



## Dental aspects of purging bulimia

## Dentalni aspekti bulimije praćene povraćanjem

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### Abstract

**Background/Aim.** Bulimia is in many cases followed by frequent vomiting, which in long term can result in irreversible loss of dental tissue, most commonly manifested as dental erosion. Frequent purging, xerostomia, lack of oral hygiene and acidic environment are also suitable for caries development. The aim of the research was to determine the presence, localization and degree of dental erosion using Basic Erosive Wear Examination (BEWE) index system, as well as to determine the Decayed, Missing and Filled Teeth (DMFT) index in purging bulimic patients. **Methods.** The study involved 30 purging bulimic patients and 30 healthy subjects. Used methods were survey (questionnaire) and clinical examination. The clinical examination included intraoral inspection and assessment of dental status using BEWE and DMFT index. **Results.** On the bases of conducted research, it has been found that dental erosion are significantly more often present in purging bulimics compared to the controls ( $\chi^2 = 5.963, p < 0.05$ ), that eroded lesions are more severe in the bulimic group ( $t = 3.925, p < 0.05$ ) and predominantly located on oral surfaces of the teeth ( $\chi^2 = 10.561, p < 0.05$ ). DMFT index values showed no significant difference between bulimic patients and controls ( $t = 0.741, p = 0.461$ ). **Conclusion.** Dental erosion are often encountered in patients suffering purging bulimia, especially on oral surfaces of anterior teeth that come into direct contact with gastric acid, so many bulimics exhibit high values of erosive tooth wear on mentioned surfaces. DMFT index score did not show significant differences compared to healthy participants, but due to complexity of carious process further investigation is necessary.

### Key words:

bulimia; dental caries; oral health; risk assessment; surveys and questionnaires; tooth erosion; vomiting.

### Apstrakt

**Uvod/Cilj.** Bulimija je često praćena učestalim povraćanjem, koje u dužem vremenskom periodu može rezultirati ireverzibilnim gubitkom zubnog tkiva, koje se manifestuje dentalnim erozijama. Učestalo povraćanje, kserostomija, loša oralna higijena i kisela sredina pogoduju i razvoju karijesa. Cilj rada bio je utvrđivanje prisustva, lokalizacije i stepena dentalnih erozija upotrebom *Basic Erosive Wear Examination* (BEWE) indeksa, kao i utvrđivanje vrednosti indeksa karijesnih, ekstrahovanih i plombiranih zuba (KEP) kod obolelih od bulimije praćene povraćanjem. **Metode.** Istraživanjem je obuhvaćeno 30 ispitanika obolelih od bulimije praćene povraćanjem i 30 zdravih ispitanika. Korišćene su metode anketnog ispitivanja (upitnik) i kliničkog pregleda. Klinički pregled podrazumevao je intraoralnu inspekciju uz beleženje statusa prisutnih zuba upotrebom BEWE i KEP indeksa. **Rezultati.** Utvrđeno je da su dentalne erozije bile značajno češće kod obolelih od bulimije praćene povraćanjem u odnosu na zdrave ispitanike ( $\chi^2 = 5.963, p < 0.05$ ), da su bile težeg stepena kod obolelih od bulimije ( $t = 3.925, p < 0.05$ ), kao i da su bile češće na oralnim površinama zuba ( $\chi^2 = 10.561, p < 0.05$ ). Između ispitivanih grupa nisu utvrđene značajne razlike u vrednostima KEP indeksa ( $t = 0.741, p = 0.461$ ). **Zaključak.** Dentalne erozije se često sreću kod obolelih od bulimije praćene povraćanjem, posebno na oralnim površinama frontalnih zuba koje su u direktnom kontaktu sa želudačnom kiselinom, zbog čega na njima postoji značajan gubitak zubne supstance. Vrednosti KEP indeksa nisu se značajno razlikovale između ispitivanih grupa, ali su zbog složenosti karijesnog procesa neophodna dalja istraživanja.

### Ključne reči:

bulimija; zub, karijes; usta, zdravlje; rizik, procena; ankete i upitnici; zub, erozija; povraćanje.

