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Objectification of Orthodontic Treatment Needs: Does the Classification of Malocclusions or a History of Orthodontic Treatment Matter?

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article

Abstract

Background. Orthodontic classifications make it possible to give an accurate diagnosis but do not indicate an objective orthodontic treatment need. In order to evaluate the need for treatment, it is necessary to use such indicators as the IOTN.

Objectives. The aim of the study was to find (i) relationships between individual diagnosis and objective recommendations for treatment and (ii) an answer to the question whether and which occlusal anomalies play an important role in the objectification of treatment needs.

Material and Methods. Two hundred three 18-year-old adolescents (104 girls, 99 boys) were examined. In order to recognize occlusal anomalies, the classifications proposed by Orlik-Grzybowska and Ackerman-Proffit were used. The occlusal anomalies were divided into three categories: belonging to both classifications, typical of Orlik-Grzybowska classification and typical of Ackerman-Proffit classification. In order to determine the objective need for orthodontic treatment, the Dental Health Component (DHC) of the IOTN was used.

Results. The occurrence of the following malocclusions covered by both classifications, namely abnormal overjet, crossbite and Angle's class, had a statistically significant ($p < 0.05$) impact on an increase of treatment needs in the subjects (DHC > 3). As for the classification by Orlik-Grzybowska, dental malpositions and canine class significantly affected the need for orthodontic treatment, while in the case of the Ackerman-Proffit scheme, it was asymmetry and crowding. There was no statistically significant correlation between past orthodontic treatment and current orthodontic treatment need.

Conclusions. IOTN may be affected by a greater number of occlusal anomalies than it was assumed. Orthodontic treatment received in the past slightly reduces the need for treatment in 18-year-olds (**Adv Clin Exp Med 2016, 25, 6, 1303–1312**).

Key words: statistics, orthodontics, malocclusion, Index of Orthodontic Treatment Need.

Diagnosis is one of the key prerequisites for the proper planning and giving of orthodontic treatment. Edward H. Angle, who developed the first classification of malocclusions [1], emphasized the importance of correct diagnosis as early as at the turn of the 19th to the 20th century. Based on mesiodistal relationships between permanent molars, Angle's classification, although used to this day, turned out to be imperfect and inaccurate. As a consequence, along with the development of orthodontics, researchers have proposed more detailed types of systematization of malocclusions, taking the three-dimensionality of occlusion, function and aesthetics into consideration. The most frequently used and globally recognized division of malocclusions was proposed in the 1960s by Ackerman and Proffit [2]. In Poland, however, the classification proposed by Orlik-Grzybowska [3] has been very popular for decades, both in the educational process and with professionals. Its main advantages include a comprehensive approach to the process of diagnosis and high clarity. Malocclusion divisions are required to define and system-

atize diagnostics, and as such, the more detailed the division, the more useful it is. On the other hand, the classifications of occlusal anomalies used in orthodontics come down to a qualitative assessment and do not allow orthodontists to measurably evaluate the need for orthodontic treatment based on the diagnosis. In order to obtain objective information about such needs or the effectiveness of treatment, it is necessary to use an indicator such as the Index of Orthodontic Treatment Need (IOTN), Peer Assessment Rating (PAR) and Index of Complexity Outcome and Need (ICON) [4–6]. To evaluate the need for orthodontic treatment, the IOTN is particularly useful; the index, based on the severity of individual occlusal anomalies, allows the patients to be classified into one of five groups: no need for treatment, slight need for treatment, moderate/borderline need for treatment, need for treatment, and definite need for orthodontic treatment. The IOTN is not based on any orthodontic classification and does not consider the diagnosis. The index value is determined by the presence and severity of anomalies belonging to one of five categories: missing teeth, overjet, crossbite, displacement of anatomical contact points and overbite [7].

In view of the foregoing, it seems justified to make an attempt to find both (i) relationships between individual diagnosis and objective recommendation for treatment and (ii) an answer to the question whether and which malocclusions (identified on the basis of a given classification) play an important role in the objectification of treatment needs.

The aim of the study was to (i) determine which of the classifications of malocclusions, that is by Orlik-Grzybowska or Ackerman-Proffit, play a more significant role in the objectification of treatment needs, and (ii) evaluate the possible impact of orthodontic treatment received in the past on the incidence of occlusal anomalies and current need for treatment.

