frequent, sleep bruxism self-report, awake bruxism self-report, oral behaviors, salivary function (viscosity, pH, flow, and buffer), erosion, and abrasion. The statistics were analyzed with IBM SPSS Version 27 for Windows (IBM) and considered a P value of $< .05$ to be statistically significant.

Results

Of the 197 invited individuals, 19 refused and 178 (88 women and 90 men) took part; however, one did not finish the salivary test and missed some salivary parameters, while others did not answer some of the questions about medical history and habits. Participants had a median age of 22 years (interquartile range [IQR], 4; from 21 to 25) and a median BMI of 22.5 (IQR, 3.9; 20.3 to 24.2). The median score of dietary acid intake was 4 (IQR, 2; 3 to 5). Overall, 52.5% regularly engaged in sports activities; 15.3% and 2.8% declared having suffered gastric reflux or some type of eating disorder, respectively; 66% declared some degree of clenching or grinding teeth when asleep; and 34% and 75% declared some degree of awake grinding and clenching, respectively. The median oral behavior checklist sum score was 24 (IQR, 10; 19 to 29) and the median perceived stress total score was 15 (IQR, 8; 11 to 19). Normal salivary function was detected for viscosity in 85%, pH in 80%, stimulated flow in 78%, and buffer capacity in 59%.

Dental attrition was observed in 74.7% (95% CI, 68% to 81%), and dental erosion and abrasion were detected in 74.2% (95% CI, 68% to 81%) and 5.1% (95% CI, 2% to 8%), respectively. Among participants with dental attrition, 7 (5.3%) had grade 2 because the wear affected the dentin in almost one tooth. Table 1 shows the results of dental attrition-related factors in the univariate analysis. Men accounted for 28.9% of participants without dental attrition and 57.9% with dental attrition ($P = .001$; chi-square). The Mann–Whitney U test positively associated dental attrition with age ($P = .005$), BMI ($P < .001$), and self-reported awake bruxism ($P = .009$). Interestingly, 46.7% of participants without dental attrition had dental erosion compared with 83.5% of those with dental attrition ($P < .001$; chi-square).

Finally, performing multiple logistic regression, age (adjusted odds ratio [aOR] = 1.15), BMI (aOR = 1.27), and the presence of erosive tooth wear (aOR = 6.31) were associated with the presence of dental attrition (Table 2).

Discussion

The study results suggest that 68% to 81% of young adults of Catalonia have dental attrition. This prevalence was slightly lower than that reported in Swedish or Indian populations, probably due to the age of the population being 10 to 20 years younger in the present study.[3,6] Despite the high prevalence, most participants lacked pathologic tooth wear to the dentin and denied pathologic symptoms such as sensitivity, pain, chewing difficulty, or impaired orofacial esthetics.[42,43] It would be advisable for those individuals aged 20 to 25 years with clinical signs of dental attrition to undergo follow-up monitoring and for preventive measures to be applied to avoid dentin wear or the development of pathologic symptoms.

It was found that individuals with at least one sign of dental erosion are 6.3 times more likely to show dental attrition, thus the research hypothesis was partially rejected. Although several authors have reported this relationship, none have demonstrated this magnitude of association in a clinical setting or using multivariate techniques to control for key parameters. Therefore, the present findings indicate that, when dental attrition is the predominant tooth wear process, preventive measures should cover both mechanical and chemical factors. General preventive measures might be oriented to reduce the consumption of erosive foods and drinks, minimize the effects of reduced salivary flow, chronic alcoholism, drug abuse, bulimia, or gastroesophageal reflux disease, increase chemical resistance of dental hard tissues with topically-applied fluoride compounds, and establish a mechanical barrier with surface sealants.[50,51] Due to the cross-sectional study design, however, it cannot be stated whether erosion results from or causes dental attrition, or indeed, if some other confounding factor has created a spurious association between erosion and attrition. Therefore, longitudinal studies must confirm the cause-and-effect relationship.

