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Prevalence of dental erosion in 12 years old children and adolescents. Investigation of etiological factors related to dental erosion

PhD thesis

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List of Abbreviations

BEWE	Basic Erosive Wear Examination
BN	Bulimia nervosa
DE	Dental Erosion
DE12HU	Dental erosion and its relation to potential influencing factors among 12-year-old Hungarian schoolchildren
EWAR	Erosive Wear Assessment of Risk
GERD	Gastroesophageal reflux disease
MuSRA	Multicenter study to develop and validate a risk assessment tool as part of composite scoring system for erosive tooth wear
RAT	Risk Assessment Tool
SEF	Socio-economical factor
TW	Tooth Wear

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1. Introduction

Tooth wear (TW), or "non-carious loss of dental hard tissue," is a regressive lesion of a tooth, the chronic and irreversible loss of tooth hard tissue by physical and/or chemical action[1]. Its various forms are an increasing problem after the turn of the millennium[2]. At the beginning of the 2000s, the proportion of adults showing tooth wear ranged from 29% to 60% worldwide (Europe and the Arabic world, respectively)[3]. One of the reasons for the increasing prevalence is to be found in the changing eating habits, which have led to an unprecedented increase in the proportion of foods and beverages that have caused erosion in recent decades. Another reason is the growing average age in European and North American societies. As age progresses, the prevalence of TW increases3, as TW suffered during life cannot be replaced by the body, so it adds up over life. The third reason is the significant prevalence of certain "civilisational" diseases, such as gastro-oesophageal reflux disease (GERD), or nutritional diseases, primarily bulimia nervosa (BN). These diseases are also often associated with sometimes significant TW.

There are two groups of TW to distinguish: we can talk about tooth wear for physical and chemical reasons. The former group includes attrition, abrasion, and, according to the newer classification, abfraction[4]. In the case of physical tooth wear, friction between the surfaces in contact with each other plays a role. In the case of attrition (*1*. Figure), two characters participate in the friction. This is called: the two bodies' wear system, which results from pathological contact between the antagonist teeth or tooth and the antagonist restoration. Attrition is always a pathological process. Between physiological circumstances, there should not be any tooth-tooth contact, and it is always a result of parafunction. In the case of abrasion, a third abrasive material is also associated with the two surfaces mentioned above, so this is also called a three-body wear system[5]. Abrasion (*1*. Figure) takes place physiologically while chewing. From which point the lesion is considered pathological depends mainly on the population's eating habits.
Since the end of the 1990s, abfraction (*1*. Figure) has also been classified as tooth wear. In the development of this form of tooth wear, during the high-force compression of the teeth, due to the elastic deformation of the tooth's crown, the chipping of the hard tissue in the cervical area near the enamel-cement border is characteristic[5]. The only chemical

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type of TW is dental erosion (DE) (*1*. Figure), where the loss of hard tissues of the tooth due to non-bacterial acid or chelation underlies the disease process[6]. Depending on the origin of the acid, there are two forms of DE: extrinsic and intrinsic. In the former, the acid comes from the outside world. In the vast majority of cases, this means increased dietary acid intake in the form of acidic drinks and foods[1, 4]. A workplace with acidic air, e.g. battery factory, or a swimming pool with a poorly adjusted pH, can be included less often as extrinsic acid sources[1, 4]. In any case, intrinsic acid means the entry of stomach acid into the oral cavity. This may be related to conditions associated with repeated vomiting (because of pregnancy, drug side effects), gastroesophageal reflux disease, and psychiatric diseases associated with self-vomiting (bulimia nervosa) [1, 4]. As some food inevitably has a pH below the critical pH, and a certain number of reflux episodes are considered clinically acceptable, DE can occur to some degree in everyone. The integrity of the compensatory mechanisms dramatically influences the degree of appearance. Demineralisation caused by acidic episodes can be remineralised for a while by calcium and phosphate in saliva. If the acidic attack is extreme, long-lasting, or repeated frequently, or if the quantity and/or quality of saliva production is insufficient, then DE develops.

a.  b. 

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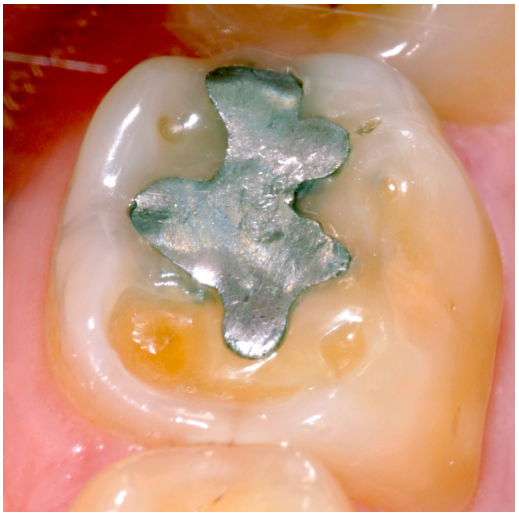
c.  d. 