Material and Methods

Two hundred three 18 year-old students (104 girls, 99 boys) from various secondary schools were examined upon prior written consent obtained from the principal of the corresponding school facility and upon confirmation that a certified school nurse is assigned to such facility. Individual classes were randomly selected. The nurse was responsible for preparing office and dental tools (mirrors) and complemented the medical records under the supervision of the orthodontist. All subjects gave their permission to be a part of the study, and were informed about the aim and method of the study as well as about the freedom of participation in the project. The individuals who were being treated orthodontically at the time of the study were excluded from the project (Fig. 1), which was approved by the Bioethics Committee of the Wroclaw Medical University (opinion number KB – 505/2008). The profile of the study group is shown in Table 1.

In each case, the study was conducted by the same doctor, who was trained in the use of the Dental Health Component of the IOTN. Information about orthodontic treatment the subjects had received in the past was collected on the basis of the patient's medical history (anamnesis).

In order to recognize occlusal anomalies, two classifications were used, namely: [1] by Orlik-Grzybowska and [2] the Ackerman-Proffit scheme.

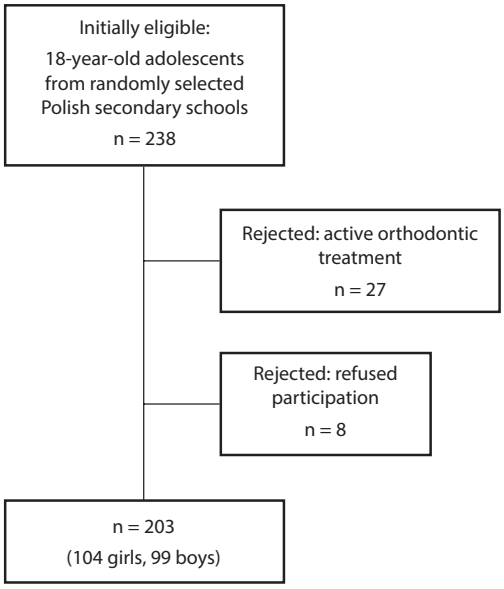

Fig. 1. Eligibility criteria of the study

Table 1. Subject distribution

Patients' gender	Type of school			All	Orthodontic treatment received in the past	
	vocational school	technical school	high school		yes	no
Males	39 (19.2%)	36 (17.7%)	29 (14.3%)	104 (51.2%)	31 (15.3%)	73 (36%)
Females	37 (18.2%)	33 (16.3%)	29 (14.3%)	99 (48.8%)	31 (15.3%)	68 (33.5%)
All	76 (37.4%)	69 (34%)	58 (28.6%)	203 (100%)	62 (30.5%)	141 (69.5%)

According to the classification by Orlik-Grzybowska, the following malocclusions were diagnosed:

a) transverse malocclusions:

– crossbites: partial anterior crossbite right/left, partial unilateral crossbite right/left, partial bilateral crossbite, complete crossbite, functional mandibular lateral displacement, morphological mandibular lateral displacement;

– scissor bite: unilateral lingual (right/left), bilateral scissor bite;

b) anterior-posterior malocclusions:

– distoclusions (class II malocclusions): partial distoclusion (molars in class I, canines in class II), complete distoclusion (molars in class II), pseudo distoclusion (prognathic position of maxilla), functional retrusive occlusion, morphological retrusive occlusion (retrogenia);

– mesioclusions (class III malocclusions): partial mesioclusion (molars in class I, canines in class III), complete mesioclusion (molars in class III), pseudo mesioclusion (maxillary deficiency), functional protrusive occlusion, morphological protrusive occlusion (mandibular prognathism);

c) vertical malocclusions:

– open bites: partial anterior open bite, partial unilateral open bite right/left, partial bilateral open bite, complete open bite (skeletal);

– deep overbites: partial deep overbite, complete deep overbite (skeletal);

d) teeth malpositions: mesiorotation, distorotation, mesioinclination, distoinclination, palatotrusion, linguotrusion, vestibulotrusion [3].

