

Article

A Comparison of Etiology-Derived and Non-Etiology-Derived Indices Utilizing for Erosive Tooth Wear in People with Eating Disorders. The Validation of Economic Value in Clinical Settings

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Abstract: Increasing occurrence of non-carious lesions in their various forms and etiologies requires reliable and valid diagnostic tools to register their distribution, severity, and progression and to become helpful in planning treatment. The aim of this work is to evaluate eight selected (etiological and non-etiological) indices of tooth wear/erosion, taking into account the subjective opinion of the researcher/operator and the patients being treated for eating disorders. The research sample included 60 people with symptoms of dental erosion. The study group included 30 patients suffering from eating disorders, recruited from three independent medical institutions providing eating disorder therapy. The control group consisted of 30 patients with no eating disorders, but with dental erosion caused mostly by a low-pH diet. The indices chosen for evaluation were: Tooth Wear Index by Smith and Knight; indexes by Lussi, Johansson et al.; Tooth Wear Index modified by de Carvahlo Sales-Peres et al.; Linkosalo and Markkanen modified by Ganss et al.; and index Oilo et al., BEWE, VEDE. The examination took place during three short visits. The study group (suffering eating disorders) and the control group (without eating disorders) evaluated the indices chosen for this research similarly. In the assessment made by both groups of patients, the usefulness and application benefits of the etiological indices set were not significantly different than in the case of a set of non-etiological indexes. An analogous opinion has been made by the operator/researcher as far, as the following aspects are concerned: the number of indexes criteria, order of difficulty in memorizing criteria and in the procedure of indexes application. According to this research, for the group at risk of dental erosive wear (with or without eating disorders), optimal research tools to evaluate dental wear occurred: index by Lussi, Tooth Wear Index modified by de Carvahlo Sales-Peres et al., BEWE, index by Oilo et al.

Keywords: tooth wear; non-carious lesions; tooth wear and erosion indices; eating disorders; anorexia; bulimia



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1. Introduction

An increase in the incidence of non-carious lesions and their diverse clinical picture requires the dentist to use accurate and reliable diagnostic and research tools in order to record these changes, classify them, attempt to establish their etiology, severity, evaluate progression, and plan and implement an appropriate treatment. The multiplicity of tooth wear and erosion indexes available in the literature and the underlined lack of a 'golden standard' leads to an attempt to compare their usefulness and economics of application. The term 'economics' is understood here as labor economics, a study of the relationship between expenditures and the obtained effects [1]. The multi-factorial etiology of non-carious lesions may be associated with both local and systemic causes. Stress plays an important role

or, to be more precise, ineffective ways of dealing with it, which may be reflected in the occurrence of bruxism or eating disorders (anorexia, bulimia) [2–5], constitute major factors of influence. Data from the literature indicate here a psychological cause as an attempt to substitute emotions. It seems, therefore, that in patients with eating disorders, the phenomenon of bruxism can occur with increased frequency. In the anorexia and bulimic patients, erosive and abrasive changes in the oral cavity can be significantly affected by the components of pathological attrition and abfraction [6–12]. Despite the fact that there are many different indices available, so far none of them have fulfilled all the requirements for this type of examination tool, such as: high accuracy and reliability, usefulness in both daily practice and researches, and the possibility of results' comparison with other indexes, all of those features are elements of a research tool's economics. The main reason for the difficulties in comparing the results seem to be the accuracy of particular types of tooth wear criteria. Tooth Wear Index by Smith and Knight is said to be the closest to the 'gold standard'. That index is accepted and commonly used in much research in epidemiological investigation and to assess the particular patient. It allows us to examine the tooth wear regardless of the etiological factors and is used mainly in adults, and rarely in children. It is a simple and practical diagnostic tool with high accuracy and clear criteria. The Tooth Wear Index may be used to monitor the progression of the process, and it allows us to distinguish between the acceptable tooth wear form a pathological one by introducing the limits describing the maximal values of tooth wear acceptable for particular age groups. The thresholds were introduced in 6 groups dependent on the patients age: 25 years or less, 26–35, 36–45, 46–55, 56–65, 66 years and more. Tooth wear characterized with values higher than the proposed thresholds is classified as pathological.

One of the basic requirements that the indexes need to fulfill is their standardization, characterized by four parameters: accuracy, reliability, sensitivity and the specificity of the diagnostic tool. The accuracy defines whether the index measures that which it is designed for. The reliability answers the question of the precision of the examination. In order to define the degree of reliability, the results obtained by two or more researchers (independent) are compared. The examinations test-reset take place, where one operator examines one sample twice in a defined time. Sensitivity is defined as the ability of diagnosing the examined feature and the specificity—the ability of not diagnosing the feature if it is not present. High accuracy, reliability and sensitivity are the most important indexes used in epidemiological research [13].

In the case of losses of non-carious origin, there are factors which may hinder the creation of an index suitable for conducting their assessment. One of them is the specificity of these defects expressed by the diversity of their clinical symptoms or the interaction of causative factors, and hence some sources show a more universal application of these indexes, which do not take into account the etiology of the changes [13–17]. The literature on the subject provides numerous reports on the aspects of the standardization of individual indexes, both etiological and non-etiological, used to register losses of non-carious origins. However, these have not yet been put into the context of effectiveness for these two groups of indexes (etiological and non-etiological) in a study of people with symptoms of dental erosion [14–16]. A self-assessment of a given index performed by both the patient and the operator conducting the study, based on specially prepared questionnaires containing questions on the time needed to conduct the tests, the patient's feelings and possible discomfort resulting from carrying out the test procedures, seems to be an important criterion for a comparative analysis of wear rates. Nevertheless, this has not been included in any available research. A group of patients with eating disorders seems to be an interesting subject of study due to the possible specific psychological or psychosomatic requirements that should be considered by the dentist conducting their dental examination [17]. The possibility to fully diagnose a patient gives a dentist a tool to have a close look at the general health of his/her patient. Many general disorders have symptoms in the oral cavity which gives dental practitioners a chance to diagnose a general disease.

The aim of this work is to evaluate eight selected (etiological and non-etiological) indices of tooth wear/erosion, taking into account the subjective opinion of the researcher/operator and the patients being treated for eating disorders.

2. Materials and Methods

The study included 60 patients with symptoms of tooth erosion and an etiological record leading to the diagnosis of erosion.

The study group consisted of 30 women (20–35 y.o.), treated for eating disorders in three Silesian centers (Center for the Treatment of Neurosis and Eating Disorders “Dąbrówka” in Gliwice, Department of Psychiatry and Psychotherapy of the Upper Silesian Medical Center in Katowice-Ochojec, Department of Affective and Neurotic Diseases of the Psychiatric Hospital in Katowice Szopienice).

The control group consisted of 30 patients—20 women (19–58 y.o.) and 10 men (24–48 y.o.)—with symptoms of erosion unrelated to eating disorders, treated in the Specialist Dentistry Center in Katowice. The subjects were randomly chosen out of all patients coming to the Specialist Dentistry Center in Katowice; patients with eating disorders were excluded.

All patients were examined by one operator. The operator was calibrated by the senior dentist.