### Introduction

Eating disorders (ED) are serious mental, psychiatric and behavioral disorders with multifactorial etiology invol-

ving sociocultural, psychological and biological factors<sup>1</sup>. As one of the most common ED, bulimia is characterized by repeated episodes of binge eating and food restriction, strong fear of gaining weight, loss of control over food intake and

inappropriate behavior in order to eliminate food (self-induced vomiting, abuse of purgatives and diuretics)<sup>2,3</sup>. Since the incidence and prevalence of these disorders has increased in the past 20 years, numerous studies regarding etiology, prevention and medical complications have been conducted<sup>4</sup>.

Regarding dental aspects of bulimia, frequent purging and impact of gastric juice are the most dominant factors causing hard tissue loss due to high acidity (mean pH 2.9), which is below critical pH for enamel dissolution<sup>5,6</sup>. Dental erosion (DE) are early and most common oral finding among bulimics, usually encountered on the palatal surfaces of teeth as a consequence of intense and repeated gastric juice influence, without bacterial involvement or trauma<sup>7-9</sup>. Vomiting at least once a week is considered to be a risk factor for progression of dental erosion that can become clinically apparent after 6 months up to 2 years<sup>5,10,11</sup>. The number and severity of erosion increase with the duration of the ED, but many modifying factors that influence erosive process must be taken into consideration<sup>12,13</sup>. Unfortunately, the process is irreversible, so early diagnosis of bulimia is crucial for prevention of oral complications<sup>13</sup>. Accompanying characteristics of bulimia, such as lack of oral hygiene, rich carbohydrate nutrition during binge, xerostomia and dominance of aciduric microbes, could increase risk of caries development<sup>5,6,11,12,14</sup>. However, studies concerning relationship between caries and bulimia are equivocal, and require questioning of many factors that influence and modify carious process<sup>12-15</sup>. In order to diagnose dental manifestations of bulimia and perceive all the factors that play a role in their evolvent, adequate knowledge about clinical features of mentioned lesions is necessary, as well as usage of detailed questionnaire.

The aim of the research was to determine the presence, localization and degree of dental erosion using Basic Erosive Wear Examination (BEWE) index system, as well as to determine the Decayed, Missing and Filled Teeth (DMFT) index in purging bulimic patients and healthy controls.

## Methods

A prospective, observational clinical study was conducted in the period 2015–2017 at Dentistry Clinic of Vojvodina (Department of Dental diseases and Endodontics), University of Novi Sad, Serbia. The study involved 30 patients diagnosed with purging bulimia and treated at the Psychiatric Clinic of Clinical Center Vojvodina, Serbia. Study included patients aged 18–35 years that suffered from bulimia followed by frequent vomiting (minimum 2–3 times a week in acute phase) for at least 3 years. Control group involved 30 healthy subjects and was matched with bulimics in age and gender.

The exclusion criteria included: patients under 18 and older than 35 years; patients diagnosed with bulimia less than 3 years ago; patients suffering non-vomiting type of bulimia, other eating disorders followed by vomiting; gastrointestinal disorders accompanied by vomiting; neurological, psychosomatic, metabolic and endocrine disorders followed by vomiting; chronic alcoholism and pregnancy.

After being properly informed about research, all participants signed the informed consent form.

Data collection was done using a standardized questionnaire administered to each patient. Questionnaire contained: general and sociodemographic data (name, age, gender and occupation), medical history (duration of bulimia and frequency of purging), oral hygiene habits (technique, duration, intensity and frequency of brushing), parafunctional habits (grinding and clenching teeth, nibbling on foreign objects) and dietary habits (frequency of sweet and acid diet intake). Questionnaire was designed to give comprehensive insight into etiological and modifying factors for appearance and development of dental erosion and caries.

The clinical examination included intraoral inspection and assessment of dental status using Basic Erosive Wear Examination (BEWE) and Decayed, Missing and Filled Teeth (DMFT) index. Examination was conducted under artificial light source using a dental probe and a mirror, with preleaning and drying of the tooth surfaces. Inspection included examination of all present teeth, recording healthy, decayed, missing teeth and fillings.