According to the Ackerman-Proffit classification, the following malocclusions were diagnosed:

– symmetry of the upper and lower arch, spacing and crowding (and their sum for a given arch; the size of crowding was determined as the difference between the sum of the tooth widths and the alveolar ridge length);

– tooth relationships to the transverse plane (the presence of unilateral and bilateral crossbite);

– anterior-posterior tooth relationships (evaluation of Angle's classes, overjet, diagnosis of anterior-posterior malocclusions);

– tooth relationships in the vertical plane (anterior and lateral open bite diagnostics and anterior deep overbite diagnostics, evaluation of the overbite size) [2].

Due to the lack of the first permanent molars, defining the Angle's class was impossible in the cases of 9 patients on the right side and in 12 patients on the left side.

The occlusal anomalies evaluated in this way were divided into:

a) malocclusions belonging to both classifications such as: crossbite, Angle's classes, overbite, overjet, anterior and lateral open bite, anterior and complete deep overbite;

b) malocclusions typical of classification by Orlik-Grzybowska such as: canine classes, dental malpositions, functional and morphological mandibular lateral displacement, partial and complete distoclusion, pseudo-distoclusion, functional and morphological retrusive occlusion, partial and total mesioclusion, pseudo-mesioclusion, functional and morphological protrusive occlusion;

c) malocclusions typical of Ackerman-Proffit classification such as: symmetry of the upper and lower arch, spacing (in mm) and crowding (in mm).

In order to determine the objective need for orthodontic treatment, the Dental Health Component of the Index of Orthodontic Treatment Need was used. In accordance with the recommendations of the index authors, individual elements of occlusion were evaluated, including in particular: the presence of retained teeth or lack of buds, the size of overjet, crossbite, crowding severity (displacement of anatomical points of contact measured in millimeters) and size of overbite [7]. Linear measurements of the size of overjet, overbite, crowding and spacing were taken with a digital caliper to an accuracy of 0.1 mm. The values of the Dental Health Component and the corresponding occlusion characteristics are shown in Table 2. DHC value = 1 means no need for orthodontic treatment, DHC = 2: slight need for treatment, DHC = 3: moderate/borderline need for treatment, DHC = 4: a need for orthodontic treatment, DHC = 5: definite need for orthodontic treatment [7].

Statistical analysis was performed using the SPSS 16.0 (2008) and STATISTICA v. 10.0 (StatSoft Inc., 2011) software packages. Descriptive statistical analysis was performed. The distribution of qualitative parameters was determined using frequency tables. For quantitative traits, the measures of location, variability, asymmetry and concentration were defined. The adherence of quantitative variables to the normal distribution was evaluated using the Shapiro-Wilk test. The relationships between variables were analyzed using the chi-square test for independence. The Kruskal-Wallis and Dunn multiple comparison tests were used to identify intergroup differences. The significance level $\alpha = 0.05$ was assumed. The results were considered statistically significant when the calculated probability p-value satisfied the inequality $p < 0.05$. In the final stage of data analysis, an attempt was made to build a statistical model that would illustrate the dependence of the IOTN DHC parameter on individual malocclusions. To this end, dependent variable regression techniques were used.

Table 2. Dental Health Component of the Index of Orthodontic Treatment Need (Richmond 2008)