Study inclusion criteria:

1. Patients with an etiological record that lead to the diagnosis of erosion and signs of erosion associated with eating disorders.
2. Etiological record leading to the diagnosis of erosion and symptoms of erosion unrelated to eating disorders.
3. Adults who agreed to participate in the study and whose health condition allowed them to carry out tests, patients with complete or almost complete dentition and a preserved normal occlusion.

Study exclusion criteria:

underage patients, incapacitated patients with larger dental deficiencies, without preserved normal occlusion, patients who did not agree to participate in the study, hindering the reliable conduct of the study, pregnant women and patients whose health rendered the conduct of a standard examination impossible.

Final criteria:

A comparison of the usefulness and economics of using etiological and non-etiological indexes in patients with an etiological record leading to the diagnosis of erosion and symptoms of erosion both related and unrelated to eating disorders, as well as an assessment of opinions of respondents and the operator, allowed to choose optimal indexes to assess tooth wear in these patients.

2.1. Research Methods

The study consisted of two main parts: indexes assessment (three appointments) and filling of questionnaires by both patients (after each appointment) and operator (after each patient). The scheme of the research is presented in Table 1.

2.2. Selection of Tooth Wear/Erosion Rates for the Purpose of the Study

The basic assumptions of this study have been carried out by evaluating the usefulness and economics of using tooth wear/erosion indexes selected on the basis of the subject literature, recruited from two groups: etiological indexes:

- The *Lussi's* index-modified version of *Linkosalo* and *Markkanen* index, assessing the level of erosion by evaluation of dentine exposure. Labial and buccal surfaces are scored with 0–3 while occlusal, lingual and palatal, with 0–2. Only erosive lesions are scored [18].
- BEWE index (Basic Erosive Wear Examination)—to calculate that index teeth are divided into sextants: 17–14; 13–23; 24–27; 47–44; 43–33; 34–37. Labial/buccal, lin-

gual/palatal and occlusal surfaces of each tooth are scored (0–3). In each sextant, the most destroyed surface is chosen. All obtained results are added and the *BEWE score sum* is obtained and defines the risk level. Authors of the index propose a particular method of treatment for each risk level: no risk—control appointments; low risk—dietary and oral hygiene habits assessment, control appointments; medium risk—control appointments, observation, identification of causative factors and proposal of individual treatment plan, conservative treatment is not recommended; high risk—already mentioned methods of treatment are included with the cavity preparation and filling if needed [19].

- *Linkosalo and Markkanen's* index modified by *Ganss* et al. (Table 2).

Table 1. Scheme of the research.

| | |
|-----------------|---|
| 1st appointment | <ul style="list-style-type: none"> • general interview and filling out a questionnaire, which was the basis for qualifying a given person for the study group (erosion associated with eating disorders) or the control group (erosion unrelated to eating disorders); • assessment of following indexes: Tooth Wear Index due to Smith and Knight, etiologic index of teeth erosion due to <i>Lussi</i>, non-etiologic index of tooth wear due to <i>Johansson</i> et al. • impressions (with the usage of elastic mass) and photos of examined teeth were taken. <p>after the appointment:</p> <ul style="list-style-type: none"> • filling out the questionnaire regarding the economics of the assessed indices by the patient; • filling out the questionnaire regarding the economics of the assessed indices by the researcher. |
| 2nd appointment | <ul style="list-style-type: none"> • assessment of following indexes: Tooth Wear Index in modification of <i>de Carvahlo Sales-Peres</i> et al., <i>BEWE</i> (Basic Erosive Wear Examination), <i>Linkosalo</i> and <i>Markkanen</i> erosion index in <i>Ganss</i> et al., modification; • analysis of patients' diagnostic models. <p>after the appointment:</p> <ul style="list-style-type: none"> • filling out the questionnaire regarding the economics of the assessed indices by the patient; • filling out the questionnaire regarding the economics of the assessed indices by the researcher. |
| 3rd appointment | <ul style="list-style-type: none"> • assessment of following indexes: Tooth wear index due to <i>Oilo</i> et al., <i>VEDE</i> index (Visual Erosion Dental Examination) (taken of appropriate photos of examined teeth). <p>after the appointment:</p> <ul style="list-style-type: none"> • filling out the questionnaire regarding the economics of the assessed indices by the patient; • filling out the questionnaire regarding the economics of the assessed indices by the researcher. |

Table 2. *Linkosalo and Markkanen's* index modified by *Ganss* et al. [20].

| Criteria | |
|--|---|
| Buccal/Vestibular and Lingual/Palatal Surfaces | |
| 0 | no erosion observed |
| 1 | shallow hollows observed in less than one third of examined surface |
| 2 | deep or shallow hollows, both types observed in more than one third of examined surface |
| occlusal surfaces | |
| 0 | no erosion observed |
| 1 | shallow hollows, rounded cusps, flattening of fissures observed, morphology of occlusal surface preserved |
| 2 | Decreasing of cusps height, deep hollows observed, edges of restorations outstand over adjacent tissues, flattening of the occlusal morphology. |

- VEDE index (Visual Erosion Dental Examination)—a modification of *Lussi* index identifying the early changes in enamel and its progression in time [21] and indexes that do not take into account the etiology of changes:
- The Tooth Wear Index by Smith and Knight (TWI)—all surfaces: occlusal/incisal, buccal, cervical and lingual are scored with 0–4 depending on the intensity of tooth wear symptoms, regardless their etiology [22].
- Occlusion index by Johansson et al., it concentrates on the problem of occlusal surfaces tooth wear, assessed with the usage of diagnostic models. It enables the analysis of the progression of changes in time. A separate scale is dedicated to assess the level of tooth wear intensification. In our research, the scale to assess the intensification of changes was used [23].
- Tooth Wear Index (TWI), with modifications by de Carvalho Sales-Peres et al., introduces the possibility of observation tooth wear of deciduous and permanent teeth, teeth are scored with 0–9 [22].
- Oilo et al.’s index (Table 3) to measure occlusal wear.

Table 3. Oilo et al.’s index [24].

| Category | Description | Code | Occlusal Wear |
|----------------|--|------|---|
| satisfactory | | | |
| R (Romeo) | no visible wear, no changes in anatomy | - | no visible wear |
| S (Sierra) | limited wear and changes in anatomy | SOF | wear facets in enamel |
| | | SDF | small areas of exposed dentin, no changes in its hardness or sensitivity |
| M (Mike) | considerable wear, change in anatomy, no need for treatment | MLR | reduction of tooth length |
| | | MED | large areas of exposed dentine, discolored, no changes in its hardness or sensitivity |
| not acceptable | | | |
| T (Tango) | considerable wear, marked change in anatomy, possible occurrence of further damage to tooth and/or adjacent tissues | TLR | considerable reduction of tooth length |
| | | TED | large areas of exposed dentine, its discoloration, sensitivity and softness |
| V (Victor) | excessive wear, extreme change in anatomy, esthetics and function, pain, occurrence of damage to tooth and/or adjacent tissues | VLR | marked reduction of tooth length |
| | | VTF | fracture of tooth and/or restoration caused by extensive wear |
| | | VSD | softening of exposed dentine |
| | | VPE | pulp exposure due to wear |
| | | VCA | Pain on chewing |
| | | VGM | Irritation of gingiva and/or oral mucosa |

Questionnaires

(A) Patients were asked following questions:

- How do you assess time needed to examine the indexes? (possible answers: (little, average, too long).
- Were you confused or felt uncomfortably while the indexes were assessed? (possible answers: no; in a little degree; in an average degree; yes, majorly).
- Was the procedure of taking the impressions and/or photographs bothersome? (possible answers: no; in a little degree; in an average degree; yes, majorly).
- Which appointment (I, II, III) was the least stressful? (possible answers: 1, 2, 3).