The presence of dental erosion was determined on the basis of objective findings and clinical signs of erosive tooth wear. Presence of erosion was noted in the upper and lower jaw, on the vestibular, oral and occlusal surfaces of the teeth, as well as in certain groups of teeth (incisors, canines, premolars, molars). BEWE index was used to determine degree of erosive wear and severity was graded according to the following criteria<sup>15</sup>: 0 – no erosive tooth wear; 1 – initial loss of surface texture; 2\* – distinct defect, hard tissue loss < 50% of the surfaced area; 3\* – hard tissue loss  $\geq$  50% of the surface area; \*scores 2 and 3 often involve dentin.

All teeth surfaces were examined and the highest score recorded. The examination was repeated for all teeth in a sextant but only the surface with the highest score was recorded for each sextant. The cumulative score of all sextants was calculated providing relevant information on the extent of erosive changes<sup>15</sup>.

DMFT index is well established as the key measure of caries experience in dental epidemiology. The DMFT index is applied to the permanent dentition and is expressed as the total number of teeth that are decayed (D), missing (M), or filled (F)<sup>16</sup>. When a carious lesion(s) or both carious lesion(s) and a restoration were present, the tooth was recorded as a D. When a tooth has been extracted due to caries, it was recorded as an M. When a permanent or temporary filling was present, or when a filling was defective but not decayed, this was counted as an F. Teeth restored for reasons other than caries were not counted as an F<sup>17</sup>.

Statistical analysis was processed using the standard statistical program licensed at the University of Novi Sad, IBM SPSS Statistics r20.0, Minitab v 16. The *t*-test and  $\chi^2$  test were used for group comparison. To evaluate relationship between continuous or ordinal variables Pearson and Spearman correlation were used. The threshold of significance retained was  $p < 0.05$ .

## Results

Bulimic group involved 30 participants, 28 female and 2 male with the average age of  $24.6 \pm 4.42$  years and control group involved 30 participants with same female predominance (14 : 1) and similar average age (Table 1). The analysis of age ( $t = -0.1, p = 0.921$ ) and gender ( $\chi^2 = 0, p = 1$ ) did not find any significant difference between the two groups. Results regarding patient occupation did not show significant difference ( $\chi^2 = 0.667, p = 0.955$ ) (Table 1).

Average duration of bulimia was  $4.75 \pm 2.58$  years, and in most patients (76.7%) it lasts for 3–5 years (Table 2). Data regarding frequency of vomiting show that 43% of bulimic patients purge several times a day, 27% at least once a day and 30% vomit several times a week (Table 2).

Oral hygiene habits of participants are shown in (Table 3). All results regarding oral hygiene habits, technique ( $\chi^2 = 2.31, p = 0.315$ ), duration ( $\chi^2 = 0.202, p = 0.904$ ), intensity ( $\chi^2 = 0.664, p = 0.717$ ) and frequency ( $t = 2.54, p = 0.8$ ), did not show significant difference between groups.

Parafunctional habits of participants are also shown in Table 3. Statistical differences were not found between groups concerning grinding/chlenching ( $\chi^2 = 0.077, p = 0.781$ ) or nibbling habit ( $\chi^2 = 0, p = 1$ ).

**Table 2**  
Duration of bulimia and vomiting frequency in the bulimic group

Parameter	Values
Bulimia duration (years), n (%)	
3–5	23 (76.7)
6–8	4 (13.3)
9–11	2 (6.7)
> 12	1 (3.3)
Average bulimia duration (years), mean $\pm$ SD	$4.75 \pm 2.58$
Vomiting frequency, n (%)	
several times a day	13 (43)
once a day	8 (27)
several times a week	9 (30)

SD – standard deviation.