Degree	Qualifier	Feature
1	extremely minor malocclusions, including displacements less than 1 mm	
2	a	increased overjet > 3.5 mm ≤ 6 mm (with competent lips)
	b	reverse overjet > 0 mm ≤ 1 mm
	c	anterior or posterior cross bite with the difference between the occlusal-posterior mandibular position and the maximum intercuspation ≤ 1 mm
	d	contact point displacement > 1 mm ≤ 2 mm
	e	anterior or lateral open bite > 1 mm ≤ 2 mm
	f	increased vertical overjet (≥ 3.5 mm) without gingival contact (traumatic occlusion)
	g	anterior-posterior contact point displacements between upper and lower lateral teeth up to half the cusp width without other associated anomalies
3	a	increased overjet > 3.5 mm ≤ 6 mm (with incompetent lips)
	b	reverse overjet > 1 mm ≤ 3.5 mm
	c	anterior or posterior crossbite with the difference between the occlusal-posterior mandibular position and the maximum intercuspation > 1 mm ≤ 2 mm
	d	contact point displacements > 2mm ≤ 4 mm
	e	anterior or lateral open bite > 2 mm ≤ 4 mm
	f	increased and complete overjet with no associated injuries to the palate or the lip
4	a	reverse overjet > 6 mm ≤ 9 mm
	b	overjet > 3.5 mm with no masticatory or speech difficulties
	c	anterior or posterior crossbite with the difference between the occlusal-posterior mandibular position and the maximum intercuspation ≤ 2 mm
	d	significant contact point displacements > 4 mm
	e	severe anterior or lateral open bite > 4 mm
	f	increased and complete overjet with no associated injuries to the palate or the lip
	h	less extensive hypodontia (one tooth missing in the quadrant) requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis
	l	posterior scissor cross bite with no functional occlusal contact in one or both buccal segments
	m	reverse overjet > 1 mm ≤ 3.5 mm with recorded masticatory or speech difficulties
	t	partially erupted teeth, tipped and impacted against adjacent teeth
	x	supernumerary teeth
5	a	increased overjet > 9 mm
	h	extensive hypodontia (more than 1 tooth missing in any quadrant) requiring prosthetic treatment preceded by orthodontic treatment
	i	impeded eruption of teeth (except for third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause
	m	reverse overjet > 3.5 mm with reported masticatory and speech difficulties
	p	cleft lip and palate
	s	submerged deciduous teeth

Results

The results of the study of the frequency of malocclusions according to the classification by Orlik-Grzybowska and the Ackerman-Proffit classification are summarized in Tables 3–6.

The objective needs for orthodontic treatment were observed in 21.4% of the subjects, in which the IOTN was ≥ 4. Eighteen percent of students orthodontically treated in the past and 22.9% of untreated students required treatment. No need for treatment (DHC ≤ 2) was observed in 50.7% of untreated subjects and in 44.3% of subjects who had received treatment in the past (Table 7). Due to concerns regarding the DHC evaluation, two cases were excluded from further analysis. There was no statistically significant relationship between orthodontic treatment received in the past and the value of DHC.

The relationships between malocclusions and the Dental Health Component values are shown in Tables 8 and 9. The occurrence of the following malocclusions in the subjects with no orthodontic medical record, namely: abnormal overjet, crossbite, anterior or lateral open bite and Angle's class (only on the right side), had the greatest and statistically significant ($p < 0.05$) impact on an increase of treatment needs in the subjects (DHC > 3). In patients who had undergone orthodontic treat-

Table 3. Distribution/frequency of malocclusions according to Orlik-Grzybowska

Malocclusion	Frequency
Partial anterior crossbite right/left	9 (4.4%)/4 (2%)
Partial posterior crossbite right/left	17 (8.3%)/15 (7.3%)
Partial bilateral crossbite	6 (3%)
Complete crossbite right/left	3 (1.5%)/0 (2%)
Lateral functional shift of the mandible	1 (0.5%)/1 (0.5%)
Lateral morphological shift of the mandible	0/0
Unilateral scissor bite right/left	2 (1%)/8 (3.9%)
Bilateral scissor bite	3 (1.5%)
Partial distoclusion	7 (3.4%)
Complete distoclusion	41 (20.2%)
Pseudo distoclusion	0
Functional retrusive occlusion	14 (6.9%)
Morphological retrusive occlusion	3 (1.5%)
Partial mesioclusion	2 (1%)
Total mesioclusion	8 (3.9%)
Spurious mesioclusion	0
Functional protrusive occlusion	1 (0.5%)
Morphological protrusive occlusion	6 (3.0%)
Canine class I right/left side	140 (69%)/139 (68.5%)
Canine class II right/left side	53 (26.1%)/50 (24.6%)
Canine class III right/left side	10 (4.9%)/14 (6.9%)
Partial anterior open bite	8 (3.9%)
Partial posterior open bite right/left	4 (2%)/3 (1.5%)
Bilateral open bite	1 (0.5%)
Complete open bite	1 (0.5%)
Partial deep overbite	33 (16.3%)
Total deep overbite	1 (0.5%)

ment for malocclusions in the past, an objectively significant need for further treatment was found in the case of the prevalence of abnormal overjet, crossbite, and right-sided Angle's class.

