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ASSESSMENT OF ORTHODONTIC TREATMENT NEED AMONG SERBIAN CHILDREN AND ADULTS: APPLICATION OF THE INDEX OF ORTHODONTIC TREATMENT NEED

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Malocclusions are common oral health issues that require precise assessment of severity and the need for orthodontic treatment. The Index of Orthodontic Treatment Need (IOTN) is a reliable tool for objective evaluation of the necessity of orthodontic therapy. This study aimed to determine the need for orthodontic treatment among children and adolescents in Serbia using the IOTN index, and to compare participants' subjective perception of dental aesthetics with evaluations provided by orthodontic professionals. The prevalence of malocclusion was also recorded. The study included 211 participants aged 9 to 25 years, all military health insurance beneficiaries who had not previously undergone orthodontic treatment. Examinations were conducted by a dentist and supervised by an orthodontic specialist at the Military Medical Academy. Assessments were performed according to IOTN guidelines, incorporating both the Dental Health Component (DHC) and Aesthetic Component (AC), and data were statistically analyzed. Findings indicated that 63% of participants had a clear need for orthodontic treatment based on the DHC component, while 28% were borderline cases. According to the AC component, 32.2% of participants self-reported a need for treatment, whereas therapists indicated a slightly lower percentage (27%). The most common orthodontic irregularity was contact point displacement, while increased overjet and deep bite were most frequently in need of treatment. Children and adolescents in Serbia exhibit a high demand for orthodontic treatment. The IOTN index has proven effective for prioritizing treatment needs. The study results emphasize the importance of integrating this index into clinical practice to optimize resource allocation and improve treatment efficiency.

Keywords: orthodontic treatment, malocclusion, IOTN, treatment need assessment, orthodontic anomalies

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INTRODUCTION

Malocclusions are among the most prevalent conditions in oral health, requiring careful evaluation and appropriate treatment. In addition to functional disorders, malocclusions can lead to aesthetic concerns, diminished quality of life, and cause psychosocial consequences, particularly in children and adolescents (1,2). Given that not all patients with malocclusions require the same type or urgency of treatment, the development of standardized assessment tools has become crucial.

The Index of Orthodontic Treatment Need (IOTN) was developed by Brook and Shaw in 1989 as a system for assessing and quantifying the need for orthodontic treatment. Due to its simplicity, reliability, and objectivity, this index quickly became an internationally recognized tool (3).

IOTN consists of two main components:

1. Dental Health Component (DHC)—A clinical component that focuses on the functional and biological aspects of malocclusion. DHC classifies patients into five categories based on the severity of malocclusion, with the following scores: 1 (no treatment needed), 2 (mild anomaly, treatment not required), 3 (borderline case, treatment may or may not be necessary), 4 (treatment required), and 5 (urgent need for treatment) (4). The scores are assigned based on the most severe orthodontic irregularity and are detailed in Figure 1 (5).
2. Aesthetic Component (AC)—This component of the IOTN index assesses the aesthetic aspect of malocclusion. It is based on a series of standardized photographs representing different degrees of dental irregularities, ranked from 1 (almost ideal appearance) to 10 (advanced esthetic disharmony) (Figure 2). Patients who did not match any of the images remained unclassified (score 0) (6). This visual representation facilitates communication between patients and orthodontists in decision-making regarding treatment initiation or prioritization, as it provides insights not only into the functional but also the aesthetic significance of orthodontic therapy (7).

A modification of the index was proposed in 1993, reducing the DHC scale from five to three categories (scores 1-2: no treatment needed; score 3: borderline; scores 4-5: treatment required). Similarly, the AC component was reduced from ten to three categories (scores 1-4: no treatment needed; scores 5-7: moderate treatment needed; scores 8-10: treatment required). This simplification aimed at improving the identification of individuals requiring orthodontic therapy (8).

The IOTN index is internationally recognized and is most commonly used in epidemiological studies. It not only assesses the need for treatment but also determines treatment priorities, which is particularly important in healthcare systems with limited resources. The DHC component provides objective clinical data, while the AC component incorporates subjective aspects and patient perception, ensuring a holistic approach. However, its aesthetic component remains subjective and may lead to variability in assessment, especially among less experienced evaluators. Another limitation is the extensive training required for clinicians to become proficient in using the index (4).

Studies conducted in different countries have demonstrated a wide range of malocclusion prevalence and treatment needs based on the IOTN index. In Serbia, a study conducted in Niš on a sample of 190 participants aged 11–14 years found that 27.4% of participants had a high need for treatment according to the DHC component, whereas only 15.3% of children rated their need for treatment as urgent based on the AC component (9).

In Bosnia and Herzegovina, a study on a sample of 295 students aged 12–14 years revealed a high treatment need according to the DHC component (53.6%) but a low need based on the AC component (3.7%) (10). A study conducted in Belgrade found that, according to the AC component, only 0.63% of participants subjectively perceived a need for treatment, while the therapist's evaluation indicated a significantly higher percentage—7.59% (7).

Studies in other countries have yielded varying results. A study in southern Italy, on a sample of 703 children aged 12 years, reported that 27.3% of children had an urgent need for treatment according to the DHC component (11). In Sweden, the percentage of children requiring treatment was 32.4%, while in the United Kingdom, this number was slightly higher—39.5% (4). Differences in results across populations can be attributed to various socio-demographic and cultural factors, as well as different approaches to malocclusion assessment. These studies highlight the importance of interpreting IOTN results in local contexts and emphasize the need for research combining both objective and subjective evaluation methods.

The aim of this study was to assess the prevalence and severity of malocclusion among children and adolescents in Serbia using the IOTN index. Particular attention was given to comparing the DHC and AC components and too evaluating the subjective patients' and clinicians' subjective perception of treatment needs.