In the present study, men showed a higher prevalence of dental attrition than women, consistent with other studies.[3,11-18] However, because men had significantly higher BMI values, the association between sex and dental attrition became insignificant in the forward stepwise regression analysis after adjusting for the BMI. Weight, BMI, intercuspal occlusal contact area, and occlusal force appear to be interrelated, with values being higher in men than in women.[40,41,45] The present results support a direct relationship between the amount of occlusal force and the presence of dental attrition.[16,20] Unfortunately, occlusal force and occlusal contact area were not evaluated in the present study, meaning that further research is needed to clarify the

Table 2 Multivariate regression analysis results for factors associated with dental attrition

Step	Variables included	Wald	Significance (*P*)	OR (95% CI)	Nagelkerke R^2
1	Erosive TW	21.12	<.001	5.71 (2.72–12.02)	0.170
	Constant	0.09	.768	0.92	
2	BMI	12.02	<.001	1.31 (1.13–1.53)	0.272
	Erosive TW	20.02	<.001	6.11 (2.77–13.49)	
	Constant	11.92	<.001	0.002	
3	Age	4.05	.044	1.15 (1.00–1.33)	0.305
	BMI	8.82	.003	1.27 (1.08–1.48)	
	Erosive TW	19.89	<.001	6.31 (2.81–14.17)	
	Constant	14.89	<.001	0.00	

CI, confidence interval; OR, odds ratio.
Nagelkerke R^2 (fraction of variance explained).

cause and effect relationship between sex, weight, BMI, occlusal force, occlusal contact area, and dental attrition.

Frequency of self-reported awake bruxism was significantly higher in individuals with dental attrition compared with those without attrition, as reported elsewhere.[22,24] However, this weak association lost significance when BMI and age were entered in the multivariate model. It is likely that people who are aware of tooth wear are also aware of parafunctional behaviors, especially among dental students.[21] When assessing sleep or awake bruxism objectively by polysomnography or ambulatory electromyography, researchers have found no association between the frequency of bruxism episodes (masticatory muscle activity) and dental attrition.[21,22,25-27] That this association became insignificant in the multivariate model in this and other studies[18] could support the argument that tooth wear cannot be used as an indicator of sleep or awake bruxism.[21,22,25-27]

The present results suggest that slight alterations of salivary parameters assessed with a salivary test kit, such as consistency, flow rate, pH, and buffer capacity, do not predict dental attrition during the initial phase of tooth wear. These results are in agreement with those in other studies that showed no relationship between salivary characteristics and the severity of occlusal tooth wear in a population with moderate tooth wear.[22,37] When considering erosive tooth wear, research has shown that only a low unstimulated saliva flow rate predicts severe erosive tooth wear.[38] Therefore, salivary tests seem to be ineffective for assessing tooth wear risk at any phase of tooth wear.[21,22,37] The protective role of saliva in the process of dental attrition may be more relevant in episodes of sleep bruxism when the presence of acid also plays a key role.[23,24] Biologic markers in salivary proteins and acquired dental pellicles may play a more significant role in protection against tooth wear.

Multivariate regression analysis showed that erosive tooth wear, BMI, and age accounted for 31% of the likelihood of dental attrition. In Thai dental patients, age, dental status, and dietary factors explained 59% of the occlusal tooth wear,[18] whereas among Swedish people, age, occlusal force, and salivary buffer capacity accounted for 57% of the occlusal wear severity.[11] In Chinese (non-patient) adults, age, male sex, dental status, and rural residence explained 28% of the occlusal tooth wear score,[14] whereas in a German population, age, male sex, dental status, self-reported bruxism, and unemployment explained 32% of occlusal wear.[12] These study results suggest that the population type affects the percentage of occlusal wear explained by assessed factors, being double in patients with evident tooth wear compared to young or healthy adults. Among the factors associated with occlusal wear, age seems to be the strongest predictor of dental attrition. Another relevant factor would be the magnitude of load expressed as maximum occlusal force, the BMI, or male sex, and not the frequency of parafunction behaviors, which appears to be less implicated. Both the strength of teeth and oral environment, expressed as dental status, saliva, degree of mineralization, or erosive clinical signs, could represent a third key factor in the progress of dental attrition. The present clinical study supports in vitro findings showing that time and load influence enamel wear exponentially (eg, attrition increased markedly under 600 g of load for 30 minutes).[30] From the results of the studies performed in different populations, it would seem reasonable to hypothesize that dental attrition progresses depending on time (eg, age), magnitude of load (eg, maximum occlusal force, male sex, BMI, dental status, self-reported sleep/awake bruxism, and heavy sport exercise), and surrounding dental state (eg, predisposition to erosive tooth wear, salivary function, dietary factors, rural residence, unemployment, and sport enthusiast).

