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Tooth Wear and Periodontal Status in a Cluster of Middle-Aged Adults in Northern Greece

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Abstract: The present observational study aims to investigate the prevalence of tooth wear (TW) in a cluster of Northern Greek adults aged 35–44 years and, additionally, to assess any probable associations and interrelationships between TW and periodontal condition and sociodemographic factors. A cross-sectional design was embraced identically to our previous study on senior citizens. A sample of 531 individuals was considered, and they were examined according to WHO guidelines for national pathfinder surveys by three calibrated dentists-examiners in different urban and rural areas of Northern Greece. Simplified Tooth Wear Index (TWI), Community Periodontal Index (CPI), Attachment Loss (AL) and simplified Oral Hygiene Index (OHI-S) were screened and calculated in a patient-level approach. TW is quite prevalent among middle-aged adults in Northern Greece, although it remains lower compared to older age groups. All the aforementioned periodontal indices were correlated significantly with TW; moreover, a tendency was detected for there to be more tooth wear in older age participants within the specific age group, in men as compared with women, in persons with lower educational levels and in those residing in rural areas.

Keywords: tooth wear; tooth wear index; periodontal index; attachment loss; oral hygiene; adults 35–44; periodontal status; sociodemographic factors

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1. Introduction

According to the recent consensus report concerning the terminology of erosive tooth wear, tooth wear (TW) is a cumulative surface loss of mineralized tooth substance due to physical or chemo-physical processes, and it is irrelevant to dental caries, resorption, or trauma [1]. TW is a very prevalent phenomenon, having been considered universal and irreversible; furthermore, it may be regarded as the outcome of dental erosion, attrition, and abrasion, with all three procedures comprising TW being able to provoke various, mild or severe disorders, both functionally and aesthetically [2]. Based on the findings of our department, for senior citizens of Northern Greece, TW prevalence among the elderly is nearly universal [2,3], and TW scores present a significant positive association with age [3]. Additional evidence accords with this postulation since there are numerous pieces of data indicative that TW deterioration progresses as age increases; nevertheless, TW cannot be attributed only to the ageing process [4,5], and numerous other parameters have been reported and discussed, which are capable of influencing the frequency and severity of mineralized tooth substance loss, mainly connected with lifestyle changes, eating habits and hygiene. Consequently, factors affecting mechanical wear (e.g., bruxism, excessive toothbrushing) and chemical wear (e.g., acidic dietary habits) have been among the ones that may connect with TW initiation or even deteriorate existing lesions. Referring to younger European adults and adolescents, dietary habits seem to significantly affect the

tooth substance loss phenomenon since fresh fruit and juice intake was positively associated with tooth wear in European adults [6], while an acidic diet was associated with increased TW in 15-year-old Polish adolescents [7]. In a recent study by our team, individuals who reported toothbrushing immediately after food/drink uptake, as well as those who reported unconscious tooth grinding or clenching, presented with significantly higher TW scores [3]. Additional sociodemographic factors have been reported to affect TW scores in different populations by a lot of researchers. These factors comprise gender, population type (urban or rural) and socio-economic status, with male gender and inhabiting a rural population being indicative of higher TW values in some populations [8–10].

On the other hand, little evidence exists as regards TW and periodontal status and probable associations between these two common phenomena in adult populations, although both TW and periodontitis are very prevalent conditions are characterized by multifactorial etiopathogenesis and both may lead to functional and aesthetic compromise, as well as to a negative impact on patients' quality of life [11,12]. Some early findings can be found reporting that specific brushing techniques might provoke abrasion [13,14], although these results have been produced only by toothbrushing technique assessment, which is eventually irrelevant to individual clinical periodontal status. Deepening towards cervical wear evaluation from a periodontal perspective, in a surface-level analysis, deeper cervical wear may be combined with advanced gingival recession and less tooth mobility, while cervical surfaces with less plaque accumulation or with deep pocketing may predispose to fewer cervical abrasion lesions [15]. Even the latter clinical study does not offer any data indicative of patient-level comparisons between total TW, with all tooth surfaces included, and clinical periodontal parameters in a patient-level approach. In our recent publication, we emphasized this lack of evidence and presented results that indicate significant associations in relation to periodontal status, expressed in terms of loss of attachment, as well as the presence of plaque and calculus, with TW in a cluster of Greek senior citizens aged 65–74 years [3]. It has yet to be shown if such statements may also apply to younger populations, such as middle-aged adults; in addition, the nature of TW may be different in senior citizens compared to younger adult clusters since erosion and/or abrasion may be more critical than attrition in younger ages.