(B) Operator answered following questions:

- Was the index complicated to calculate? (possible answers: easy, average, difficult).
- Was it difficult to learn the criteria and the procedure of index calculating? (possible answers: easy, average, difficult).
- How difficult was it to differ the stages of dentine exposure (when was it included in the index calculation procedure)? (possible answers: easy, average, difficult).
- How difficult was it to prepare additional materials (models and photographs)? (possible answers: easy, average, difficult).
- How long did it take to prepare the additional materials (models and photographs)? (possible answers: easy, average, difficult).
- Were the additional materials helpful in index assessment? (possible answers: easy, average, difficult).
- Were the additional materials easy to storage? (possible answers: easy, average, difficult).
- How do you assess the time of conducting the examination? (possible answers: easy, average, difficult).

Patients were asked about their eating habits and the medications they take.

2.3. Statistical Methods

Statistical analysis of the duration of the study. To verify the normality of distributions, the Shapiro–Wilk test was used. The hypothesis of normality was rejected for each index, thus the non-parametric Mann–Whitney test was used in the further analysis. The Friedman test was used to assess the possible statistically significant differences in the assessment of the test time by means of individual wear rates within the test group, and separately within the control group. Statistical analysis regarding the selection of the optimal index according to the subjective assessment of the patient and the operator performing the test. The χ^2 independence test was applied here. In the case of four-field tables, the Yates's correction was obligatorily and taken into account, and was supplementary; in situations of negligible numbers, an exact F-test was used.

3. Results

3.1. Characteristic of Examined and Control Groups

In the study group with the etiological record of erosion, 7 patients reported (currently or in the past) anorexia, 14 bulimia and 1 gastroesophageal reflux disease (GERD). In addition, 5 patients reported both anorexia and bulimia disorders, and 2 more anorexia, bulimia and GERD. One patient reported the combined incidence of anorexia and GERD. Based on the questionnaire study, 21 patients experienced vomiting, occurring at a frequency ranging from several episodes a month to 7 times a day. In 25 patients, a record of co-existence was also associated with erosive factors associated with a frequent consumption of food with a low pH index. Some of the patients reported taking medications that could affect the formation of erosive changes (anti-depressants, 21; calming drugs, 10; medication that irritates the mucous membrane of the gastrointestinal tract, 1). Twenty five patients scored higher than 20 points in the Eating Attitude Test-26, which corresponds to the probability of eating disorders, and the range of scores in the study group ranged from 2 points to 72 points. In 18 patients in the study group, symptoms of temporomandibular joint dysfunction were recorded (according to the Hellkimo index).

All patients in the control group had a record of frequent acidic food intake, and some patients reported taking drugs that could have an erosive activity. In this group, 5 people reported taking antidepressant drugs and 2 people reported taking sedatives. All control patients in the EAT-26 scored less than 20 points. In 13 people, symptoms of temporomandibular joint dysfunction were reported (according to the Hellkimo index).

3.2. Results Regarding Examination Times in the Assessment of Particular Indices

There were statistically significant differences between the test and control groups in the duration of the test using individual indices of tooth wear/erosion with respect to the following indexes: BEWE, TWI with the de Carvahlo Sales-Peres et al. modification, Oilo et al. and Johansson et al. In all of the above cases, longer examination times were obtained in the study group (Table 4).

Table 4. Comparison of examination times of particular indexes.

| Index | Examined Group | | Control Group | | Manna-Whitney Test Results |
|---|----------------|---------------|---------------|---------------|----------------------------|
| | Mediana [min] | SD (RM) [min] | Mediana [min] | SD (RM) [min] | |
| TWI due to <i>Smitha and Knighta</i> | 5.60 (4.75) | 2.07 (2.00) | 5.45 (5.00) | 1.39 (1.50) | 0.2769 |
| <i>Lussi</i> | 3.43 (3.25) | 0.68 (0.88) | 3.32 (3.00) | 0.66 (0.50) | 0.2122 |
| <i>Johansson et al.</i> | 4.72 (4.50) | 1.10 (1.00) | 4.25 (4.00) | 0.91 (0.50) | 0.0163 |
| TWI in. <i>de Carvahlo Sales-Peresa et al.</i> , modification | 3.46 (3.00) | 0.93 (0.50) | 3.27 (3.00) | 1.16 (0.50) | 0.0065 |
| BEWE | 3.35 (3.00) | 0.79 (0.50) | 3.13 (3.00) | 1.06 (0.50) | 0.0023 |
| <i>Linkossallo-Markannen in Ganss et al.</i> , modification | 4.73 (4.00) | 1.85 (2.50) | 4.07 (4.00) | 1.25 (1.38) | 0.1526 |
| VEDE | 5.22 (5.00) | 1.22 (1.00) | 5.40 (5.00) | 1.42 (1.40) | 0.2491 |
| <i>Oilo et al.</i> | 5.10 (4.25) | 1.72 (1.75) | 4.54 (4.00) | 1.65 (0.00) | 0.0109 |

The largest differences in the study group occurred between the average examination time (minutes) using the Tooth Wear Index according to Smith and Knight (VEDE) and the following indexes: BEWE, Lussi’s and TWI modified by de Carvahlo Sales-Peres et al. Differences were observed within the control group in the same way as above (Figures 1 and 2).

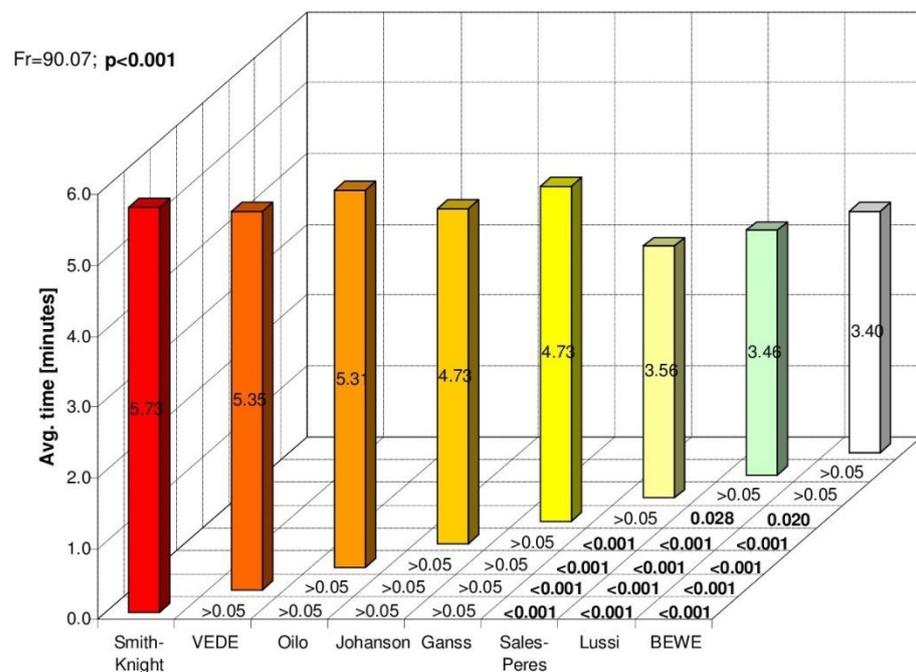


Figure 1. The result of the Friedman test in the assessment of the significance of the differences in the test time using individual wear/erosion indexes in the study group.