1. Figure

a. Abrasion on maxillary premolars and molars because of a raw-food diet

b. Attrition on the mandibular arch due to abnormal bruxing of teeth

c. Abfraction on the right maxillary premolar because of clenching of the teeth

d. Erosion on mandibular molars due to regular daily consumption of carbonated soft drinks

The above-mentioned significant increase in the prevalence of TW can be explained primarily by the dramatic rise in the prevalence of DE, with little change in the frequency of physical forms of tooth wear. For this reason, is the chemical form of tooth wear the main focus of the dissertation.

The prevalence of DE among European young adults was around 30%, according to systematic review studies processing turn-of-the-millennium data[3, 7]. Still, it was much higher in some countries in the millennium's second decade. In an extensive European study (Estonia, Finland, France, Italy, Latvia, Spain, UK) in 2013, the prevalence of DE was 57.1%[8]. A Dutch study in the same year found a 99% DE prevalence in the Netherlands in the adult population, of which 6% showed a severe, advanced condition [9]. Along with the above, several additional data point out that the prevalence of DE is increasing rapidly, and the lesion appears in an increasingly severe form [8, 10]. With these prevalence figures, Europe is slowly catching up with the rest of the world, where the prevalence of DE for longer has been extremely high[11]. For example, in China, a DE prevalence of 55[12]-75%[13] has been reported, while in Indonesia, a prevalence of 96%, with the latter two data referring to the 12-year age group. These data draw attention to the fact that today, contrary to previous perceptions, DE is by no means a lesion affecting

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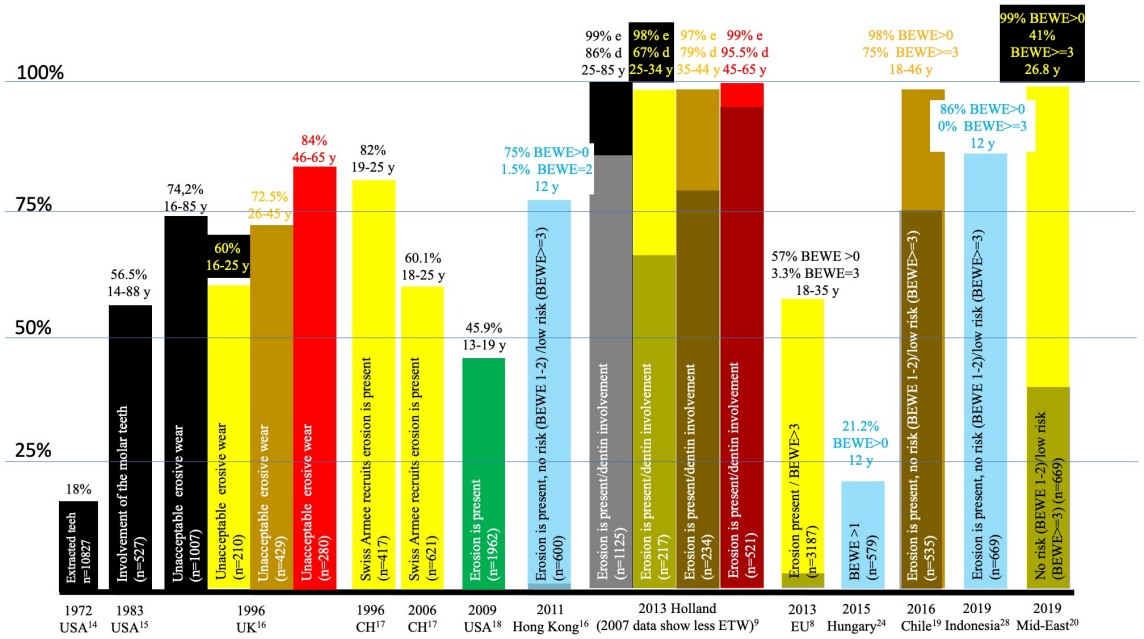
the adult or elderly population but is increasingly affecting children with Increasing severity as well (2. Figure). Suppose you look at the 2. Figure, it is clear that as you move forward in time (from left to right on the number line), the prevalence values continue to rise (the coloured bars are getting higher). This is especially true when looking at a specific age group, indicated with distinct colours.



2. Figure

Prevalence of DE at different periods, in different geographical locations, and various age groups.

Below are the location and time of the examination. The height of the column indicates the frequency of occurrence. The frequency is also displayed numerically at the top of the column. The age of the study group is also included here. The column's colour also refers to age: black: no separate age group; blue: 6-12 years old; green 12-18 years old; yellow 19-35 years old; orange 25-45 years old; red 45-65 years old. Where the coloured column is shaded, the height of the shaded column indicates the frequency of more severe involvement (see the given column for a detailed explanation). The case number of the study can also be read here. [8, 9, 10, 14, 15, 16, 17, 18, 19, 20, 24, 28]

Visual indices have been used for decades to examine DE. Such previously used indices were the Smith and Knight Tooth Wear index and Lussi erosion index[21]. For these indices, a detailed examination of all surfaces of all teeth and accurate recording of these results is characteristic. This exhaustive data collection has been professionally advantageous on the one hand. Still, it is incredibly time-consuming and challenging to carry out studies with a large number of items and therefore unsuitable for everyday clinical use. In addition to maintaining scientific sophistication, an index published in 2008, the Basic Erosive Wear Examination (BEWE) Index[22], tried to move towards simplicity and became virtually dominant since its inception. The huge advantage of using a single uniformised index would be to make studies anywhere in the world easily comparable. This index was initially described for use in adults but was later validated for children[23]. The essence of the examination method is to divide both dental arches into three parts, the total oral cavity into six sextants (premolars and molars per se, and the canines and incisors form one sextant per jawbone). Each sextant's tooth surface showing the most severe erosive lesion is selected, evaluated, and registered using a four-point scale.