**Table 1**  
Age, gender and occupation in the bulimic and the control group

Parameters	Bulimic group	Control group	<i>p</i>
Average age (years), mean $\pm$ SD	$24.6 \pm 4.42$	$24.73 \pm 5.81$	0.921
Gender, n (%)			
female	28 (93.3)	28 (93.3)	1
male	2 (6.7)	2 (6.7)	
Occupation, n (%)			
students	25 (83.4)	25 (83.4)	0.955
healthcare employees	1 (3.3)	2 (6.7)	
education employees	1 (3.3)	1 (3.3)	
lawyers and economists	2 (6.7)	1 (3.3)	
engineers	1 (3.3)	1 (3.3)	

SD – standard deviation.

**Table 3**  
Oral hygiene and parafunctional habits in the bulimic and the control group

Parameters	Bulimic group n (%)	Control group n (%)	<i>p</i>
Brushing technique			0.315
vertical	8 (26.6)	7 (23.3)	
horizontal	2 (6.7)	6 (20)	
rotary	20 (66.7)	17 (56.7)	
Brushing duration (min)			0.904
< 3	20 (66.6)	20 (66.6)	
> 3	5 (16.7)	4 (13.4)	
not sure	5 (16.7)	6 (20)	
Brushing intensity			0.717
mild	2 (6.7)	2 (6.7)	
moderate	18 (60)	15 (50)	
vigorous	10 (33.3)	13 (43.3)	
Brushing frequency (daily)			0.8
> 3 times	4 (13.4)	3 (10)	
2–3 times	24 (80)	24 (80)	
1–2 times	1 (3.3)	3 (10)	
< 1	1 (3.3)	-	
Parafunctional habits			
grinding and chlenching	21 (70)	20 (66.7)	0.781
nibbling of foreign objects	17 (56.7)	17 (56.7)	1

**Table 4**  
**Dietary habits (frequency of consumption) in the bulimic and the control group**

Parameters	Bulimic group n (%)	Control group n (%)	<i>p</i>
<b>Sweets</b>			
every day	21 (70)	25 (83.4)	0.617
1–2 times a week	6 (20)	3 (10)	
1–2 times a month	1 (3.3)	1 (3.3)	
rarely/never	2 (6.7)	1 (3.3)	
<b>Yogurt</b>			
every day	19 (63.3)	11 (36.7)	0.208
1–2 times a week	6 (20)	12 (40)	
1–2 times a month	5 (16.7)	1 (3.3)	
rarely/never	-	6 (20)	
<b>Herbal tea</b>			
every day	15 (50)	11 (36.7)	0.539
1–2 times a week	6 (20)	5 (16.7)	
1–2 times a month	-	8 (26.6)	
rarely/never	9 (30)	6 (20)	
<b>Carbonated beverages</b>			
every day	5 (16.7)	11 (36.7)	< 0.05
1–2 times a week	2 (6.7)	8 (26.7)	
1–2 times a month	-	4 (13.3)	
rarely/never	23 (76.6)	7 (23.3)	
<b>Non-carbonated beverages</b>			
every day	5 (16.7)	6 (20)	< 0.05
1–2 times a week	3 (10)	11 (36.7)	
1–2 times a month	1 (3.3)	4 (13.3)	
rarely/never	21 (70)	9 (30)	
<b>Vinegar</b>			
every day	10 (33.3)	12 (40)	0.06
1–2 times a week	8 (26.7)	12 (40)	
1–2 times a month	1 (3.3)	4 (13.3)	
rarely/never	11 (36.7)	2 (6.7)	
<b>Energy drinks</b>			
every day	1 (3.3)	-	0.589
1–2 times a week	2 (6.7)	3 (10)	
1–2 times a month	2 (6.7)	6 (20)	
rarely/never	25 (83.3)	21 (70)	
<b>Citrus fruit</b>			
every day	11 (36.7)	8 (26.6)	0.817
1–2 times a week	-	11 (36.7)	
1–2 times a month	11 (36.7)	7 (23.4)	
rarely/never	8 (26.6)	4 (13.3)	

Analysis of dietary habits noted that on daily bases many bulimic patients consumed sweets, yogurt and herbal teas, while majority of them rarely or never consumed energy drinks, carbonated and noncarbonated juices. Sweets and vinegar were daily consumed by great number of participants in the control group, while most of them rarely or never consumed energy drinks (Table 4). Significant differences between groups were found regarding intake of carbonated ( $t = -3.684$ ,  $p < 0.05$ ) and non-carbonated juices ( $t = -2.428$ ,  $p < 0.05$ ), which were both more frequently consumed by participants in the control group (Table 4).