Variables occurring only in the classification proposed by Orlik-Grzybowska also significantly ($p < 0.05$) determined the objective need for orthodontic treatment (DHC > 3). They included: distoclusion, retrusive occlusion, canine class and all evaluated dental malpositions (mesiorotation, distorotation, mesioinclination, distoinclination, palatotrusion, linguotrusion, vestibulotrusion, palatal position, lingual position and vestibular position) in the subjects with no orthodontic medical record and such dental malpositions as distorotation, palatal position and canine class on the right side in the subjects orthodontically treated in the past.

The parameters taken into account in the Ackerman-Proffit classification also significantly ($p < 0.05$) influenced the need for treatment. These parameters included: asymmetry in the upper or lower arch and crowding in the upper or lower arch in untreated subjects and asymmetry in the upper or lower arch and crowding in the upper arch in patients who had undergone orthodontic treatment.

The regression function of the dependent variable was used to make an attempt to build a math-

Table 4. Tooth malposition frequency according to Orlik-Grzybowska

Dental malposition	Number
Mesiorotation	155 (76.4%)
Distorotation	154 (75.9%)
Mesioinclination	121 (59.6%)
Distoinclination	74 (36.5%)
Palatotrusion	82 (40.4%)
Linguotrusion	51 (25.1%)
Vestibulotrusion	78 (38.4%)
Palatal position	20 (9.9%)
Lingual position	24 (11.8%)
Vestibular position	47 (23.2%)

Table 5. Frequency of dental arch asymmetry, crowding and spacing in the upper and lower dental arch according to Ackerman-Proffit

Type of dental disorder	Maxilla	Mandible
Asymmetry of the arch	27 (13.3%)	28 (13.8%)
Crowding	139 (68.5%)	146 (71.9%)
Spacing	32 (15.8%)	23 (11.3%)

Table 6. Frequency of malocclusions according to Ackerman-Proffit classification

Malocclusion	Frequency
Unilateral crossbite	44 (21.7%)
Bilateral crossbite	13 (6.4%)
Unilateral scissor bite	11 (5.4%)
Bilateral scissor bite	3 (1.5%)
Angle's class I right/left side	123 (60.6%)/126 (62.1%)
Angle's class II right/left side	49 (24.2%)/47 (23.2%)
Angle's class III right/left side	21 (10.3%)/18 (8.9%)
Anterior open bite	11 (5.4%)
Posterior open bite	7 (3.4%)
Anterior deep overbite	33 (16.3%)
Posterior deep overbite	2 (1%)

ematical model representing the variability of the Dental Health Component of the IOTN, depending on the prevalence of specific occlusal anomalies:

Table 7. Dental Health Component of the Index of Orthodontic Treatment Need in the group of subjects

DHC	Treated group	Untreated group	The whole group
1 or 2	27 (44.3%)	71 (50.7%)	98 (48.8%)
3	23 (37.7%)	37 (26.4%)	60 (29.9%)
4 or 5	11 (18%)	32 (22.9%)	43 (21.4%)
In total	61 (100%)	140 (100%)	201 (100%)

DHC = 1 or 2 – no need for orthodontic treatment;
DHC = 3 – slight treatment need;
DHC = 4 or 5 – present need for orthodontic treatment.

$$\text{OTN DHC} = 2.29 + \underset{(\pm 0.08)}{0.63} \times \text{A\&P crossbite} + \underset{(\pm 0.10)}{0,72} \times$$

$$\times \text{OG scissor bite} + \underset{(\pm 0.18)}{0.22} \times \text{OG distoclusion} \pm \underset{(\pm 0.05)}{0.82}$$

$$R^2 = 0.28$$

where:
IOTN DHC = the dental health component of the IOTN,
A&P crossbite = crossbite evaluated with the Ackerman-Proffit classification,
OG scissor bite = scissor bite evaluated with classification proposed by Orlik-Grzybowska,
OG distoclusion = distoclusions evaluated with classification proposed by Orlik-Grzybowska.

The model explains almost 30% of the variation of the dental health component of the IOTN.