The four stages are shown in 1. Table. The values of the six sextants are simply summed to get the cumulative BEWE score. Patients can be classified into risk groups based on the score obtained, providing a therapeutic recommendation for additional care (2. Table).

1. Table

Criteria for grading erosive wear[22]

Score	
0	No erosive tooth wear
1	Initial loss of surface texture
2	Distinct defect, hard tissue loss <50% of the surface area
3	Hard tissue loss ≥50% of the surface area

2. Table

Risk levels as a guide to clinical management[22]

Risk level	**Cumulative score of all sextants**	**Management**
None	0-2	Routine maintenance and observation Repeat at 3-year intervals
Low	3-8	Oral hygiene and dietary assessment, and advice, routine maintenance and observation Repeat at 2-year intervals
Medium	9-13	Oral hygiene and dietary assessment, and advice, identify the main aetiological factor(s) for tissue loss and develop strategies to eliminate respective impacts Consider fluoridation measures or other strategies to increase the resistance of tooth surfaces Ideally, avoid the placement of restorations and monitor erosive wear with study casts, photographs, or silicone impressions Repeat at 6–12-month intervals
High	≥14	Oral hygiene and dietary assessment, and advice, identify the main aetiological factor(s) for tissue loss and develop strategies to eliminate respective impacts Consider fluoridation measures or other strategies to increase the resistance of tooth surfaces Ideally, avoid restorations and monitor tooth wear with study casts, photographs, or silicone impressions. Especially in cases of severe progression, consider special care that may involve restorations Repeat at 6–12-month intervals

The increasing prevalence and severity of tooth wear, especially DE, calls attention to the need to take this lesion seriously. TW is an irreversible lesion for the body, and regeneration and replacement of lost hard tissue is not possible naturally, only artificially. Therefore, it is essential for effective prevention that risk groups can be identified as early and as accurately as possible so that as many people can access primary, secondary, and worst-case tertiary prevention care as possible.

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2. Objectives

The primary hypothesis of the dissertation was that domestic prevalence data are close to the European average but below the values measured in Asia and the Arab world. In addition, we looked for nutritional, lifestyle, and socioeconomic factors that show a statistically significant correlation with the prevalence of DE. Consumption of carbonated soft drinks, fruit juices, sports and energy drinks, alcohol, and fresh fruits was examined as potential factors. Gastro-oesophageal reflux disease, conditions causing vomiting, tooth sensitivity, the highest level of education of the parents of the examined child, and whether the nature of the residence is urban or rural were also investigated.

Only incomplete epidemiological data are available on the prevalence of TW and DE in Hungary. In addition, most of the existing data are 40-50 years old, so due to the rapid changes mentioned above, they certainly do not give a realistic picture of the current situation. As the prevalence of DE among tooth wear after the turn of the millennium became more and more evident, the international trend today is that the mapping of DE prevalence instead of TW has come to the forefront of interest. Instead of outdated data, it is also essential to have up-to-date information available in Hungary. The main goal of the study of ”Dental erosion and its relation to potential influencing factors among the 12-year-old Hungarian schoolchildren” (DE12HU)[24] was to complete authentic and nationally representative sampling, but this seemed feasible in only one age group considering the available resources. Due to the emergence of DE at an earlier age, the choice was made for the 12-year-old. It would be crucial to carry out a national, representative screening of at least two other age groups, young adults (20-25 years) and middle-aged people (40-45 years). Through these data, it would be possible to get an accurate picture of the erosion of the entire Hungarian population, which is essential for a sufficiently effective prevention strategy.

During the evaluation of the DE12HU study data, it was suggested that the questionnaire could also be used for risk assessment, especially its significantly correlated questions. Therefore, an international research team led by Vasileios Margaritis was established in 2016 to create a risk assessment tool for clinical use. Furthermore, it has been suggested that a risk assessment tool (RAT) should be worked out by analysing the presence of

factors previously associated with DE. This tool can be easily used in everyday clinical practice and can be developed to identify individuals at risk with high specificity primary prevention. Thus was born the Multicenter study to develop and validate the risk assessment tool as part of the composite scoring system for erosive tooth wear[25]. The purpose of this study was primarily to validate the risk assessment tool. In addition, we looked for dietary factors and eating habits that show a statistically verifiable correlation with the development of DE. In this study, the prevalence data showed a lower number of cases and weaker representativeness than in the DE12HU study.