Dental erosion were significantly more often present in purging bulimics compared to the controls ( $\chi^2 = 5.963$ ,  $p < 0.05$ ), with significantly higher total ( $\chi^2 = 5.765$ ,  $p < 0.05$ ) and average number ( $t = 2.243$ ,  $p < 0.05$ ) of erosion per patient (Table 5).

In bulimic group most of erosive lesions were found on incisors (41.5%), while in control group erosion were dominantly present on molars (38.9%). The analysis of erosion localization in different teeth groups did not find any significant difference between groups ( $\chi^2 = 1.044$ ,  $p = 0.791$ ) (Table 5). Analyzing tooth surfaces, significant difference

between groups was noted ( $\chi^2 = 10.561$ ,  $p < 0.05$ ), referring that majority of lesions in bulimic group (43.9%) were located on oral surfaces, and in control group predominantly on vestibular surfaces (44%) (Table 5). Regarding jaw location, there were no significant difference between examined groups ( $\chi^2 = 0.717$ ,  $p = 0.397$ ) (Table 5).

Severity of eroded lesions assessed by BEWE index showed that bulimic patients had significantly higher average values of BEWE score ( $t = 3.925$ ,  $p < 0.05$ ) (Table 5). Significant

differences between groups were found in second ( $t = 3.089$ ,  $p < 0.05$ ) and fourth ( $t = 2.565$ ,  $p < 0.05$ ) sextant, showing higher average BEWE score in bulimic group (Table 5).

Average values of DMFT index showed no significant difference between groups ( $t = 0.741$ ,  $p = 0.461$ ) (Table 6). The analysis of average number of decayed ( $t = -0.917$ ,  $p = 0.363$ ), missing ( $t = 1.969$ ,  $p = 0.054$ ) and filled teeth ( $t = 0.787$ ,  $p = 0.434$ ) did not find significant differences between two groups (Table 6).

**Table 5**  
**Dental erosion (DE) presence, localization and severity (BEWE index) in the bulimic and the control group**

Parameters	Bulimic group	Control group	<i>p</i>
Patients diagnosed with DE, n (%)	27 (90)	19 (63.3)	< 0.05
Total number of DE	82	54	< 0.05
Average number of DE, mean $\pm$ SD	2.73 $\pm$ 1.53	1.8 $\pm$ 1.69	< 0.05
Localization of DE in tooth groups, *n (%)			
incisors	34 (41.5)	18 (33.3)	
canines	6 (7.3)	5 (9.3)	0.791
premolars	15 (18.3)	10 (18.5)	
molars	27 (32.9)	21 (38.9)	
Localization of DE on tooth surfaces, *n (%)			
vestibular	18 (22)	24 (44.4)	
oral	36 (43.9)	11 (20.4)	< 0.05
occlusal	28 (34.1)	19 (35.2)	
Localization of DE in jaws, *n (%)			
upper jaw	41 (50)	31 (57.4)	0.397
lower jaw	41 (50)	23 (42.6)	
BEWE index score, mean $\pm$ SD	2.67 $\pm$ 1.6	1.23 $\pm$ 1.19	< 0.05
BEWE index score in sextants, mean $\pm$ SD			
I	0.17 $\pm$ 0.38	0.13 $\pm$ 0.35	0.723
II	0.9 $\pm$ 0.96	0.27 $\pm$ 0.58	< 0.05
III	0.27 $\pm$ 0.58	0.23 $\pm$ 0.5	0.814
IV	0.57 $\pm$ 0.82	0.13 $\pm$ 0.43	< 0.05
V	0.5 $\pm$ 0.78	0.27 $\pm$ 0.58	0.193
VI	0.23 $\pm$ 0.57	0.23 $\pm$ 0.64	0.832

BEWE – Basic Erosive Wear Examination; n – number of patients; \*n – number of teeth; SD – standard deviation.