Discussion

Although both classifications radically differ from one another, they represent two ways to subjectively describe one problem, namely malocclusion. And as such a tool, they appear to be equally effective. As for the Ackerman-Proffit classification, occlusal anomalies were reported in 75.4% of the subjects, whereas according to Orlik-Grzybowska, this problem concerned 67% of the participants of the study. Pursuant to both classifications, distoclusions were the most frequently diagnosed type of malocclusion, which is consistent with the findings of other researchers, both Polish and international [8–10]. In the literature, however, there are differences with respect to frequency of malocclusion. For example, in the study conducted by Lisiecka [11] on Polish children, the problem of abnormal occlusion affected 2/3 of 18-year olds, while in the study conducted by Colonna-Walewska [9], malocclusions were diagnosed less frequently, that is in 56.7% of 18-year olds, and in Hungarian studies carried out in the

Table 8. Relationship between particular malocclusions and the Dental Health Component in subjects who had not received orthodontic treatment in the past (n = 141)

Malocclusion		DHC = 1 or 2	DHC = 3	DHC = 4 or 5	P
Common	crossbite	11 (7.8%)	14 (9.9%)	15 (10.6%)	p = 0.003
	Angle's Class I right	50 (35.5%)	24 (17%)	10 (7%)	p = 0.015
	Angle's Class II right	12 (8.5%)	10 (7%)	11 (7.8%)	
	Angle's Class III right	5 (3.5%)	4 (2.8%)	8 (5.7%)	
	no right molar tooth	4 (2.8%)	1 (0.7%)	2 (1.4%)	
	Angle's Class I left	51 (36.2%)	24 (17%)	13 (9.2%)	p = 0.169
	Angle's Class II left	12 (8.5%)	9 (6.4%)	11 (7.8%)	
	Angle's Class III left	4 (2.8%)	4 (2.8%)	5 (3.5%)	
	no left molar tooth	4 (2.8%)	2 (1.4%)	2 (1.4%)	
	abnormal overbite	35 (24.8%)	22 (15.6%)	22 (15.6%)	p = 0.332
	abnormal overjet	51 (36.2%)	15 (10.6%)	25 (17.7%)	p < 0.001
	anterior/lateral open bite	1 (0.7%)	5 (3.5%)	3 (2.1%)	p = 0.006
	anterior/complete deep overbite	9 (6.4%)	6 (4.3%)	9 (6.4%)	p = 0.207
O-G	canine class I right	56 (39.7%)	27 (19.1%)	14 (9.9%)	p = 0.021
	canine class II right	13 (9.2%)	10 (7.1%)	14 (9.9%)	
	canine class III right	2 (1.4%)	2 (1.4%)	3 (2.1%)	
	canine class I left	57 (40.4%)	27 (19.1%)	16 (11.3%)	p = 0.049
	canine class II left	11 (7.8%)	9 (6.4%)	13 (9.2%)	
	canine class III left	3 (2.1%)	3 (2.1%)	2 (1.4%)	
	mesiorotation	48 (34%)	34 (24%)	28 (19.9%)	p = 0.010
	distorotation	46 (32.6%)	35 (25.5%)	27 (19.1%)	p = 0.004
	mesioinclination	34 (24%)	21 (14.9%)	23 (16.3%)	p = 0.047
	distoinclination	17 (12.1%)	19 (13.5%)	16 (11.3%)	p = 0.006
	palatotrusion	20 (14.2%)	20 (14.2%)	18 (12.8%)	p = 0.006
	linguotrusion	9 (6.4%)	10 (7.1%)	12 (8.5%)	p = 0.011
	vestibulotrusion	56 (39.7%)	16 (11.3%)	15 (10.6%)	p < 0.001
	palatal position	2 (1.4%)	4 (2.8%)	8 (5.7%)	p = 0.002
	lingual position	3 (2.1%)	6 (4.3%)	7 (5%)	p = 0.017
	vestibular position	6 (4.3%)	9 (6.4%)	16 (11.3%)	p < 0.001
	lateral functional/morphological shift of the mandible	0	0	1 (0.7%)	p = 0.167
	distoclusion/retrusive occlusion	16 (11.3%)	13 (9.2%)	14 (9.9%)	p = 0.036
	mesioclusion/protrusive occlusion	4 (2.8%)	3 (2.1%)	5 (3.5%)	p = 0.205
A&P	lack of symmetry of the upper arch	3 (2.1%)	5 (3.5%)	11 (7.8%)	p < 0.001
	lack of symmetry of the lower arch	1 (0.7%)	9 (6.4%)	11 (7.8%)	p < 0.001
	spacing in the upper arch	16 (11.3%)	3 (2.1%)	6 (4.3%)	p = 0.144
	spacing in the lower arch	13 (9.2%)	3 (2.1%)	5 (3.5%)	p = 0.319
	crowding in the upper arch	37 (26.2%)	34 (24.1%)	24 (17%)	p < 0.001
	crowding in the lower arch	42 (29.8%)	34 (24.1%)	20 (14.2%)	p = 0.009