3. Results

Results of the "Dental erosion and its relation to potential influencing factors among 12-year-old Hungarian schoolchildren (DE12HU)" epidemiological study

A total of 609 individuals were examined, but 30 had to be excluded due to a fixed orthodontic appliance, an amount of tartar or plaque that made the examination impossible, or due to a lack of cooperation. Thus, the final sample consisted of 579 (287 boys, 292 girls) children aged 12 years. In the questionnaire survey, not all questions were answered in all cases, or the answer could not be evaluated, so the number of responses used for statistical processing varied between 405-556 for each question.

The prevalence of DE in the study population was 21.2% (20.9%, 21.6% for boys and girls, respectively)[24].

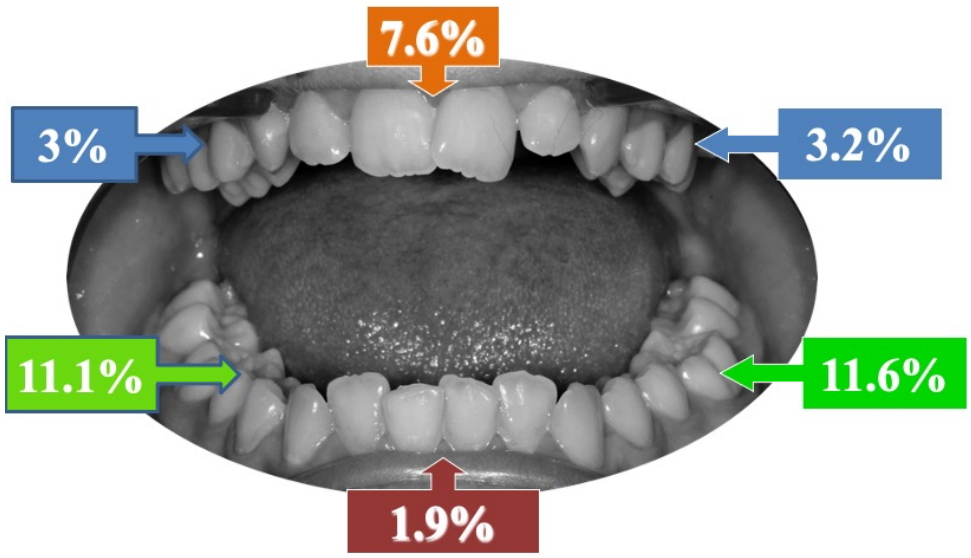
The mean BEWE value was 0.39 ± 0.83 (mean ± SD), and its distribution showed significant geographical differences (3. Table). The mean BEWE was 0.48 ± 0.92 (mean ± SD) in urban areas and 0.29 ± 0.72 (mean ± SD) in rural areas (p = 0.0058)[24].

3. Table
Mean values of the BEWE cumulative scores by geographic location in Hungary[24]

Urban			**Rural**		
Location	Number	Mean (SD)	Location	Number	Mean (SD)
Budapest	66	0.63 (1.03)	Gödöllő	27	0.15 (0.46)
Győr	45	0.16 (0.52)	Tét	28	0.14 (0.52)
Pécs	49	0.71 (1.12)	Boly	51	0.45 (0.88)
Szombathely	19	1.21 (1.31)	Kiskunfélegyháza	42	0.71 (0.94)
Szeged	26	0.46 (0.81)	Szikszó	45	0.29 (0.66)
Miskolc	55	0.36 (0.68)	Józsa	46	0.22 (0.76)
Nyiregyháza	29	0.06 (0.37)	Tiszavasvári	51	0.04 (0.28)
Total	**289**	**0.48 (0.92)** *		**290**	**0.29 (0.72)** *

*p=0.0058
Total: urban + rural: 0.39 (0.83)

Examining the oral distribution of the prevalence of DE, there was no statistically significant difference between the involvement of the upper and lower dental arches. However, the mean cumulative BEWE value, which describes the severity of DE, was 0.25 ± 0.64 (mean ± SD) and 0.14 ± 0.45 (mean ± SD) in the mandible and maxilla, respectively, and the difference was statistically highly significant ($p < 0.001$). Examined separately for each tooth group, the prevalence of mild erosion (BEWE 1 or 2) was highest among the mandibular molars (11.6% and 11.1% on the left and right sides, respectively), followed by maxillary incisors (7.6%), while it was lowest in the upper molars (3.0% and 3.2% on the right and left sides, respectively) and in sextants 5, in the lower incisors and canines (1.9%)[17]



3. Figure

DE prevalence in the examined sextants

Results of the questionnaire survey

Those who consumed "Lemonade, Coca-Cola, or other soft drinks" daily had a significantly higher prevalence of three or higher cumulative BEWE scores than those who consumed such beverages less frequently (16.4% vs 10%, respectively; $p = 0.034$) (*4*. Table).

4. Table

Association between the frequency of carbonated soft drink consumption and BEWE scores[24]

	BEWE score	BEWE 0-2	BEWE≥3	Total n
Consumption of carbonated soft drinks	Once or more daily % (n)	83.6% (178)	16.4% (35)*	213
	Less often than daily % (n)	90% (305)	10% (34)*	339
	Total n	483	69	552**

*Fisher's Exact Test 2-sided exact significance p=0.034

**Not all of the questions were answered by all participants, hence the differences in participant numbers.

Cumulative BEWE above two was also significantly more common in children with a mother with the highest education level only secondary than in children of mothers with tertiary education (5. Table).