**Table 6**

**Average decayed, missing, and filled teeth (DMFT) index scores in the bulimic and the control group**

Parameters	Bulimic group (mean $\pm$ SD)	Control group (mean $\pm$ SD)	<i>p</i>
DMFT index score	8.87 $\pm$ 3.43	8.1 $\pm$ 4.51	0.461
decayed teeth score	1.93 $\pm$ 2.35	1.47 $\pm$ 1.5	0.363
missing teeth score	1.23 $\pm$ 1.14	0.67 $\pm$ 1.09	0.054
filled teeth score	6.23 $\pm$ 2.46	5.5 $\pm$ 4.47	0.434

### Discussion

The aim of the research was designed after analysis of numerous scientific papers regarding bulimia and its oral manifestations, considering claims of significantly greater

possibility of developing erosive and caries lesions in these patients, as well as eventual changes of lifestyle habits<sup>6,12,13</sup>. While fast modernization of society raises the prevalence of diseases such as bulimia, oral manifestations of ED are not sufficiently recorded and monitored by dentists in Southeast

stern Europe, so dental protocols for prevention and treatment of bulimic patients are still missing.

In most studies involving bulimic patients, it is very difficult to reach a representative sample because large number of patients are hiding their disorder, they are young and not interested in cooperation<sup>12, 18</sup>. This is the reason why most of the modifying factors affecting DE and caries can not fully be investigated and confirmed in bulimic patients<sup>12</sup>.

Questionnaire was designed as set of questions that resembles the ones that were used in other original scientific papers with similar subject matter, considering all data that seemed to be anamnesticly significant for analysis of presence, localization and degree of DE, tooth decay and life habits in bulimic patients<sup>18, 19</sup>. The clinical examination included intraoral inspection. DMFT index is considered to be the standard for continuous and cumulative annual monitoring of decayed, missed and filled teeth<sup>14</sup>, and BEWE index was used as simple scoring system that easily indicates severity of tooth wear in everyday practice<sup>15</sup>.

The age of participants was selected according to the scientific findings referring to the age when bulimia usually occurs (age 18–35), and control group was gender and age matched. The average age of bulimic patients is  $24.6 \pm 4.42$  years and 83.3% of them were students, which corresponds to the fact that bulimia is most commonly present in university population<sup>13</sup>. Paszynska et al.<sup>20</sup> examined a group of 33 patients suffering bulimia and found that the average age of the diseased was  $21.2 \pm 3.2$  years, and three years ago same authors repeated the study with 25 patients of the same age<sup>21</sup>, while another study included 62 bulimic patients of the average age 27.7<sup>19</sup>.

Gender affiliation of the participants was in favor of the female sex, with a ratio of 14 : 1, which corresponds to the claims that bulimia more commonly affects women (10 : 1–20 : 1)<sup>13</sup>.

Patients's vocation is considered to be a significant data because certain professions have an increased risk of additional exposure to acidic agents, such as chemical and metal industry, professional swimmers, sommeliers, etc.<sup>10</sup>, but in this study none of the participants belonged to high risk groups.

The average duration of bulimia was  $4.75 \pm 2.58$  years, and this period can be considered as a sufficient for occurrence of irreversible oral changes<sup>10</sup>. Paszynska et al.<sup>20</sup> had similar findings, examining 33 bulimic patients with average duration of  $3.5 \pm 2.4$  years and the frequency of vomiting on average twice a day. Uhlen et al.<sup>19</sup> examined 62 bulimics with an average disease duration of 10.6 years, and Schlueter et al.<sup>22</sup> found that 7 years lasting bulimia accompanied by vomiting 2.5–5 times a day, can lead to clinically manifested erosion. Duration of disease and frequency of vomiting are significant factors affecting erosion development, but meta-analysis from 2015 found that the correlation between these factors and erosive process is complex and there is no linear association of these parameters<sup>14</sup>. In this study duration of bulimia significantly correlated with DE appearance ( $r = -0.214$ ,  $p < 0.05$ ) and localization on the oral surfaces ( $r = -0.385$ ,  $p < 0.05$ ), but did not significantly correlate with severity of erosion ( $r = -0.340$ ,  $p = 0.06$ ). Higher frequency

of vomiting significantly correlates with more frequent occurrence of erosion on the oral teeth surfaces ( $r = -0.118$ ,  $p < 0.05$ ), while correlations with DE appearance ( $r = -0.411$ ,  $p = 0.059$ ) and severity ( $r = -0.008$ ,  $p = 0.996$ ) were not found. This finding supports the fact that appearance and progression of erosion depends on chronicity of disease and that repeated vomiting causes endogenous erosion in typical localization<sup>5, 12</sup>.