"Common" – common features found in both classifications; "O-G" – classification by Orlik-Grzybowska; "A&P" – Ackerman-Proffit classification.

Table 9. Relationship between particular malocclusions and the Dental Health Component (DHC) in subjects who had received orthodontic treatment in the past (n = 60)

Malocclusion		**DHC = 1 or 2**	**DHC = 3**	**DHC = 4 or 5**	**P**
Common	crossbite	2 (3.3%)	10 (16.7%)	3 (5%)	**p = 0.011**
	Angle's Class I right	19 (31.7%)	16 (26.7%)	2 (3.3%)	**p = 0.035**
	Angle's Class II right	6 (10%)	3 (5%)	7 (11.7%)	
	Angle's Class III right	2 (3.3%)	2 (3.3%)	1 (1.7%)	
	no right molar tooth	0	1 (1.7%)	1 (1.7%)	
	Angle's Class I left	20 (33.3%)	14 (23.3%)	3 (5%)	p = 0.187
	Angle's Class II left	4 (6.7%)	6 (10%)	5 (8.3%)	
	Angle's Class III left	2 (3.3%)	1 (1.7%)	1 (1.7%)	
	no left molar tooth	1 (1.7%)	1 (1.7%)	2 (3.3%)	
	abnormal overbite	16 (26.7%)	13 (21.7%)	10 (16.7%)	p = 0.196
	abnormal overjet	13 (21.7%)	19 (31.7%)	11 (18.3%)	**p = 0.005**
	anterior/lateral open bite	2 (3.3%)	3 (5%)	3 (5%)	p = 0.368
	anterior/complete deep overbite	2 (3.3%)	7 (11.7%)	2 (3.3%)	p = 0.096
O-G	Canine class I right	21 (35%)	18 (30%)	3 (5%)	**p = 0.016**
	Canine class II right	5 (8.3%)	3 (5%)	7 (11.7%)	
	Canine class III right	1 (1.7%)	1 (1.7%)	1 (1.7%)	
	Canine class I left	22 (36.7%)	13 (21.7%)	4 (6.7%)	p = 0.073
	Canine class II left	3 (5%)	7 (11.7%)	6 (10%)	
	Canine class III left	2 (3.3%)	2 (3.3%)	1 (1.7%)	
	mesiorotation	19 (31.7%)	16 (26.7%)	10 (16.7%)	p = 0.396
	distorotation	16 (26.7%)	21 (35%)	9 (15%)	**p = 0.011**
	mesioinclination	17 (28.3%)	18 (30%)	7 (11.7%)	p = 0.315
	distoinclination	11 (18.3%)	5 (8.3%)	6 (10%)	p = 0.170
	palatotrusion	7 (11.7%)	12 (20%)	5 (8.3%)	p = 0.116
	linguotrusion	8 (13.3%)	8 (13.3%)	4 (6.7%)	p = 0.859
	vestibulotrusion	19 (31.7%)	12 (20%)	5 (8.3%)	p = 0.293
	palatal position	0	5 (8.3%)	1 (1.7%)	**p = 0.031**
	lingual position	2 (3.3%)	3 (5%)	3 (5%)	p = 0.261
	vestibular position	4 (6.7%)	7 (11.7%)	5 (8.3%)	p = 0.121
	lateral functional/morphological shift of the mandible	1 (1.7%)	0	0	p = 0.537
	distoclusion/retrusive occlusion	8 (13.3%)	6 (10%)	7 (11.7%)	p = 0.103
	mesioclusion/protrusive occlusion	2 (3.3%)	1 (1.7%)	1 (1.7%)	p = 0.404
A&P	lack of symmetry of the upper arch	0	6 (10%)	2 (3.3%)	**p = 0.018**
	lack of symmetry of the lower arch	0	5 (8.3%)	2 (3.3%)	**p = 0.036**
	spacing in the upper arch	5 (8.3%)	1 (1.7%)	1 (1.7%)	p = 0.304
	spacing in the lower arch	0	2 (3.3%)	0	p = 0.167
	crowding in the upper arch	15 (25%)	20 (33.3%)	9 (15%)	**p = 0.016**
	crowding in the lower arch	20 (33.3%)	19 (31.7%)	10 (16.7%)	p = 0.369