A limitation of the present study was that participants were recruited as a convenience sample from dental students and might not be representative of the whole population. However, the use of a sample of this kind offered several benefits. In young adults, the risk factor and the clinical sign of dental wear are more likely to match over time, and in addition, it is probably easier to differentiate dental erosion from dental attrition in this population. A second limitation is not having foreseen a loss of the initial sample, so the analyzed sample was 10% below the calculated sample size. Therefore, estimated prevalence values should be interpreted with caution.

Conclusion

The present results show that dental attrition is highly prevalent among young adults from Catalonia, although most have no evidence of pathologic tooth wear. Significantly, those with dental erosion were 6.3 times more likely to show dental attrition. Although this was the most significant early risk factor for dental attrition, body mass index and age were also important. Slight alterations of salivary parameters assessed with a salivary test kit did not seem to predict dental attrition during the initial phase of tooth wear. When dental attrition is the dominant cause of tooth wear, preventive measures should focus on both mechanical and chemical factors.

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References

1. Schlueter N, Amaechi BT, Bartlett D, et al. Terminology of erosive tooth wear: Consensus report of a workshop organized by the ORCA and the Cariology Research Group of the IADR. Caries Res 2020;54:2–6.

2. Liu B, Zhang M, Chen Y, Yao Y. Tooth wear in aging people: an investigation of the prevalence and the influential factors of incisal/occlusal tooth wear in northwest China. BMC Oral Health 2014;14:65.

3. Gillborg S, Åkerman S, Ekberg E. Tooth wear in Swedish adults: A cross-sectional study. J Oral Rehabil 2020;47:235–245.

4. Bartlett D, O'Toole S. Tooth wear: best evidence consensus statement. J Prosthodont 2021;30(Suppl 1):20–25.

5. Schlueter N, Luka B. Erosive tooth wear: a review on global prevalence and on its prevalence in risk groups. Br Dent J 2018;224: 364–370.

6. Yadav S. A study on prevalence of dental attrition and its relation to factors of age, gender and to the signs of TMJ dysfunction. J Indian Prosthodont Soc 2011;11:98–105.

7. Hara AT, Livengood SV, Lippert F, Eckert GJ, Ungar PS. Dental surface texture characterization based on erosive tooth wear processes. J Dent Res 2016;95:537–542.

8. Ranjitkar S, Turan A, Mann C, et al. Surface-sensitive microwear texture analysis of attrition and erosion. J Dent Res 2017; 96:300–307.

9. Wetselaar P, Lobbezoo F. The tooth wear evaluation system: a modular clinical guideline for the diagnosis and management planning of worn dentitions. J Oral Rehabil 2016;43:69–80.

10. Hammoudi W, Trulsson M, Smedberg JI, Svensson P. Clinical presentation of two phenotypes of tooth wear patients. J Dent 2019;86:60–68.

11. Johansson A, Kiliaridis S, Haraldson T, Omar R, Carlsson GE. Covariation of some factors associated with occlusal tooth wear in a selected high-wear sample. Scand J Dent Res 1993;101:398–406.

12. Bernhardt O, Gesch D, Splieth C, et al. Risk factors for high occlusal wear scores in a population-based sample: results of the Study of Health in Pomerania (SHIP). Int J Prosthodont 2004;17:333–339.

13. Cunha-Cruz J, Pashova H, Packard JD, Zhou L, Hilton TJ; for Northwest PRECEDENT. Tooth wear: prevalence and associated factors in general practice patients. Community Dent Oral Epidemiol 2010;38:228–234.