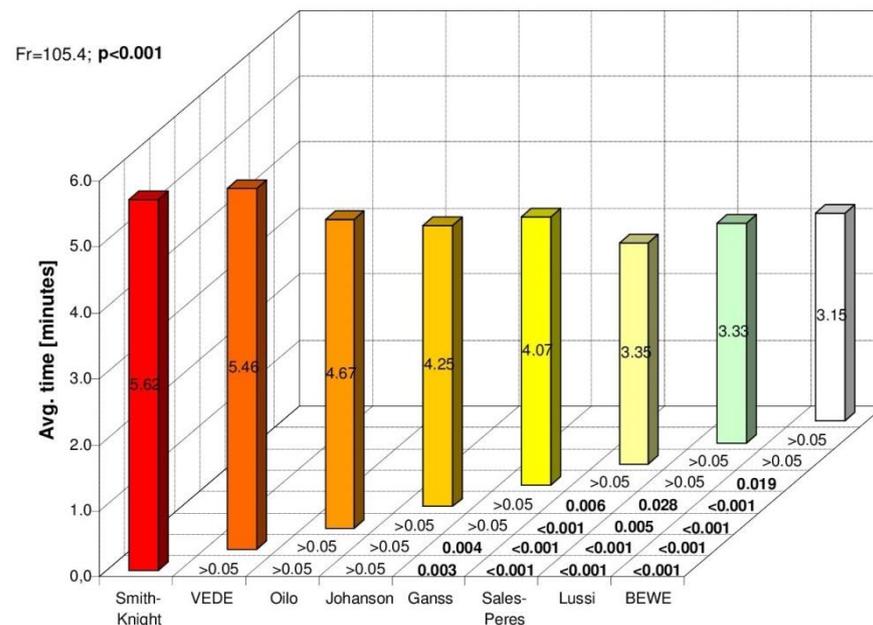


Figure 2. The result of the Friedman test in the assessment of the significance of the differences in the test time using individual wear/erosion indexes in the control group.

Based on the questionnaire study in the subjective assessment of patients in both the study and control groups, it was shown that the examination time for the following indexes: Lussi's, TWI modified by de Carvahlo Sales-Peres et al., BEWE, VEDE and Oilo et al., was most often described as 'short', while Smith and Knight's Tooth Wear Index was described as 'average'.

Patients in the study group most often determined the examination times of Johanson's and Linkosalo and Markkanen's modified by Ganss et al. indices as 'average', whereas the control group described those examinations as 'short'.

3.3. Subjective Assessment of Indices by Patients

While analyzing the patients' answers to the questionnaire, which concerned the subjective perception of the least bothersome assessment of the patient's tooth wear/erosion index, no statistically significant differences were found in the frequency of selecting 'the least bothersome' answer when comparing the examined group and the control group. In the answers to the question, it being an attempt to compare the indexes and the visits (indexes: TWI according to Smith and Knight, Lussi, Johansson et al.), there were statistically significant differences among the patients in the study group ($\chi^2 = 22.28$; $p < 0.001$). The Lussi's index was assessed by the patients of this group to be significantly higher than the TWI and Johansson's indexes.

In the control group, the Lussi's index was also chosen as not too bothersome. Likewise, in this group, the worst assessments from the first visit were obtained by the Johansson et al.'s index. Between Lussi's, Smith and Knight's TWI and Johansson et al.'s indexes there were statistically significant differences ($\chi^2 = 23.25$; $p < 0.001$).

Answers to the questions regarding the evaluation of indexes during the second visit (TWI modified by de Carvahlo Sales-Peres et al., BEWE, Linkosalo and Markkanen's modified by Ganss et al.) proved that the patients of the test group significantly more advantageously ($\chi^2 = 14.32$; $p < 0.001$) assessed the TWI by de Carvahlo Sales-Peres et al., and the BEWE index than the Linkosallo and Markkanen's index modified by Ganss et al. The evaluation of these indexes by the control group was similar ($\chi^2 = 28.37$; $p < 0.001$).

The analysis of the responses to questions from the patient questionnaire in the aspect of an evaluation of indexes during the third visit (VEDE, Oilo et al.) showed that both groups were more favorably assessed by the Oilo et al. index, with statistically signifi-

cant differences between the indexes only observed within the control group ($\chi^2 = 4.435$; $p = 0.035$).

Subsequently, the most frequently selected indexes during the first, second and third visit within each group were compared. The indexes of Lussi, BEWE and Oilo et al., were best evaluated by the patients of the study group, while patients from the control group chose the following indexes as the least bothersome: Lussi, BEWE, TWI modified by de Carvahlo Sales-Peres et al., and the Oilo et al. index. In the control group, the BEWE and TWI modified by de Carvahlo Sales-Peres et al. indexes were selected at a similar frequency for being the least bothersome. When comparing the sets of indexes chosen by patients as optimal within the studied group ($\chi^2 = 2.06$, $p = 0.357$) and within the control group ($\chi^2 = 2.61$, $p = 0.455$), there were no statistically significant differences in the frequency of their selection (Table 5).

Table 5. Comparison of the most frequently selected indexes during all appointments in examined and control groups.

| Index | Examined Group | | | Control Group | | | |
|---------------|----------------|------|-------------|---------------|--------------|------|-------------|
| | Lussi | BEWE | Oilo et al. | Lussi | TWI Modified | BEWE | Oilo et al. |
| least onerous | 19 | 14 | 17 | 20 | 20 | 15 | 20 |
| onerous | 10 | 15 | 10 | 10 | 9 | 14 | 9 |

The statistical analysis showed that there were no statistically significant differences in the frequency of selection of non-etiological indexes as compared to etiological indices chosen as the optimal set in the case of the two groups ($\chi^2 = 0.333$, $p = 0.564$).

When asked about the possible feeling of anxiety and embarrassment during the VEDE and Oilo et al.'s tests, most patients of both groups denied such an occurrence during this procedure. As for the assessment of possible discomfort in posing for digital photographs of the oral cavity, the prevailing opinion was its absence, with fewer answers confirming some discomfort felt but only to a small extent, both in the control group and in the study group.