5. Table

Association between the educational level of the mother and BEWE scores[17]

	BEWE score	BEWE 0-2	BEWE≥3	Total n
The educational level of the mother	High school graduate or lower % (n)	77.5% (76)	22.5% (22)*	98
	University degree % (n)	91.6% (281)	8.4% (26)*	307
	Total n	357	48	405**

*Fisher's Exact Test 2-sided exact significance p=0.000

**Not all of the questions were answered by all participants, hence the differences in participant numbers.

No statistically significant association was found between the other potential risk factors examined in the questionnaire, such as non-carbonated fruit juices, flavoured tea, fresh fruits, confectionery, and the incidence of toothbrushing and oral hygiene habits and ED[24].

6. Table

Association between earlier investigated, possible influencing erosive factors and BEWE scores 0 to 2 and no less than 3[24]

Related factor		**BEWE 0-2**	**BEWE≥3**	**Total**	**Fisher's exact significance 2-sided**
Number of daily toothbrushing	max. 1 per day	214	33	247	0.605
	two or more per day	273	36	309	
Consumption of fresh fruits	at least once daily	354	51	405	1.000
	less frequently than daily	127	18	145	
Tea with sugar	at least once daily	250	37	287	0.898
	less frequently than daily	226	32	258	
Non-carbonated fruit juices	at least once daily	269	40	309	0.354
	less frequently than daily	208	27	235	
Sweets, candies	at least once daily	271	44	315	0.096
	less frequently than daily	209	23	232	

Results of the "Multicenter study to develop and validate a risk assessment tool as part of composite scoring system for erosive tooth wear" (MuSRA) study

Signs of DE were present in 58.5% of the study population (cumulative BEWE> 0), of which cumulative BEWE was ≥3 in 24.5%, so almost a quarter of the subjects require further preventive intervention based on BEWE therapeutic recommendations. Among the potential factors associated with DE during the risk assessment, the following factors actually showed a significant correlation, with Bivariate (Chi-square) and multivariable (binomial logistic regression) analysis: "energy drink consumption (V = 0.317, p <0.0001), low secretion of stimulated saliva (V = 0.298, p <0.0001), juices consumption (V = 0.278, p <0.0001), erosive drink consumption for quenching thirst between meals (V = 0.168, p <0.053), and erosive drink kept in the mouth (V = 0.157, p <0.024) " [25]. In the MuSRA study, no statistically significant relationship was found between other potentially erosive factors such as the frequency of intake of carbonated soft drinks, fruits, alcohol consumption, toothbrushing frequency, and the toothbrush's hardness GERD symptoms and vomiting (7. Table).

When comparing DE12HU and MuSRA data, we find striking differences, the prevalence of DE being almost three times higher (21.2 vs 58.5%) (8. Table).

7. Table Comparison of the results of the DE12HU and MuSRA studies

Dental erosion and its relation to potential influencing factors among 12-year-old Hungarian schoolchildren[17]	**Fisher's exact significance 2-sided**	**Multicenter study to develop and validate a risk assessment tool as part of composite scoring system for erosive tooth wear[19]**	**Chi-square test**
Lemonade, Coca Cola or other soft drinks	0.034	Consumption of soft drinks	n.s.
		Consumption of energy or/and sports drinks	0.0001
Non-carbonated fruit juices	n.s.	Consumption of juices	0,0001
		Consumption of alcohol	n.s.
Fresh fruit	n.s.	Consumption of fruits	n.s.
Tea with sugar	n.s.		
		Erosive drinks (soft, sports, energy drinks, juices) kept in the mouth for longer period when consumed	0.024
		Erosive drinks (soft, sport, energy drinks, juices) for quenching thirst between meals	0.053
		GERD symptoms, such as regurgitation and heartburn	n.s.
		Vomiting (for any reason)	n.s.
		Do you feel pain or "icing" after eating or drinking something acidic or cold?	0.001

Number of daily toothbrushing	n.s.	Brushing frequency	n.s.
		Type of toothbrush (soft, medium, hard)	n.s.
Sweets, candies	n.s.		
What level of education have your father completed?	n.s.		
What level of education have your mother completed?	0.000		

8. Table
Comparison of DE prevalence data from DE12HU and MuSRA studies

	Dental erosion and its relation to potential influencing factors among 12-year-old Hungarian schoolchildren[24]	**Multicenter study to develop and validate a risk assessment tool as part of composite scoring system for erosive tooth wear[25]**
Age	12	15-18 19-21
Gender differences	n.s.	not investigated
Erosion free individuals	78.8%	41.5%
No risk (BEWE 0-2)	97.7%	75.5%
Low risk (BEWE 3-8)	2.3%	20.7%
Medium risk (BEWE 9-13)	0%	3.8%
High risk (BEWE≥14)	0%	0%

n.s. Not significant

4. Discussion

We know from previous reports that the prevalence of erosion can be very different in different geographical areas and different age groups[3, 8, 9, 10]. The results obtained in the DE12HU and MuSRA examinations are similarly contradictory. One of the reasons for the different results is undoubted to be found in the different age groups. Still, the effect that the sampling took place in other countries presumably might play an important role. If we examine the results of the MUsRA study by country, we can observe exciting differences. In Romania, which borders Hungary to the east, the proportion of people without erosion is even higher than the value registered among 12-year-olds in Hungary (86.7% vs 78.8%, respectively).