14. Zhang Q, Witter DJ, Bronkhorst EM, Bartlett DW, Creugers NH. Occlusal tooth wear in Chinese adults with shortened dental arches. J Oral Rehabil 2014;41:101–107.

15. Wetselaar P, Vermaire JH, Visscher CM, Lobbezoo F, Schuller AA. The prevalence of tooth wear in the Dutch adult population. Caries Res 2016;50:543–550.

16. Kumar M, Verma R, Bansal M, et al. To evaluate the severity, distribution of occlusal tooth wear and its correlation with bite force in young north Indian adults. Open Dent J 2018;12:735–741.

17. Kaklamanos EG, Menexes G, Makrygiannakis MA, Topitsoglou V, Kalfas S. Tooth wear in a sample of community-dwelling elderly Greeks. Oral Health Prev Dent 2020;18:133–138.

18. Chuajedong P, Kedjarune-Leggat U, Kertpon V, Chongsuvivatwong V, Benjakul P. Associated factors of tooth wear in southern Thailand. J Oral Rehabil 2002;29:997–1002.

19. Zhang J, Du Y, Wei Z, Tai B, Jiang H, Du M. The prevalence and risk indicators of tooth wear in 12- and 15-year-old adolescents in Central China. BMC Oral Health 2015;15:120.

20. Dıraçoğlu D, Alptekin K, Cifter ED, Güçlü B, Karan A, Aksoy C. Relationship between maximal bite force and tooth wear in bruxist and non-bruxist individuals. Arch Oral Biol 2011;56:1569–1575.

21. Jonsgar C, Hordvik PA, Berge ME, Johansson AK, Svensson P, Johansson A. Sleep bruxism in individuals with and without attrition-type tooth wear: An exploratory matched case-control electromyographic study. J Dent 2015;43:1504–1510.

22. Hammoudi W, Trulsson M, Smedberg JI, Svensson P. Phenotypes of patients with extensive tooth wear: A novel approach using cluster analysis. J Dent 2019;82:22–29.

23. Wetselaar P, Manfredini D, Ahlberg J, et al. Associations between tooth wear and dental sleep disorders: A narrative overview. J Oral Rehabil 2019;46:765–775.

24. Li Y, Yu F, Niu L, et al. Associations among bruxism, gastroesophageal reflux disease, and tooth wear. J Clin Med 2018; 7:417.

25. Abe S, Yamaguchi T, Rompré PH, De Grandmont P, Chen YJ, Lavigne GJ. Tooth wear in young subjects: a discriminator between sleep bruxers and controls? Int J Prosthodont 2009;22:342–350.

26. Manfredini D, Lombardo L, Visentin A, Arreghini A, Siciliani G. Correlation between sleep-time masseter muscle activity and tooth wear: an electromyographic study. J Oral Facial Pain Headache 2019;33:199–204.

27. Kapagiannidou D, Koutris M, Wetselaar P, Visscher CM, van der Zaag J, Lobbezoo F. Association between polysomnographic parameters of sleep bruxism and attrition-type tooth wear. J Oral Rehabil 2021;48: 687–691.

28. Polmann H, Réus JC, Massignan C, et al. Association between sleep bruxism and stress symptoms in adults: A systematic review and meta-analysis. J Oral Rehabil 2021;48:621–631.

29. Sorvari R, Pelttari A, Meurman JH. Surface ultrastructure of rat molar teeth after experimentally induced erosion and attrition. Caries Res 1996;30:163–168.

30. Eisenburger M, Addy M. Erosion and attrition of human enamel in vitro part II: influence of time and loading. J Dent 2002;30:349–352.

31. Shellis RP, Addy M. The interactions between attrition, abrasion and erosion in tooth wear. Monogr Oral Sci 2014;25:32–45.

32. Cheng LL. Individuals with gastro-esophageal reflux disease or symptoms may have increased odds of erosive tooth wear. J Evid Based Dent Pract 2020;20:101497.

33. O'Toole S, Newton T, Moazzez R, Hasan A, Bartlett D. Randomised controlled clinical trial investigating the impact of implementation planning on behaviour related to the diet. Sci Rep 2018;8:8024.