Patients of both groups did not feel anxiety or self-restraint while carrying out tests using individual assessment of tooth wear/erosion indices, with the exception of indices related to the making of impressions. During the test using the Johansson's index, 30% of patients in the study group did not feel anxiety or embarrassment during the whole examination; however, another 30% indicated that they were anxious and slightly embarrassed. In the assessment of the study by the indices according to Linkosalo and Markkanen as modified by Ganss et al., a similar relationship occurred among the control group of patients. Patients of the study group slightly more frequently chose the answer 'occurrence of anxiety and embarrassment, but only slight'. The impressions themselves were assessed by the majority of patients in both groups as 'discomfort to a small extent' in the case of both indices. It should be noted, however, that 6 patients from the study group and 4 patients from the control group used the option to refuse to take part in the making of impressions during the second visit (index modified by Ganss et al.). All respondents explained their decision in writing as being due to unpleasant sensations while taking impressions during the first visit (Johansson et al.'s index).

3.4. Subjective Assessment of the Indices by the Operator

The analysis of the response to the questionnaire of the operator's questionnaire showed that in the operator's subjective assessment of the time needed to examine the patient with the use of individual tooth wear/erosion indexes, there were statistically significant differences ($\chi^2 = 258.9$; $p < 0.001$) between all indexes selected in the study. The time of testing using Smith and Knight's TWI and VEDE indices was most often referred to by the operator as 'too long'. In the case of Johansson's, Linkosalo and Markkanen's modified by Ganss et al. and Oilo et al., it was described as 'average'. The research using

the indexes by *Lussi, de Carvahlo Sales-Peres* et al. (TWI) and BEWE was described as 'short' (Table 6).

Table 6. Answers of the operator regarding the time needed to calculate a particular index.

| Answer | Index | | | | | | | |
|----------|---------------------------|--------------|--------------------|--------------------------|------|--------------|------|-------------|
| | <i>Smith and Knight's</i> | <i>Lussi</i> | <i>Johansson's</i> | <i>de Carvahlo-Peres</i> | BEWE | <i>Ganss</i> | VEDE | <i>Oilo</i> |
| short | 6 | 42 | 15 | 54 | 56 | 19 | 7 | 10 |
| average | 28 | 17 | 31 | 6 | 4 | 23 | 28 | 47 |
| too long | 26 | 1 | 14 | 0 | 0 | 8 | 25 | 3 |

Both in the case of the set of non-etiological and etiological indices, the subjective operator's assessment of the degree of scale development and the degree of difficulty in assimilating the evaluation criteria and the index application algorithm were usually referred to as 'average'. There were statistically significant differences between the selected indices in the aspect of the extension of scales and the degree of difficulty in assimilating their assessment criteria.

Based on the answer to the question regarding the degree of difficulty in the preparation of diagnostic aids accompanying the study, there were no statistically significant differences ($\chi^2 = 0.742$; $p = 0.690$) between the difficulty of preparing impressions according to *Johansson* et al. or *Linkosalo* and *Markkanen* modified by *Ganss* et al. Such differences ($\chi^2 = 41.91$; $p < 0.001$) occurred for the level of difficulty in preparing digital photography in the suggested projections accompanying the VEDE and *Oilo* et al. indexes. In that case, preparation of photos was assessed as less troublesome and laborious during the course of study as recommended by *Oilo* et al.'s index.

The operator's opinion about the length of time needed to prepare diagnostic help was similar. In the case of models, there were no statistically significant differences ($\chi^2 = 5.483$; $p = 0.064$) between the indexes of *Johansson* et al. and *Linkosalo* and *Markkanen* modified by *Ganss* et al. However, they occurred ($\chi^2 = 23.07$; $p < 0.001$) in assessing the length of time needed to prepare digital photographs. In the case of the *Oilo* et al.'s index, this time was more often subjectively assessed by the operator as short or average, while in the case of the VEDE index, as average or long. In the subjective assessment of the operator regarding the usefulness of models in the assessment of changes, statistically significant differences were found ($\chi^2 = 35.31$; $p < 0.001$) in the case of indexes using models. That usefulness was usually assessed as small or average in the case of the *Johansson* et al.'s index, while in the case of the index modified by *Ganss* et al., the answers small, average and significant were more evenly distributed.

While considering subjective opinions of the operator in the aspect of the usefulness of digital photographs of the oral cavity in an assessment of tooth wear/erosion changes, it was found that, in the case of the VEDE index, this usefulness was most often assessed as significant, while in the case of *Oilo* et al., it was average. However, there were no statistically significant differences between these indexes ($\chi^2 = 2.267$; $p = 0.322$). In the case of indices which use diagnostic models, the convenience of archiving these diagnostic aids was most often assessed by the operator as small, and in the case of indices which use digital photographs, as significant.

4. Discussion

The evaluation of the different research tools/indices selected for this study also required account to be taken of the limitations of this project. The main one, in the author's opinion, was the lack of gender diversity within the study group compared to the control group. In the control group, nearly 67% were women, while in the study group it was 100%. At the center for the treatment of neuroses and eating disorders, after the preliminary information about the planned studies, a desire to participate in them was expressed by several men; however, they did not meet the criteria for inclusion in the study (they were

treated for neurosis, not eating disorders). In developing the project's initial assumptions, the authors decided to randomly qualify the patients who met the inclusion criteria for tooth wear/erosion and who are not disqualified by gender.

When taking a summary of the results, it should be noted that the specificity of the study group could have a potential impact on the preference results in relation to the used indices. In the scientific literature concentrated on the analysis of the condition of this group of patients, specific characteristics affecting the quality of contact and the way in which the proposed medical procedures are performed are highlighted. Increased levels of anxiety can be expected during the selected dental procedures, mainly due to the presence of foreign matter in the mouth during the examination (mirror). Of great importance for these patients is the necessity to meticulously inform them about the course of individual procedures accompanying the planned oral examinations. It is also necessary to take into account the association of the occurrence of eating disorders with the increased vegetative reactions of the body. The influence of the environmental conditions and organoleptic properties of materials and tools to obtain diagnostic models on the subjective reception of the course of the study in patients with eating disorders must not be overlooked. In addition, some authors highlight the gender preferences of patients with eating disorders with regards to the doctors and medical staff [1,11,17].

In the case of the Smith and Knight's TWI index, the literature draws attention to its usefulness both for individual research and in epidemiological studies. This index is considered to be closest to the 'golden standard' in studies of losses of non-carries origin. Its non-etiological formula allows for the evaluation of multifactor wear. The high reliability and validity of this research tool is often emphasized. The only doubts concerning this index arise from the inclusion of the criterion of 'exposed dentin', which is not considered very reliable. However, it is used in a large number of research works, which has a positive effect on the possibility of comparing their results [18–26]. Smith and Knight emphasized that the average TWI test time does not exceed 5 min, including the time needed to clean the tooth surface. However, in the present study, the mean time of examination with this index was 5.60 min for patients in the study group and 5.45 min for patients in the control group. Bardsley, Taylor and Milosevic developed a simplified version of this index in order to limit the time of the examination, due to the fact that their research was epidemiological, taking into account a large sample group of patients [22,27].