In contrast, in southern Europe, the proportion of erosion-free in the 15–21-year-old population studied is only 46.7%, in the United States, 35.1%, and in Finland, 18.5%. Suppose the above countries are ranked based on GDP per capita. In that case, the order is practically the same; only the first and second places are exchanged (Romania 12,813 USD/person, Hungary 15,372 USD/person, Finland 48,461 USD/person, USA 63,051 USD/person in 2020)[26]. However, this is contradicted by Bartlett et al.'s 2013 data. In the European countries they examined (Estonia, Finland, France, Italy, Latvia, Spain, UK), they looked at the prevalence of DE. The lowest prevalence (17.7%) was found in Finland[8], where the GDP per capita was the highest among the countries examined (48,461 USD/person[26]). On the other hand, in the UK, which has the second highest GDP among the examined nations, the prevalence of DE was 54.4%, the highest value found in the study[8]. So it seems that the expected prevalence of DE cannot be guessed simply from the per capita GDP of a country alone.

The picture is similarly contradictory if we examine the differences within the country. The result of the DE12HU study showed a significant difference in the cumulative BEWE values at urban and rural sampling sites in Hungary (0.48 ± 0.92 (mean ± SD) and 0.29 ± 0.72 (mean ± SD), respectively $p = 0.0058$)[24]. Interestingly, there is also a significant difference between the GDP per capita of Hungary's rural and urban populations, in favour of the latter 44,586 PPS in Budapest vs 21,898 PPS on a national average (CSO 2018)[27]. Bartlett et al. reached the exact opposite result in this field also: in their 2013

extensive European study, they found that the prevalence of DE among people living in the countryside was 38.9%, while among the urban population, it was 26.2% (p=0.003)[8]. In summary, there are significant differences in the prevalence of DE, which apparently have a geographical background. However, the results are so contradictory that it cannot be stated that the geographical location of a country, the GDP per capita, and the urban or rural character of the place of residence alone or together would determine the expected DE prevalence. It is worth examining another essential factor to understand what is behind these differences and find some explanation for them.

Geographical differences are further nuanced by different socioeconomic factors (SEFs). The questionnaire results of the DE12HU study showed a statistically significant correlation between the mother's highest educational attainment and the cumulative BEWE score: children whose mother had at least tertiary education had a BEWE±3 much less often than children whose mother had secondary or lower education (8.4% vs 22.5% respectively, p = 0.000)[24]. The association between better SEF and lower DE prevalence has been confirmed in several studies. In a Dutch longitudinal survey, El Aidi found a DE prevalence in the low, medium, and high socioeconomic groups: 36.8%, 29.5%, and 28.9%, respectively[28]. In an Indonesian study also conducted among 12-year-olds, the results were consistent with the HU12DE study: the prevalence of DE in children was 99% for those whose mothers had primary education, 97% and 98%, respectively for children whose mothers or fathers had secondary education. While the prevalence of DE was 90% and 86%, respectively, for children having mothers and fathers with tertiary education[29]. Finally, we find an exciting discrepancy in a study in Sudan and Brazil, where erosion data were just the opposite between 12-year-olds attending public and private schools. While in Brazil, the prevalence of DE was 78.9% for private schools with a higher SEF and 90.3% for public schools[30], in Sudan, the prevalence of DE was 86.6% for children attending private schools and 47.5% for children attending public school[31]. This contradiction is perhaps the best illustration of how SEFs affect the development of DE.

The critical point is that eating habits, especially those with high erosive potential, play a crucial role in developing erosion. There may be significant differences in the consumption of these beverages between different SEF-labelled groups. In addition, differences may vary from country to country. In European studies, higher SEF is

associated with lower DE prevalence, which may be related to a more health-conscious diet of affluent European and North American social strata. In contrast, people with less pronounced SEF in developing countries are associated with lower erosion prevalence. One possible explanation for this reverse pattern in these countries is that the more impoverished populations cannot afford drinks with high erosive potential simply because of their price. Nowadays, store shelves are full of beverages with high erosive potential, such as carbonated soft drinks, energy drinks, rehydrating sports drinks, and ice tea[32]. The frequency of their consumption is likely to be very different between different SEF groups. On the one hand, in countries with lower GDP, these drinks are expensive, so the poorer members of society are simply unable to afford them. On the other hand, the wealthier members of these societies try to express their belonging to richer countries by consuming these well-known products from advertising. In contrast, these products are affordable in welfare societies, even for those living among more modest SEFs. In these societies, a higher degree of conscious distancing has developed in the case of higher SEFs due to mindful nutrition and deliberate rejection of unhealthy foods. All this may explain the above seemingly contradictory processes.