For these reasons, the objectives of the present observational study have been the investigation of the prevalence of tooth wear in middle-aged adults of Northern Greece, as well as the assessment of its probable association with periodontal parameters in a patient-level approach. The potential influence of several sociodemographic factors in relation to TW has additionally been assessed. The null hypothesis tested was that TW is not associated with either periodontal status or sociodemographic factors in middle-aged adults of Northern Greece.

2. Materials and Methods

The present cross-sectional study has been designed similarly to our previous study, which reported on TW in senior citizens living in Northern Greece [3]; nevertheless, the current study is focused on a cluster of middle-aged adults in Northern Greece. The enrollment of the cluster sample was based on WHO guidelines for national pathfinder surveys, which incorporate a type of stratified sampling design ensuring the participation of a satisfactory size of individuals that may present different disease prevalence for the examined variables. The participants were drawn from readily accessible, mainly working population groups, as the WHO methodology describes, and their ages varied from 35 to 44 years in the specific age cluster [16]. For comparability purposes, the sample was collected in the same manner and from the same areas as in past national Greek epidemiological studies [17–19]. In each sampling site, sampling points representing places where 35–44-year-old adults tend to gather were selected randomly (mainly working places in the public and in the private sector, but also places such as churches, culture clubs, public squares, as well as private properties), according to the layout of the region under examination, rural or urban [20]. The only inclusion criterion for the participants, other than

being dentate individuals aged 35–44 years, was Greek citizenship and their willingness to participate. WHO guidelines were followed in reference to the sampling strategy and, more specifically, care had been taken to avoid obvious selection bias, such as sampling patients at medical care facilities [16]; therefore, such participants were excluded. More analytical descriptions concerning our sampling procedures have been reported in our recent publication regarding the population types, that is, urban and rural, as well as the specific geographical provinces of Northern Greece (regions), which were screened for participants [3]. The regions where sampling sites were developed were the metropolitan city of Thessaloniki and four other counties of Northern Greece: Evros, Ioannina, Kastoria, and Larissa.

Permission from the Greek Ministry of Health (#143207/15-12-2012) was acquired before the initiation of the clinical procedures. The Ethical Committee of Aristotle University Thessaloniki approved the present cross-sectional study, with regard to data processing and analysis (#11/01-07-2020). All individuals who participated had previously been informed about the study, and written consent was obtained.

In the present study, data from 531 middle-aged adults were included, who were examined and screened by three dentist examiners, supported by three dental assistants. The three examiners were trained and calibrated in relation to the examined parameters, with very good interexaminer agreement (Kappa Coefficient > 0.85), prior to the initiation of the clinical procedures. A field dentistry protocol was utilized, in which the participants were examined under artificial light (Daray lamps) using dental mirrors, the WHO CPI periodontal probe and cotton rolls or pieces of sterilized gauze for moisture control and plaque removal. The time bracket required for patient examination and questionnaire interview varied depending on parameters such as existing teeth and participant communication: approximately 30 min per subject.

A Tooth Wear Index (TWI) [21] was defined as the primary outcome variable. The specific index that was used is a simplified version of the original TWI introduced by Smith and Knight [22], which has also been adapted, as previously discussed, in order for cervical wear to also be identified and incorporated in relation to the examined tooth surfaces [3]. Periodontal status was assessed in terms of Community Periodontal Index (CPI) as well as by an ordinal version of attachment loss (AL) introduced by the WHO [16]. These periodontal indices have been applied to teeth 11, 31, 16/17, 26/27, 36/37 and 46/47 according to the WHO recommendations [16]. Additionally, the simplified oral hygiene index [23] was considered, for plaque (DI) and calculus (CI) to be evaluated, based on examinations of the buccal surfaces of teeth 11, 31, 16 and 26, as well as the lingual surfaces of teeth 36 and 46, covered with soft debris or calculus deposits. Sociodemographic data, including gender, age, area, population type, level of education, and monthly income, were obtained through a structured questionnaire during an interview with the participants. Further information concerning these periodontal health indices and the investigated sociodemographic factors are provided in our recent publications that belong to the same research project [3,20].