In our own studies, no statistically significant differences were found between the control group and the study group as regards the length of the examination times using Smith and Knight's TWI index. In the assessment of examination time, the most common term among patients in both groups was 'average'. In the subjective opinion of the operator, it was usually perceived as too long. The advantages of the TWI index described in the literature were not reflected in the evaluations of the participants in this research in terms of simplicity of its application/submission to the study using it. In this aspect, within the indexes of the first visit, the research group assessed that index as significantly more difficult/more embarrassing than the Lussi's index. Similarly, in the set of the most-chosen as the best, easy-to-use indexes of all three visits, Smith and Knight's Tooth Wear Index was not mentioned by any of the groups.

The operator's opinion on the subject of the examination using this index seems to be similar to the patients' opinions. The most frequent answers were: "difficult, extended assessment criteria", followed by "too long examination time", "difficult assessment of the neck and buccal surfaces of the upper third molars included in the index". Taking into account the difficulty to use complicated and extensive criteria, attention was also paid to the importance of good cooperation and the positive attitude of patients during the examination. The advantages of the index mentioned by the operator include those easy to remember and only one group of teeth was rejected from the assessment, which were "teeth with extensive restorations filled tightly".

However, Donachie and Walls, in their article demonstrating the need to modify the TWI for the elderly population, criticized the issue of exclusion from teeth with extensive

fillings assessment. According to them, fillings in the Black's class V Black may mask a significant degree of wear [28]. The operator primarily emphasized accuracy as an advantage of using this index. When analyzing the results of our own research, the conclusion is that this index seems to be more useful for studying the wear of an individual patient than a large group of them.

The Lussi's index is regarded almost as the 'golden standard' among those indexes that take into account the etiology of changes. Studies highlight high results in both components of reliability, simplicity of use, and ease of comparison of results obtained from independent research [18,29,30]. In our own research, the patients of both groups evaluated the examination time using this index as 'favorable/short'. Mean examination times were only 3.43 min for the study group and 3.32 min for the control group. The short duration of the examination is also raised by the operator as the main advantage of this index. In the opinion of the patients of the study group, the Lussi's index turned out to be statistically significantly simpler/less embarrassing than the remaining indexes of the first visit. In the free, subjective opinions of patients in the course of the examination, the following opinions prevailed: short, non-invasive, comfortable examination. When assessing the indexes for examinations carried out without using diagnostic aids, resembling a standard dental review, the significance of obtaining earlier accurate information and predictability of applied procedures was reported only by patients from the study group.

As one of the disadvantages of using the index, the operator reported the presence of two separate scales to assess the labial/cheek, occlusal surfaces and incisal edges. Despite this, the evaluation criteria were still assessed as easy and understandable. The Lussi's index takes into account the criterion of exposed dentine, but its creator emphasizes a much easier use of this criterion when it is not considered = in relation to 1/3 of the test area (as is the case for TWI and VEDE indices), but up to 1/2 of the tested area [29]. The opinion of the operator conducting the Lussi's index examination was similar in this respect.

The TWI modification created by de Carvahlo Sales-Peres et al. for epidemiological purposes was distinguished in our research by the short time needed to conduct the examination [16]. Time values were similar to those obtained during the Lussi's index, but in the case of de Carvahlo Sales-Peres et al.'s modification, the examinations of the control group were statistically significantly shorter than in the study group. According to our own observations, patients with eating disorders (which in their free written statements emphasized the importance of obtaining accurate information) were already slightly encouraged after the first visit. During de Carvahlo Sales-Peres et al.'s TWI examination, which was the first index during the second visit, they used the course of the study to ask a lot of questions about their state of teeth and methods of prevention and treatment of non-carious lesions. The same regularity was applied to the BEWE index. The third visit was dominated by the acquisition of oral photographs and generally a large amount of equipment was used for those procedures; questions about the state of teeth were almost never asked by the patients. Thus, it seems that the statistically significant difference in the length of the examination time with these indices (TWI modified by de Carvahlo Sales-Peres et al. BEWE) between the study group and the control group may have some psychological explanation.

Among the indexes of the second visit, the TWI modification was assessed by both groups as an easier/more favorable examination than the Linkosalo and Markkanen's index modified by Ganss et al. There were statistically significant differences in the assessment of these indices. In the list of the most optimal metrics out of all three visits, the TWI by de Carvahlo Sales-Peres et al. received recognition among patients in the control group, where it was selected as optimal with a similar frequency as the BEWE index. In any written statements of patients about the course of the examination, frequent descriptions of these two indexes are similar and 'almost indistinguishable'. It seems, therefore, that due to the similarity of the examination times and algorithms used by these indexes from the point of view of the examined person, the main differences in their assessment may come almost exclusively from the operator conducting the study. It draws the most attention to simplicity, transparency and ease of remembering the assessment criteria, short

examination time, and index universalism. In 16 cases, the operator drew attention to their feelings of an easier, more comfortable carrying out of the TWI procedure in the modified version. It should be noted that the de Carvahlo Sales-Peres et al. TWI version, which, unlike the original, does not take into account the degree of exposed dentin, obtained higher results in reliability tests [16]. As a drawback, the operator listed a large number of groups of teeth classified in category 9, which means teeth rejected from the assessment. This may seem difficult to remember and may lead to a lack of therapeutic indexes (in comparison with the BEWE). These few flaws, however, do not change the fact that from the viewpoint of the operator, this index appears to be a tool covering the largest number of issues/advantages among all the indexes selected for this study.

The average duration of the examination while using the BEWE index differed in a statistically significant way in the study group from the mean duration of the examination in the control group. The control group was tested for a shorter period, similarly to the case of the TWI index modified by de Carvahlo Sales-Peres et al. Both the patient groups and the operator perceived the examination time as short. The prevailing opinion among all participating patients was that in comparison with the algorithm of other selected indexes, the BEWE index test method was one of the least troublesome procedures for them. It has been evaluated as being more advantageous in a statistically significant manner, e.g., from the method of the Linkosalo and Markkanen's index modified by Ganss et al. These assessments are in line with Lussi's opinion that the index is a modern, simplified and easily applicable research tool in all conditions [31]. A similar opinion was reported by the operator conducting the examination. In the comments section, which is an element of the operator's questionnaire, the most frequent opinions were related to the short examination time (23.6% of all operator's comments on the research method with this index), clarity and transparency of the evaluation criteria used (21.7%) and the easy-to-remember system of sextants (17.9%). The operator also emphasized the advantages of the presence of therapeutic indices, assigned to the appropriate 'BEWE score sum' thresholds, which, according to Bartlett, Ganss and Lussi's intention while creating this tool, was to significantly contribute to facilitating the doctor's future decisions regarding solving the problem of erosion in a given patient [32]. As an advantage of the BEWE system, the literature cites no need to distinguish the degree of exposed dentin, which translates into the ease of distinguishing between types 2 and 3 of the index. This fact was recognized in the operator's opinions, but was mentioned infrequently (3.8% of opinions). According to the operator, the disadvantage of the BEWE index was its etiological character, which may seem a little less universal. Analogical considerations were expressed by Young et al. in an article that analyzes the validity of the erosion assessment criteria [33]. Summing up, in own research, the BEWE index, together with the Lussi's and TWI modified by de Carvahlo Sales-Peres et al., achieves the status of one of the leading choices for the study of tooth wear/erosion rates in terms of optimality of use, from the point of view of the physician and both groups of patients.