As seen above, the prevalence of DE is not directly related to GDP per capita. It is worth examining DE's most critical etiological factors to understand better the relationship between the different possible etiological factors and DE. Several potential risk factors for the development of DE are known. Many laboratory and clinical studies have attempted to confirm the association of these factors with DE. Unfortunately, the results are contradictory in some places, even in this field.

The development of DE is basically due to the disruption of an equilibrium process. Acid entering the oral cavity, which might originate from the outside world (extrinsic form) or the stomach (intrinsic form), is tolerable within certain limits. This is because saliva in the oral cavity can physically and chemically neutralise the acid. However, if the amount of acid entering the mouth exceeds the tolerable level and/or the acid defence mechanism of the oral cavity is already inadequately functioning or damaged, it leads to the development of DE[1]. The most important source of extrinsic acid in developing DE is consuming acidic foods and drinks [1, 4, 6, 24, 25, 33, 38.] At the same time, some diseases, such as GERD[34, 35, 36], or bulimia nervosa (BN) [37], play an essential role in the intrinsic form. These diseases are much more common in welfare societies[34, 35, 36, 37].

In vitro studies have shown an increased erosive potential by surface ultra-hardness testing in many foods and beverages[38]. After the exposure of deciduous human enamel samples to Gatorade® , which is a sports drink, or Sprite®, Fanta®, Coca Cola® for 2x2 minutes, they all caused a significant decrease in surface ultra – hardness: -115.4±20.2, -124.4±4.7, -100.6±9.8, -90.2±11.3 (mean±SEM) repectively38. Beverages with a high natural fruit content occurred only approximately one-third of the above-mentioned ultra-hardness changes. The loss of surface ultra-hardness of mixed fruit smoothie, apple juice, and orange juice was as follows: -38.8±10.8, -37.5±13.6, and -19.2±5.2 (mean±SEM) respectively38.

In the clinical examination of DE, it is customary to assess the daily intake and mode of beverages with high erosive potential, most often with the help of individually completed self-declaration questionnaires. However, the results of the different clinical trials do not always show a statistically significant correlation with the above-mentioned erosive drinks and foods, and the results of the individual clinical trials differ several times from each other as well.

In the DE12HU study, a questionnaire recommended by the WHO was completed and supplemented with questions about erosion. The dichotomy of the MuSRA study included several potentially erosive foods and beverages based on previous results and experience, as the study aimed to determine precisely which of them showed a statistically significant association with DE. The results of the questionnaire responses used in the DE12HU and those used in the MuSRA study were compared in 9. Table. While in the former, the soft drink showed a statistically significant correlation with DE and the juices did not, in MuSRA, the final result was just the opposite. Only the fruit juice showed a statistically significant relationship, and the soft drink did not. The reason for this difference is not entirely apparent. It may be related to the insufficient number of cases.

9. Table
Comparison of the results of the DE12HU and MuSRA studies

	Dental erosion and its relation to potential influencing factors among 12-year-old Hungarian schoolchildren[24]	Multicenter study to develop and validate a risk assessment tool as part of composite scoring system for erosive tooth wear[25]
Soft drinks	Lemonade, Coca Cola or other soft drinks	Consumption of soft drinks
Sport, energy drinks	No question on this topic	Consumption of energy or/and sports drinks
Fruit juices	Non-carbonated fruit juices	Consumption of juices
Alcohol	No question on this topic	Consumption of alcohol
Fresh fruit	Fresh fruit	Consumption of fruits
Drinking habits I.	No question on this topic	Erosive drinks (soft, sports, energy drinks, juices) kept in the mouth for longer period when consumed
Drinking habits II.	No question on this topic	Erosive drinks (soft, sport, energy drinks, juices) for quenching thirst between meals
Candys	Sweets, candies	No question on this topic
GERD	No question on this topic	GERD symptoms, such as regurgitation and heartburn
Vomiting	No question on this topic	Vomiting (for any reason)
Tooth sensitivity	No question on this topic	Do you feel pain or""icin"" after eating or drinking something acidic or cold?
Toothbrushing	Number of daily toothbrushing	Brushing frequency

Toothbrush	No question on this topic	Type of toothbrush (soft, medium, hard)
Socioeconomic status I.	What level of education have your father completed?	No question on this topic
Socio-economic status II.	What level of education have your mother completed?	No question on this topic

An important finding consistent in the two studies was that the consumption of fresh fruits did not correlate with the prevalence or severity of DE [25]. This result is important because regular consumption of fresh vegetables and fruits is dietetically essential and desirable. Based on these results, it does not appear to pose a severe risk of erosion. Nevertheless, a combination of "healthy eating" that is an extreme and one-sided preference for increased intake of raw fruits, vegetables, and high-fruit content juices may already be associated with an increased risk of DE[33].