The numerical data were processed and summarized in order to calculate the absolute and relative frequencies, the indices of central tendency (mean and median values) and the indices of variability (minimum and maximum values, standard deviations, and standard errors of mean values). The study variables, both nominal and numerical, have been analyzed and presented at a participant-based level. Continuous variables were set for comparisons concerning participant groupings via the utilization of Kruskal–Wallis (KW) or Mann–Whitney (MW) tests, as appropriate. Correlations between numerical variables were examined utilizing the magnitude and the statistical significance of Spearman's rho rank correlation coefficient. In all hypotheses and testing procedures (MW tests and KW tests), the observed significance level (p-value) was computed with the Monte-Carlo simulation method based on 10,000 resampling circles [24]. We consider this method more proper and methodologically sound since the stimulation that it offers may lead to valid inferential conclusions even in cases where the methodological presuppositions of the

statistical test used are not satisfied. All statistical analyses were performed using IBM SPSS statistics v.23.0 enhanced with the module Exact Tests to perform the Monte-Carlo simulation method [24]. The significance level in all hypotheses and testing procedures was predetermined at a = 0.05 ($p \leq 0.05$).

3. Results

Out of 531 middle-aged dentate Greek individuals who participated in the study and underwent the clinical procedures and the questionnaire interview, 265 (49.9%) were males, and 266 (50.1%) were females. The study took place across eleven sampling sites in total, three of them in the metropolitan city of Thessaloniki, enrolling an urban population, and eight sites in the other regions reported, enrolling four urban and four rural sampling population sites. In total, 341 participants were categorized as urban inhabitants, whereas 190 resided in rural areas. Table 1 presents the descriptive statistics of the clinical indices utilized, that is, TWI, CPI, AL, DI, and CI, in terms of central tendency and dispersion. Moreover, descriptive statistics concerning TWI and the examined sociodemographic variables are presented in Table 2.

Table 1. Descriptive statistics for Tooth Wear Index and periodontal health indices.

Index	Minimum	Median	Maximum	Mean	Std. Deviation	Std. Error of Mean
DI average	0	0.83	3.00	0.87	0.70	0.03
CI average	0	0.50	3.00	0.73	0.73	0.03
CPI average	0	1.83	4.00	1.63	0.96	0.04
AL average	0	0	3.33	0.25	0.42	0.02
TWI average	0	0.37	4.00	0.42	0.28	0.01

Plaque index (DI); calculus index (CI); Community Periodontal index (CPI); Attachment Loss (AL); Tooth Wear index (TWI).

Table 2. TWI descriptive statistics for the sociodemographic factors that underwent analysis.

	Minimum	Median	Maximum	Mean	Std. Deviation	Std. Error of Mean	N
Gender							
Males	0	0.42	2.00	0.47	0.29	0.02	265
Females	0	0.32	1.27	0.38	0.26	0.02	266
Total	0	0.37	2.00	0.42	0.28	0.01	531
Population Types							
Urban	0	0.30	2.00	0.39	0.27	0.01	341
Rural	0.07	0.45	1.25	0.50	0.28	0.04	190
Total	0	0.37	2.00	0.42	0.28	0.01	531
Region							
Thessaloniki	0	0.30	1.41	0.37	0.26	0.02	141
Ioannina	0	0.52	1.24	0.55	0.27	0.03	93
Larissa	0	0.45	1.25	0.47	0.30	0.03	98
Kastoria	0	0.46	1.23	0.48	0.25	0.03	100
Evros	0	0.23	2.00	0.29	0.24	0.02	99
Total	0	0.37	2.00	0.42	0.28	0.01	531
Monthly Income							
≤590 EUR	0	0.37	1.19	0.42	0.28	0.03	118
591 EUR–1200 EUR	0	0.38	2.00	0.43	0.28	0.02	393
>1200 EUR	0	0.32	1.41	0.42	0.28	0.03	98
Total	0	0.37	2.00	0.42	0.28	0.01	529

Table 2. *Cont.*

	Minimum	Median	Maximum	Mean	Std. Deviation	Std. Error of Mean	N
			Level of Education				
Illiterates	0	0.27	0.63	0.30	0.30	0.15	4
Basic	0	0.46	1.19	0.51	0.29	0.05	34
Lower secondary	0.08	0.50	2.00	0.58	0.41	0.06	43
Secondary graduates	0	0.36	1.24	0.42	0.25	0.02	192
Non-university tertiary	0.02	0.36	1.41	0.41	0.25	0.02	125
University graduates	0	0.27	1.27	0.37	0.26	0.02	133
Total	0	0.37	2.00	0.42	0.28	0.01	531

The MW non-parametric test indicated a statistically significant association between TWI and gender (U = 29,369, Z = −3,324, and $p < 0.001$); additionally, a significantly different result was detected between population type (urban or rural) and TWI (U = 23,736.5, Z = −5,109, and $p < 0.001$). The KW test indicated significant differences among the examined geographical regions of Northern Greece relative to TWI ($X^2 = 70.360$, df = 4, and $p < 0.001$). The KW test also detected a significant difference in terms of the level of education and TWI ($X^2 = 18.130$, df = 5, and $p = 0.002$), but no significant associations were found between TWI and monthly income ($X^2 = 0.411$, df = 2, and $p = 0.812$).