In the case of the examination conducted according to the Johansson et al.'s index, the time needed to test the control group was on average 47 s shorter, which was a statistically significant difference. Similarly, patients in the study group perceived the examination as subjectively longer than those in the control group. Considering the aspect of 'optimum use based on the feelings of being subjected to a patient's examination', this rate was assessed by patients of both groups as the worst among the indexes of the first visit was statistically significantly worse than the Lussi's index.

Even though the majority of the members of both groups marked the level of anxiety, embarrassment or discomfort as "present but low" while completing the patient questionnaire, somewhat different conclusions arose in the analysis of subjective, written opinions of patients on the topic of taking impressions, especially in relation to patients with eating disorders. During the assessment of this procedure, psychological aspects of the examination such as the predictability of the examination and trust in the dentist (three times more often than in the control group), anxiety caused by the occurrence of negative dental

experiences from the past were expressed in the examined group more often than issues of somatic feelings (possible pain, discomfort, too many items in the mouth). Both groups reported the occurrence of the gag reflex with a similar frequency, but greater difficulty in breathing was reported by as much as 25% of patients in the test group and was reported more than in the control group. In contrast, the issue of the occurrence of retching in patients of both groups was differently expressed by the operator. The analysis of their remarks shows that the occurrence of the gag reflex during the taking of impressions was twice as frequent in the patients of the test group than in the control group. In addition, the feeling of an anxious attitude or poor cooperation on the part of the patient during the procedure was reported 24% more often in patients with eating disorders.

On the basis of the feelings accompanying the taking of impressions using Johansson et al.'s algorithm, some patients refused to take part in that procedure during the next visit. Patients in the study group accounted for as much as 60% of this group. Larsen et al. state that the use of plaster models based on alginate impressions to assess early erosive lesions does not actually fulfill its role due to the poorly reflected small details of the surface patterns. These authors, however, emphasize the general advantages of impressions accompanying the clinical examination, ensuring that the use of materials recommended by them (silicone masses, models of epoxy resins) for the assessment of the models sometimes allows to capture subtle changes in the surface, which cannot be found in a clinical study [34]. In our own research, the usefulness of models in assessing changes according to the Johansson et al.'s index was assessed by the operator as "little" or "average". The opinion of the operator does not coincide with the opinion of Ganss et al., who mention the numerous advantages of using models for assessing changes, such as: the possibility of evaluating repeatedly, in convenient lighting conditions, the freedom to choose the time of the implementation [20]. A similar opinion is expressed by Hooper et al. [14]. In our own research, from the operator's point of view, the prevalence of an examination combined with a clinical trial was emphasized, in comparison with the index use scheme, where the assessment of the tooth surface was carried out only on the basis of an analysis of diagnostic models. The lack of an ability to evaluate the optical properties of the enamel, such as gloss or color, made it difficult to assess the early changes in the model, especially those according to the index use scheme: alginate impressions were used and the models were cast from gypsum. This confirms the opinion of Larsen et al. on the limitations of those materials in the assessment of the described changes [34]. Another limitation of this study was the omission of an assessment of progression changes while using indexes that include an assessment of plaster models. The Johansson et al. index, in its original version, also contained a separate scale to assess the progression of changes over time, with the evaluation being based on models cast from impressions taken 18 months apart [23]. Despite the high reliability of the results obtained by this research tool, its assessment from the point of view of the participants in this study was less favorable than it was the case with other tooth wear/erosion indexes.

There were many analogies between the evaluation of examination using the following indexes: Johansson et al.'s as well as Linkosalo and Markkanen's modified by Ganss et al. Similar to the case of Johansson et al.'s index, the objective average time of the examination while using the index modified by Ganss et al. was statistically significantly longer than the analogous time for the control group. Certainly, a significant limitation of the assessment of the examination time with these indexes was that only the time of taking diagnostic aids in the surgery was measured. It did not take into account the time needed to prepare plaster models in the technician's workshop and their evaluation by the operator. However, this issue was reflected in the subjective opinions of the operator on the research using these indexes and the results of the assessment in terms of the convenience of archiving and storage of diagnostic models, which they assessed as 'little'. From the operator's point of view, the degree of difficulty and the time of preparation of impressions was similar to that of Johansson et al. In the subjective perception of the control group of patients, the time of the examination following Ganss et al.'s modification seemed 'short', whereas the

group with eating disorders and the operator conducting the test reported it as 'average'. Similarly, as in the case of the indexes of the first visit, also among the tools selected for research during the second visit, the index associated with taking impressions was assessed as the most troublesome/least optimal for the patients of both groups. The differences between the indexes presented here were statistically significant for both groups of patients.

Subjective written comments of the patients over the course of the examination conducted with the Ganss et al.'s index were analogous with the comments regarding the previous index, and some patients refused to participate in the study, explaining in writing their fear and unpleasant sensations while taking previous impressions. A surprising conclusion is that as many as 53% of the study group and 26% of the control group reported the organoleptic properties of the impression material, such as its taste, appearance, smell or temperature, as being important issues. The main disadvantages of this index, from the operator's point of view, included the lack of an accompanying clinical trial, as already described in the case of Johansson et al. It was difficult to distinguish the tooth tissues from the solid fillings present in it without the possibility of assessing the color or level of translucence. The issue of the quality of the impression and the model was of key importance here. In the case of this index, the operator also clearly emphasized the importance of the degree of cooperation on the part of the patient.

In the case of difficult cooperation, the ability of a more accurate analysis of the possible erosion occurring in the area of the last teeth of the arch, which would be impossible during a clinical trial, was a certain advantage of the models. For the physician conducting the examination, it was also easier to apply the indexes that used one unified scale to assess all the present tooth surfaces, than those in which the assessment included two separate scales with different criteria. In its original version, the index was used for epidemiological and long-term assessment of the degree of erosion in children and adolescents on the basis of models taken for orthodontic purposes within an interval of 5 years [20]. The ability to assess the progression of changes over time is an indisputable advantage of this method. The results of our own research, however, suggest that the use of research tools in which the analysis of plaster models serve as the basis for tooth assessment is more justified when we already have ready models previously made for other therapeutic and diagnostic purposes [14,20]. This is indicated by more favorable assessments of other indexes for tooth wear/erosion tests for both groups of patients, as well as for the operator conducting the examination. The index, in which the performance of impressions and models was strictly planned to assess the wear/erosion, was, for example, Larsen et al.'s index. However, it did not gain widespread approval due to its time-consuming and complex quantitative and qualitative criteria [18,34].