In addition to the above, the consumption of rehydrating sports drinks and energy drinks with extremely high erosive potential is widespread in welfare societies. Although the erosive effects of sports drinks have previously been demonstrated primarily by in vitro studies[38], several clinical studies have concluded that the frequency of their consumption is not associated with the frequency or severity of DE [39 40]. Nevertheless, increased exercise-related fluid loss, dehydration, and associated hyposalivation may increase the propensity for erosion, as indicated by data in which the number of weekly workouts of amateur runners correlated with the prevalence of DE[40]. Both clinical trials[41, 42] and the MUsRA study showed a statistically significant correlation between the consumption of sports drinks and the prevalence of DE. However, the latter may have been somewhat influenced by the fact that sports and energy drinks were studied together in one issue[25]. The high erosive potential of energy drinks has also been confirmed by several in vitro studies[38, 43, 44]. Frequent consumption of these drinks and their high erosive potential is not desirable from a cariological or dietary point of view due to the extraordinary amount of free sugar.

Finally, it is essential to mention that in the case of beverages with high erosive potential, the frequency and pattern of consumption can also significantly influence the

development of DE. For example, several previous studies[3, 6, 45], and MuSRA also found a significantly higher prevalence of DE among those who held beverages with high erosive potential in their mouths for more extended periods, "rinsing" with them, compared to those who swallowed immediately. In addition, MuSRA found an expressed, but not statistically significant, higher prevalence of DE in those who quench their thirst with beverages with high erosive potential between meals[25].

In European and North American societies, the average age of per capita drug use is much higher than in developing countries due to the increasing age and the increased prevalence of diseases of civilisation. Drugs can contribute to the development of DE in two ways. On the one hand, they may appear as a source of extrinsic acid. Vitamin C and acetylsalicylic acid derivatives are the most commonly used preparations with an increased acid load[46]. An even higher erosion potential is expected in the form of chewable tablets or if the granules to be dissolved are used without dissolution[46]. On the other hand, several drugs do not present any acid load. Still, hyposalivation, the side effect of these drugs, impairs the oral cavity's acid resistance, which can also lead to severe DE[1, 36]. Reducing salivary secretion is a side effect of many drugs widely used in developed Western societies. Examples of such medications are antidepressants[1, 36], certain antihypertensive agents[1], antihistamines[46], and anti-Parkinson's agents[46]. Together, the above dietary, lifestyle and health factors may explain the increasing prevalence of DE in welfare societies.

The main reason for the development of DE is the increased acid load resulting from the consumption of foods and drinks with high erosive potential, acidic drugs, or the reflux of stomach acid, as well as the loss of balance caused by hyposalivation due to side effects of drugs or other reasons. When examining all the factors that potentially impact erosion formation, it is worth trying to trace the causes back to this level. In some cases, this helps to resolve the tension caused by the often contradictory data found in the various studies.

5. Conclusions

- Based on the results of the DE12HU study, it can be stated that the primary hypothesis has not been confirmed. The prevalence of ED in Hungary at 12 does not reach the European average but remains below it (21.2%)[24].
- In the MuSRA study, the prevalence of ED in the 15-21 age group was much higher at 58.5%[25].
- Within the limitation of these studies, it can be assumed that the following factors showed a statistically significant association with the prevalence and/or severity of ED:
    - energy drinks consumed on a daily basis[25]
    - rehydrating sports drinks[25]
    - carbonated soft drinks[24]
    - soft drinks with a high fruit content[25]
    - the mother's secondary or lower education level[24]
    - living in an urban environment[24]
- Neither DE12HU nor MuSRA showed an association with ED prevalence and the following factors:
    - consumption of fresh fruit[24, 25]
    - daily frequency of toothbrushing and the hardness of toothbrush[24, 25]

6. Summary

The results obtained determine the fundamental pillars of patient education. The information should clarify that uncontrolled over-consumption of carbonated soft drinks, energy drinks and sports drinks should be avoided as much as possible, as these drinks have high erosive potential and general dietary effects, which are unwanted. If someone drinks such beverages, do so in connection with the main meals and keep the oral transit time as short as possible.

It is also important to note that there is no strong relationship between the frequency of brushing teeth, the consumption of raw fruit, and the development of ED. Thus, the frequency of brushing continues to be determined by cariological and periodontal needs and cannot be overridden by erosion prevention. It is also essential to emphasise that restricting the dietary intake of fruit within a regular mixed diet is not justified for erosion prevention reasons.

In Hungary, ED is by no means the most critical lesion causing tooth hard tissue loss. Still, Western European and North American trends predict that a radical increase in the prevalence of ED is expected in parallel with the joyful decrease in caries frequency. As the latter process has not yet exploded in Hungary, it would be essential to learn from the mistakes of those countries where it has already started and is more or less advanced. The experiences, successes and failures there mark the direction of successful prevention, which is worth following. To ensure effective prevention, it is essential to identify the target groups as accurately as possible and, in addition to the general etiological factors known so far, to explore the unique aspects characteristic of the Hungarian population. The latter can only be done in part by analysing the solution strategies of other countries and mapping individual characteristics, eating, and other social habits which play an essential role. Therefore, it would be an urgent task to assess the frequency and severity of ED in different age groups in Hungary and identify unique risk factors and eating habits important in the development of ED because the most important means of combating ED is information and prevention.

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Unless the LORD builds the house, the builder's labour in vain. Unless the LORD watches over the city, the guards stand watch in vain. Psalms 127, 1

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