A statistically significant ($p < 0.001$) medium positive correlation was detected between TWI and CPI. Furthermore, a significant ($p < 0.001$) weak positive correlation was revealed concerning TW and the other periodontal indices examined, that is, AL, CI, and DI. All these correlations and the exact Spearman's rho correlation coefficients are presented in Table 3. Finally, a significant ($p < 0.001$), weak positive correlation between TWI and the specific individual ages within the examined age cluster was also detected.

Table 3. Correlation analysis between TWI, periodontal indices, and age according to Spearman's rho correlation coefficient (Cor. Coeff. rho).

	CPI	AL	DI	CI	Age
TWI	Cor. Coeff. rho = 0.40	Cor. Coeff. rho = 0.25	Cor. Coeff. rho = 0.35	Cor. Coeff. rho = 0.30	Cor. Coeff. rho = 0.16
p value:	<0.001	<0.001	<0.001	<0.001	<0.001

Plaque index (DI); Calculus index (CI); Community Periodontal index (CPI); Attachment Loss (AL); Tooth Wear index (TWI).

4. Discussion

TW has been found to be a very prevalent condition in Northern Greek adults. As a matter of fact, 39 out of 531 participants presented with 0 or 0.1 TWI average scores, which are indicative of no wear at all, meaning that the vast majority of the tooth surfaces examined had already been worn at the time of examination. It can be generally stated that the prevalence of tooth wear observed in Greek 35–44-year-old adults is in line with analogous evidence previously existing in the literature, which supports the fact that TW is a relatively common phenomenon in adults, implying that there is a significant cohort of the global population with increasing prevalence and pathological progression [25]. Nevertheless, the general statement that TW is a common phenomenon in the adult population may be misleading, and a thorough discussion of TW prevalence appears to be more complicated. In the existing literature, for all the abundance of studies reporting on TW prevalence, there is a large variation in critical parameters, rendering finding comparability among studies seriously compromised, and hence, a mere juxtaposition of numerical data between different studies may be meaningless. Heterogeneity in the TW measuring indices having

been utilized, as well as in population types and in the level of clinical assessment of wear (patient/tooth/surface level) is a major problem in terms of direct comparisons and reviews to be achieved [26]. Additionally, the reported findings depend on and are significantly affected by each study's objective. That is the reason for our decision to emphasize more in the associations and the interrelationships between TW and periodontal status or sociodemographic factors and designing our study accordingly rather than attempting to carry out another TW prevalence determination study. The reported prevalence of TW in middle-aged adults in the present study, albeit high, remains lower than the almost universal prevalence that was found in our previous study of 65–74-year-old adults. Furthermore, the individuals that took place in the present study presented with less average TW compared to senior citizens living in the same region in our previous study [3], with this comparison being considered valid since both of our studies have been methodologically identical. Despite the high presence of TW in our participants, we have to point out that the wear itself is characterized by a wide range of severity, varying from partial enamel loss to pulp exposure and total crown destruction, and in most cases, the examined wear cannot be regarded as pathological. However, there might have been sub-populations that are more prone to wear development or more vulnerable in terms of presenting with progressively increased wear in the future. In addition, there is evidence supporting a progressively increased prevalence of tooth wear compared to previous decades since a 10% increase in the dentate population of England, from 66% in 1998 to 76% in 2009, was reported in the Adult Dental Health Survey (ADHS) by the NHS [27].