Average study times with the Visual Erosive Wear Examination Index (VEDE) did not show statistically significant differences between the groups and fluctuated around 5.5 min. Therefore, that time was only slightly shorter than the examination using the most time-consuming of the indexes selected for the study, which was the TWI. Despite the fact that, objectively, they achieved similar values in terms of minutes, the VEDE examination seemed shorter in the subjective perception of the patients. The operator described the examination time as "too long" in the case of both indices. Most patients in both groups indicated in the survey that they did not feel fear or embarrassment while taking digital photographs of their oral cavities. On the other hand, the negative feelings associated with the presence of expanders in the mouth appeared three times more often among patients in the study group than in the control group. The opinion of the operator shows that lip stretching with the expander was more often perceived as oppressive and caused an unattractive facial appearance in the study group, which may be explained by the elevated level of anxiety and narcissism in these patients, which was proven in scientific publications [11,35]. Of all the patients who, in their examination descriptions, complained about too many objects being in their mouth during the examination, patients with eating disorders constituted a group 14% greater than the control group. At the

same time, the same percentage distribution occurred when describing the study as ‘an interesting, new experience’.

According to the answers given in the operator’s questionnaire, the time devoted to the preparation of diagnostic aids was usually referred to as ‘average’ or ‘too long’. However, they perceived the convenience of archiving images and their considerable usefulness to evaluate erosive changes as the undoubted advantages of the VEDE index. The presence of a very good, accurate and helpful photo index, accompanied by an algorithm describing its use, is a crucial advantage, as it significantly facilitates assigning the stage of development of changes to the appropriate category. This opinion coincides with the results of research carried out by Mulic et al., which are a comparative analysis of reliability of the VEDE index, compared to the BEWE index [26]. In line with the guidelines for the standardization process of research tools, these studies were preceded by the training of researchers. Their results proved that in the tests of compatibility between researchers, while using the ‘test–retest’ patterns during the evaluation of photos, higher reliability results were achieved by the VEDE index. It should be noted that the VEDE index takes into account the criterion of the degree of exposed dentine, which is considered to be of debatable reliability, due to the differentiated distribution of enamel thickness on the tooth surface [21].

Based on the analysis of subjective written comments on the use of the VEDE index, it is clear from the operator’s point of view that the greatest drawbacks are: the difficulty in performing digital projections and mapping of the tooth surfaces in such a way that they correspond to the photo guide included in the index. The operator expressed this opinion 55% more frequently after conducting the test within the examined group than in the control group. Another issue, raised most frequently by the operator, was the large amount of specialized equipment needed for the examination (camera with a ‘macro’ lens function, expanders, a set of intraoral mirrors). It is difficult to describe this index as a simple research tool that enables a quick, routine erosion test in all conditions. It is actually necessary to have help from a dental assistant for the perfect quality of the photos taken for this index. Despite the use of indexed teeth, which aims at shortening the examination time, in our own research it seemed relatively long compared with other selected indexes. Considering the above data, the opinion expressed in the studies of Mulic et al. seems to be true, claiming that the VEDE index better serves research at the individual level than for epidemiological purposes, as it allows a further assessment of the progression of erosive changes over time [26]. This last feature would seem particularly important during the diagnosis and planning of erosion treatment, especially in the group of patients with eating disorders. However, this index is a time-consuming, complicated procedure for preparing digital photo projections from the operator’s point of view. Moreover, it was also less often described as ‘optimal’ by patients in other indexes, receiving worse assessments in comparison with other research tools selected for this research.

The examination with the Oilo et al.’s index was statistically significantly longer in the group of patients with eating disorders, but was subjectively perceived by these patients as being ‘short’. The control group assessed it similarly. From the point of view of the operator conducting the examination, this time was perceived as ‘average’. Examinations with this index were less difficult in both groups than was the case with the VEDE index, although in the control group there were statistically significant differences in this respect. This index was among the most frequently selected among all three visits in both groups of patients. The research scheme of Oilo et al.’s index did not generally entail negative feelings of anxiety, embarrassment or discomfort. Unlike the indexes taking into account the necessity of taking impressions, after the patients got acquainted with the procedure of taking digital photos of the inside of the mouth during the VEDE test, there was not a single refusal to participate in the next examination involving taking pictures. In the operator’s opinion, the projections assigned to Oilo et al.’s index proved to be significantly simpler in preparation when compared to the previous index. Oilo et al.’s index is intended for assessing the occlusive wear, regardless of its etiology, and is based rather on the assessment of the overall contour of the tooth than on the depth of individual defects [14,24]. Extremely

original categories created by its authors are a characteristic feature of this research tool. Unlike most indexes, these are no numerical thresholds but categories in the form of proper names or male names. This difference contributed to the opinion of the operator conducting the examination, that it was easy to memorize the main categories of the index and the evaluation criteria assigned to them, as well as the fact that the last two categories describe the wear as unacceptable, indicating the necessity to undertake therapeutic intervention.

Oilo et al.'s index uses qualitative assessment criteria such as, for example, hardness of tissues, their color or hypersensitivity [18,24]. However, since the maximum degree of wear in the majority of patients in both groups was SDF (small areas of exposed dentine unrelated to hypersensitivity of tissues or changes in their hardness) or even less severe: SOF (wear spots within the incisal edge of enamel and occlusal surfaces of teeth), qualifying patients to the initial wear category: Sierra, the overwhelming need to use only the first few subcategories did not pose difficulties during the examination. The designation of the concept of 'individual level of wear' is another innovative solution used in this index, which covers 90% of the results found in a given patient and also depends on the number of teeth preserved in the patient's mouth [21]. The introduction of this concept seems to be of particular importance when comparing results. The patients of both groups, examined for the purpose of this study, in their written reports commented on the increase of the comfort level in the procedures conducted according to Oilo et al.'s index, as compared to the VEDE, due to the lack of the necessity to use intraoral mirrors. When using the previous index, they were perceived as problematic by 26.6% of patients in each group. According to the operator's own observations, the positive opinions of patients regarding the examination following Oilo et al.'s index could be influenced by the fact that it was already the last index, ending the entire series of examinations. Patients had a higher level of trust and experience in cooperation with the operator, which was reflected in their opinions. While testing according to Oilo et al.'s index, its authors preceded the research with a training and calibration of researchers and an attempt to assess its reliability, obtaining the results of compatibility between researchers at a level of 85%. They also emphasize the good level of sensitivity of this research tool, reflecting on the degree of detection of changes, as they were actually present on the examined surfaces [13,24].

It is widely discussed that a multidisciplinary approach to the patients is crucial [36]. More and more patients are having eating disorders and the possibility of meeting patients suffering from this problem is higher. It seems to be very important to implement the tooth wear indexes into the medical history, which would make more dentists pay attention to the characteristic symptoms of bulimia and anorexia. As a result, dentists could be a part of an interdisciplinary group of experts who can diagnose and treat the patient due to the latest standards.

5. Conclusions

In the assessment of all study participants, both subjects and operators, the usefulness and economics of using the set of etiological indexes selected for this study did not differ significantly from the usefulness and economics of using a set of indexes that did not take into account the causative factor.

The optimal indices to assess tooth wear in patients with a reported tendency to erosion and symptoms of erosion turned out to be the following indexes: Lussi's, Tooth Wear Index modified by de Carvahlo Sales-Peres et al.'s, BEWE and Oilo et al.'s.

In order to improve the diagnosis of teeth wear in patients with a tendency to erosion, it seems to be crucial to implement one of the indices, assessed as optimal, to the scheme of dental examination and introduce it to the medical history.

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