"Common" – common features found in both classifications; "O-G" – classification by Orlik-Grzybowska; "A&P" – Ackerman-Proffit classification.

same age group, the prevalence of malocclusion among high school students was very high: its percentage was 70% [12].

As mentioned above, objective indicators such as the IOTN are frequently used in epidemiological studies. Their use guarantees repeatability of results, and allows researchers to compare their results to those obtained by others [13–15]. The crucial point, however, is, what is the relationship between subjective (i.e. a diagnosis determining the treatment plan) and objective evaluation (i.e. the actual need for orthodontic treatment)? The study showed that, apart from the previously-defined anomalies, there are others that affect the value of the Dental Health Component of the IOTN, covered by the classification of malocclusion proposed by Orlik-Grzybowska and the Ackerman-Proffit scheme. The factors of particular importance include: the size of overjet, which is the symptom of most common malocclusions, distoclusions, crossbite and crowding. However, the objective need for orthodontic treatment was also found in the case of open bite, dental malpositions, distoclusions or asymmetry of dental arches. The said mathematical model is an attempt to connect the diagnosis with the need for treatment. The model explains only 30% of the DHC variation and requires the use of elements from both classifications (that is by Orlik-Grzybowska and the Ackerman-Proffit scheme). It requires a verification in the future on a larger examined group if it can be useful in practice.

When discussing the results, attention should be paid to the Dental Health Component value in the context of orthodontic treatment possibly received in the past. Interestingly, the need for orthodontic treatment was reported in 18% of treated and in 22.9% of untreated 18-year-olds. This can be explained by the fact that removable orthodontic devices – used to treat mild cases – were the main treatment method. Subsequent changes related to the patient's growth or possibly lack of cooperation on his/her part, may have contributed to the treatment ineffectiveness as well. In this study, the need for treatment was observed in 21.4% of all the subjects. This percentage is higher than in Finnish studies (15% of the subjects required treatment), comparable to British (21%) and French (21%) findings and lower than results obtained by Italian researchers (27.3%) [16–19].

The result of the analysis of the relationship between the DHC and the diagnostic elements may support the hypothesis that early orthodontic treatment resulted in a reduction of the variety of indications to therapy in the future. While in the case of untreated subjects, there were many factors that determined the need for orthodontic treatment (cross bite, Angle's Class on the right side, abnormal overjet, open bite, canine class, dental malpositions, distoclusions, asymmetry of dental arches and crowding), in the case of treated subjects, such factors were considerably less numerous. The value of the DHC among 18-year-olds who had undergone orthodontic treatment was affected by: crossbite, overjet, some dental malpositions, canine class and Angle's Class on the right side, asymmetry of arches and crowding in the upper arch.

There is a need to revise the assumptions of the authors' IOTN index – it seems that this ratio may be affected by greater number of malocclusions than it was assumed (e.g. crossbite, open bite, dental malpositions, distoclusions, and asymmetry of dental arches and crowding).

The results presented herein have shown that orthodontic treatment received in the past slightly reduces the need for treatment in 18-year-olds and revealed that both orthodontic prevention and increased effectiveness of early treatment are gaining in importance. Therefore, it needs to be emphasized that interceptive orthodontic treatment as well as efficient elimination of already existing malocclusions in children may factually reduce health care spending on adult patients.

Further studies in larger groups can significantly contribute to a better planning of orthodontic treatment and may help to improve orthodontic care at the state level.

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