34. Yu T, Tao DY, Lu HX, et al. Prevalence and associated factors of tooth wear in Shanghai. Chin J Dent Res 2021;24:95–103.

35. Bartlett DW, Lussi A, West NX, Bouchard P, Sanz M, Bourgeois D. Prevalence of tooth wear on buccal and lingual surfaces and possible risk factors in young European adults. J Dent 2013;41:1007–1013.

36. Awad MA, El Kassas D, Al Harthi L, et al. Prevalence, severity and explanatory factors of tooth wear in Arab populations. J Dent 2019;80:69–74.

37. Ramsay DS, Rothen M, Scott JM, Cunha-Cruz J; Northwest PRECEDENT network. Tooth wear and the role of salivary measures in general practice patients. Clin Oral Investig 2015;19:85–95.

38. Alaraudanjoki V, Laitala ML, Tjäderhane L, et al. Influence of intrinsic factors on erosive tooth wear in a large-scale epidemiological study. Caries Res 2016;50:508–516.

39. Souza CMS, Sakae LO, Carneiro PMA, Esteves RA, Scaramucci T. Interplay between different manual toothbrushes and brushing loads on erosive tooth wear. J Dent 2021; 105:103577.

40. Lujan-Climent M, Martinez-Gomis J, Palau S, Ayuso-Montero R, Salsench J, Peraire M. Influence of static and dynamic occlusal characteristics and muscle force on masticatory performance in dentate adults. Eur J Oral Sci 2008;116:229–236.

41. Flores-Orozco EI, Tiznado-Orozco GE, Osuna-González OD, Amaro-Navarrete CL, Rovira-Lastra B, Martinez-Gomis J. Lack of relationship between masticatory performance and nutritional status in adults with natural dentition. Arch Oral Biol 2016;71: 117–121.

42. Loomans B, Opdam N, Attin T, et al. Severe tooth wear: European consensus statement on management guidelines. J Adhes Dent 2017;19:111–119.

43. Wetselaar P, Wetselaar-Glas MJM, Katzer LD, Ahlers MO. Diagnosing tooth wear, a new taxonomy based on the revised version of the Tooth Wear Evaluation System (TWES 2.0). J Oral Rehabil 2020;47:703–712.

44. Roca-Obis P, Rius-Bonet O, Zamora-Olave C, Willaert E, Martinez-Gomis J. Sex-specific reference values for the crown lengths of permanent anterior teeth for assessing tooth wear (online ahead of print, 9 June 2022). Acta Odontol Scand doi: 10.1080/00016357.2022.2084157.

45. Flores-Orozco EI, Pérez-Rodríguez PM, Flores-Mendoza EA, Flores-Ramos JM, Rovira-Lastra B, Martinez-Gomis J. Nutritional status and masticatory function of the indigenous compared with non-indigenous people of Nayarit, Mexico. Arch Oral Biol 2020;115:104731.

46. Remor E. Psychometric properties of a European Spanish version of the Perceived Stress Scale (PSS). Span J Psychol 2006;9:86–93.

47. O'Toole S, Bernabé E, Moazzez R, Bartlett D. Timing of dietary acid intake and erosive tooth wear: A case-control study. J Dent 2017;56:99–104.

48. Ohrbach R. Assessment and further development of RDC/TMD Axis II biobehavioural instruments: a research programme progress report. J Oral Rehabil 2010;37:784–798.

49. Rothen M, Cunha-Cruz J, Mancl L, et al. Inter-examiner reliability of salivary diagnostic tests in a practice-based research network. J Dent Hyg 2011;85:143–150.

50. Buzalaf MAR, Magalhães AC, Rios D. Prevention of erosive tooth wear: targeting nutritional and patient-related risks factors. Br Dent J 2018;224:371–378.

51. Wegehaupt FJ, Tauböck TT, Attin T. Durability of the anti-erosive effect of surfaces sealants under erosive abrasive conditions. Acta Odontol Scand 2013;71:1188–1194.

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