Oral hygiene habits are especially important and considered as one of the main factors when it comes to caries appearance and progression of DE<sup>23</sup>. The quality of oral hygiene is assessed according to technique, duration, intensity and frequency of tooth brushing. All these parameters are also important because abrasive forces can lead to impairment of present erosive lesions. Acid demineralised enamel is non-resistant to abrasion, so softened enamel is very easy to remove by vigorous or frequent brushing, especially immediately after vomiting<sup>7, 13, 24, 25</sup>. Study done by Al-Zarea<sup>26</sup> founded that the frequency and brushing technique positively correlated with degree of enamel loss, but in this study none of the mentioned parameters correlated positively with the degree of erosive lesions. However, certain tendencies have been observed, so the participants in both groups experienced more severe erosion if brushing was intensive and more frequent.

Parafunctional habits can be significant because eroded lesions are sensitive to mechanical influence and attrition forces that can impair degree of erosive lesions. Bruxism can be a clinical sign of emotional and psychological stress, that are common symptoms of ED, so in bulimic patients attrition could cause erosive tooth wear to increase and progress faster<sup>27</sup>. Distinguishing abrasion and attrition apart from erosion is very important in differential diagnosis, and implies excellent knowledge about clinical symptoms of noncarious lesions combined with detailed anamnestic data. In this study, parafunctional habits did not positively correlate to severity of DE, although some studies confirm positive correlation between parafunctional habits and increased loss of hard dental tissue on eroded surfaces<sup>26</sup>.

In bulimic patients dietary habits are mentioned as the most indicative factor in determination of dental erosion origin and localization<sup>5, 28</sup>. Palatal lesions are most commonly found in patients who chronically vomit, while vestibular lesions are usually exogenous and originate from acidic food and beverages, so diet rich in citrus fruits, herbal teas and carbonated juices can increase the prevalence of exogenous erosion<sup>28</sup>. Regarding dietary habits significant differences between group were found for non-carbonated juices ( $t = -2.482$ ,  $p < 0.05$ ) and carbonated juices ( $t = -3.684$ ,  $p < 0.05$ ) that are consumed more often by healthy participants. The fact that control group participants intake more acidic beverages, explains predominant location of lesions on vestibular teeth surfaces in this group, confirming exogenous type of erosion, while bulimics have significantly more DE on oral surfaces which can be explained by frequent vomiting. Research by Dynesen et al.<sup>29</sup> found no positive correlation between consumption of acidic beverages and the presence of DE in bulimic or control group. In this study,

presence, location and degree of DE did not correlate with dietary habits in bulimic group, but in control group frequent consumption of carbonated juices correlated positively with degree of tissue loss ( $p = 0.434$ ,  $p < 0.05$ ) and localization of lesions on vestibular surfaces ( $r = -2.814$ ,  $p < 0.05$ ).

DE in bulimic patients were subject of numerous studies and meta-analyses and great majority of them pointed the fact that DE are significantly more often present in patients suffering ED compared to healthy subjects<sup>3, 21, 29, 30</sup>. Purging as repeated behavioral pattern increases risk of dental erosion appearance up to 5–8.5 times, and their presence 2.6–5.5 times, so DE can be detected in 90% of purging bulimics, while these lesions are not typical for non-purging types of eating disorders<sup>14, 18, 30</sup>. These findings are confirmed by studies that prove DE presence in 63%–86% of purging bulimics, and none of non-purging patients<sup>31, 32</sup>.