To the best of the authors' knowledge, the present study is the first study with a cross-sectional design that enrolls middle-aged adults and, more specifically, a cluster of 35–44-year-old participants in Balkan countries and deals with TW investigation in a large, stratified cluster sample. Other than the previous study having been conducted by our team in another age cluster, it is also the only epidemiological study trying to detect the association between TW and periodontal status by embracing a patient-level approach. Concerning the latter, we have found a significant positive correlation between attachment loss and the TWI. This may be explained by the hypothesis that when loss of attachment occurs and gingival recession is present, exposed root parts may be more vulnerable to abrasive forces and, consequently, several of these individuals tend to experience hard tissue loss easier and faster. This finding that had also been present when senior citizens from Northern Greece were enrolled can be amplified by the fact that, in the current study, TWI scores were also correlated positively with CPI. It can thus be advocated that middle-aged Greeks presenting periodontal disease, in terms of clinical parameters such as CPI and AL, may also be at higher risk of developing TW. This characteristic may reflect an overall tendency of some people towards dental negligence, indicating a lack of oral health culture and absence of dental care. Another finding that stands in line with the above is the fact that oral hygiene indices (DI and CI) are also positively correlated with TWI, implying that, in this sub-population, oral health is characterized as having a low priority. We consider these findings important from a clinical and community science point of view since specific preventive health actions should be considered at both community and individual levels so as to inform citizens of the detrimental effects that might arise on account of poor oral health when systematic negligence is present. Moreover, these associations between periodontal condition and TW ought to be considered from another direction also since TW lesions, especially on cervical surfaces, may act as local risk factors for increased biofilm accumulation and, thus, may predispose a person to periodontal inflammation, gingivitis or periodontitis. In other words, cervical wear may create rough and uneven surfaces, such as cervical grooves, V-shaped defects and crevices, which are more appropriate for plaque to be collected and harder to reach when toothbrushing.

With regard to sociodemographic factors, a positive correlation has been revealed in terms of TWI on the specific individual age of the participants who belong to the age cluster of 35–44 years. Despite being universally accepted that TW exacerbates with age [9], this finding is indicative of the fact that even in the same age cluster, a weak yet significant

amelioration of TW severity was detected as the age of the participants increased. The male gender was associated with significantly higher values of TWI; this is a common finding in the literature and has been one of the earliest well-documented findings in different adult populations [28,29], Greeks included [3]. Regarding the investigation of specific populations, in a recent Dutch study, enrolling the same adult age cluster as we did, males presented with significantly higher TW scores too, with their findings being consistent with ours [9]. There is no scientific evidence capable of identifying the exact reasons for male susceptibility to increased TW values; however, some hypotheses have been reported in relation to different dietary behaviors in males and stronger chewing forces [3,9]. Although monthly income did not show any significant association with TW, educational level was detected to be a significant sociodemographic parameter referring to TWI scores in middle-aged Greeks. Both income and educational level are factors utilized in epidemiology to monitor socio-economic status. Generally, the literature is characterized by some controversy concerning the influence of socio-economic status on tooth wear. Lower socio-economic status has previously been associated with higher TW presence in adult populations [8,9], even though other researchers have not detected any connection [28,29]. Neither level of education nor monthly income was detected as a significant parameter regarding TW scores in our previous study of senior Greek citizens, although it had been tested with the same approach and protocol as used in the present one [3]. The same stands for population type, that is, urban or rural, were found to be factors significantly effecting TW in middle-aged adults, with rural population being connected with higher TWI scores; however, this factor was not revealed to be significant in the senior citizen study.

These findings in our studies may seem contradictory; however, such differences between significance in the findings of different age clusters may be explained if the different presence and severity of TW in the age clusters are considered. More specifically, the average level of wear being observed between the age clusters may reflect that in older populations, presenting higher levels of total wear in terms of prevalence and severity, the association of some probable risk indicators is alleviated. On the other hand, in younger adults, who have not experienced high TW, almost universally, specific differences in TW in sub-populations characterized by different sociodemographic factors, such as educational level and population type, may be more easily detectable. It needs to be stated though that for all the rationale of the aforementioned assumption, it is advisable that more in-depth research be conducted, focusing on the probable impact of sociodemographic factors on TW since both rurality and lower socio-economic status may reveal a decreased awareness of oral health importance, which is a factor capable of modification. In addition, we ought to point out that the present study is based on the presentation and analysis of cross-sectional data, which may be considered a limitation of our study; therefore, definite conclusions regarding more casual relationships cannot be drawn from our results since observational studies present data mainly appropriate for surveillance purposes.

5. Conclusions

The present study is based on the presentation and analysis of cross-sectional data, which are consistent with high tooth wear prevalence in middle-aged adults in Northern Greece. Several sociodemographic factors, such as age, male gender, rural populations and lower educational level, have been significantly associated with increased tooth wear.

A medium positive correlation was identified between the Tooth Wear Index and periodontal status, expressed in terms of Community Periodontal Index. Additionally, a weak positive association was detected as regards tooth wear and attachment loss index, as well as plaque and calculus presence in a patient-level approach.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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