In accordance with previous findings, our study proves presence of DE in 90% of bulimics, confirming that erosion more frequently occurs in purging bulimics ( $\chi^2 = 5.963$ ,  $p < 0.05$ ) who experience significantly higher number of erosive lesions compared to controls ( $\chi^2 = 5.765$ ,  $p < 0.05$ ) and higher average number of erosive lesions per person ( $\chi^2 = 2.243$ ,  $p < 0.05$ ). In 10% of bulimics who chronically vomit, lesions were absent. Study by Uhlen et al.<sup>19</sup> found that as many as 30.3% of purging ED patients do not have to experience erosive changes, probably because of low vomiting frequency, good salivary composition and adequate lifestyle habits.

Palatal surfaces of upper anterior incisors and occlusal surfaces of the lower molars are considered to be typical sites of DE occurrence in purging bulimics, and it is explained by intense and frequent contact with gastric juice, fluid gravitating to the rear mouth floor, as well as poor salivation in the upper anterior teeth<sup>19, 28</sup>. Typical localization of DE was confirmed in this study, finding 41.5% of DE on incisors, 43.9% on oral and 34.1% of lesions on occlusal teeth surfaces in bulimic group. Regarding DE localization significant difference between groups was found ( $\chi^2 = 10.561$ ,  $p < 0.05$ ). Presence of DE on oral surfaces positively correlates to bulimia duration ( $r = -0.385$ ,  $p < 0.05$ ), as well as to frequency of vomiting ( $r = -0.118$ ,  $p < 0.05$ ), marking repeated purging as crucial etiological factor for DE occurrence in bulimics.

The erosive process is multifactorial, so severity of erosive lesions depends on presence and individual or cumulative effects of many modifying factors. Using BEWE index, the study has found that more severe erosive lesions were found in bulimic group compared to controls ( $t = -3.925$ ,

$p < 0.05$ ), which was already proven by other studies<sup>18, 19–21, 29</sup>. Explanation for severe degree of DE lies in nature of hydrochloric acid that is considered to be an extremely erosive chemical agent due to low pH and low calcium and phosphate levels<sup>15, 33, 34</sup>.

In bulimic group average BEWE index score was the highest in the second sextant, and these patients had significantly higher average BEWE score in second ( $t = -3.089$ ,  $p < 0.05$ ) and fourth ( $t = 2.565$ ,  $p < 0.05$ ) sextant compared to controls. These sextants match upper anterior teeth and lower lateral teeth, where most of the erosion were located in bulimic group, so this finding implicates that their severe degree could be result of aggressive etiological factor – gastric juice. In both groups, BEWE index score did not correlate with any of oral hygiene parameters of parafunctional habits.

Results regarding average DMFT index and separate analysis of decayed, missing and filled teeth showed absence of significant differences between two groups, and this result fits the fact that there were no differences in oral hygiene habits as well. Correlation between DMFT index and vomiting, oral hygiene or dietary habits was not found. Numerous studies have confirmed similar findings<sup>12, 30, 35</sup>, but others proved lower DMFT index in bulimic patients due to obsessive-compulsive hygiene habits, especially after vomiting<sup>19, 36</sup>. However, many studies claim that bulimic patients have higher caries prevalence as a result of poor oral hygiene, xerostomia, high sugar intake and rich aciduric bacterial flora<sup>5, 11, 14</sup>. The issue of dental caries in patients with ED is multifactorial and requires detailed and simultaneous analysis of vomiting habits, salivary factors, oral hygiene and dietary habits.

## Conclusion

Self-induced vomiting can be considered as main cause of dental erosion in bulimic patients. Erosive lesions are usually found on oral surfaces of anterior teeth which come into direct contact with vomitus and gastric acid, so many bulimics exhibit severe lesions on mentioned surfaces. DMFT index did not show significant differences compared to healthy participants, but due to complexity of carious process further investigation is necessary. Dental practitioners are usually one of the first healthcare professionals to whom a previously undiagnosed ED may present, so adequate knowledge about oral manifestations of bulimia is necessary. Creating a dental protocol for these patients should be a priority, reducing complications and providing appropriate preventive and treatment measures.

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