	Overjet	Reverse overbite	Crossbite	Contact point displacement	Open bite	Overbite	Angle class (molars)	Hypodontia	Eruption disturbance	Craniofacial abnormalities	Ankylosis/ retained primary teeth
1				1 mm							
2	3.5 - 6 mm, competent lips	0-1 mm	< 1 mm	1 - 2 mm	1 - 2 mm	< 3.5 mm increased overbite without gingival contact	Class II or III without any dysfunction				
3	3.5 - 6 mm, incompetent lips	1 - 3.5 mm	1 – 2 mm	2 - 4 mm	2 – 4 mm	> 3.5 mm increased overbite without gingival contact					
4	6 - 9 mm	> 3.5 mm no speech and masticatory dysfunction, 1 – 3 mm with dysfunction	> 2 mm crossbite	> 4 mm	> 4 mm	Increased overbite with gingival or palatal contact		Orthodontic treatment indicated for space closure or space gaining	Partially erupted, tilted, or impacted tooth, hyperdontia		
5	> 9 mm	> 3.5 mm with speech and masticatory dysfunction						Hypodontia of at least 1 tooth per quadrant, prosthetic treatment required	Impacted tooth	Definitive treatment required	Definitive treatment required

Figure 1. *Criteria table for the IOTN index, adapted from the Orthodontic Handbook by Stjepan Spalj.*

Figure 2. *Photographs illustrating the AC component of the IOTN index: Scores 1-4— treatment needed, 5-7— moderate treatment need, and 8-10—treatment required.*

METHODS

This study examined the need for orthodontic treatment in patients with mixed and permanent dentition using the Index of Orthodontic Treatment Need (IOTN). The sample consisted of 211 participants aged 9 to 25 years, including 112 females and 99 males. Participants were selected at the Department of Orthodontics, Military Medical Academy, between January 2017 and January 2018. All participants were beneficiaries of military health insurance from various cities across Serbia. None had previously undergone orthodontic treatment. Patients with cognitive impairments or chronic diseases were excluded from the study.

The clinical examinations were conducted in the morning under natural daylight at the Department of Orthodontics. Each participant was examined for 15 minutes by a dentist undergoing an academic specialization in Orthodontics, under the supervision of an orthodontic specialist. The examination followed the World Health Organization (WHO) guidelines and was performed using sterile gloves, a dental mirror, a millimeter ruler, and a photographic reference of the AC component of the index.

Participants' personal data were collected directly from them. The DHC score was determined first by the examiner, followed by the AC score. Subsequently, participants were shown the AC component photograph

depicting ten different degrees of dental aesthetics and asked to identify which image best represented their perception of their own dentition.

The following parameters were assessed in the study: molar relationship, overjet and overbite dimensions, presence of anterior crossbite, tooth position discrepancies, including misalignment, rotations, and dislocations, presence of open bite and crossbite, anomalies in tooth number such as hypodontia and hyperdontia, difficulties in tooth eruption, and the presence of craniofacial anomalies.

The collected data were statistically analyzed, including descriptive statistical parameters such as mean values and 95% confidence intervals for both the DHC and AC components of the IOTN index.

RESULTS

A total of 211 participants, aged 9 to 25 years, were included in the study, with 53.1% female and 46.9% male participants. The average age of the participants was 9 years, accounting for slightly more than a quarter of the total sample.

According to the DHC component of the IOTN index, 63% of participants (60.7% female and 65.7% male) demonstrated a clear need for orthodontic treatment, while 28% fell into the borderline category (26.8% female and 29.3% male) (Table 1).

Based on therapists' assessments, the AC component indicated that 27% of participants (25.9% female and 28.3% male) had an urgent need for treatment. However, according to participants' self-perception, this percentage was slightly higher, reaching 32.2% (30.4% female and 34.3% male), suggesting a stricter self-assessment of the aesthetic need for treatment (Tables 2 and 3).

Figure 3 illustrates the relationship between therapists' and participants' AC component scores, showing general agreement between the two assessments, except for scores 8-10, where participants tended to rate their aesthetic need for treatment more strictly.

The DHC component was found to be stricter than the AC component, according to both therapists' and participants' evaluations, with a significantly higher number of patients requiring treatment based on the DHC component (Figures 4 and 5).

The types and prevalence of malocclusions, as well as the need for treatment across the sample, are presented in Figure 6. Analysis of horizontal overjet indicated that treatment was necessary in 18.4% of cases, while anterior crossbite required treatment in 2.3% of cases.

Displacement of contact points was the most common anomaly, observed in 34.1% of participants, though only 4.3% required treatment. Examination of anterior and posterior open bite revealed that treatment was necessary for 2.8% of participants, while crossbite was diagnosed in 11.8% of participants, of whom 10% required treatment.

For vertical overbite anomalies, 10.9% of participants required treatment. Participants with missing or supernumerary teeth, craniofacial anomalies, delayed eruption, impacted teeth, or partially erupted teeth required orthodontic treatment in all cases.

Table 1. *Distribution of subjects by DHC* component of IOTN** index*

DHC		1	2	3	4	5	Σ
Full sample	n	1	18	59	108	25	211
	%	0.5	8.5	28.0	51.2	11.8	100.0
	Confidence interval	0.0-1.4%	4.8-12.3%	21.9-34.0%	44.4-57.9%	7.5-16.2%	
Female	n	0	14	30	53	15	112
	%	0.0	12.5	26.8	47.3	13.4	100.0
	Confidence interval	0.0-0.0%	6.4-18.6%	18.6-35.0%	38.1-56.6%	7.1-19.7%	
Male	n	1	4	29	55	10	99
	%	1.0	4.0	29.3	55.6	10.1	100.0
	Confidence interval	0.0-3.0%	0.2-7.9%	20.3-38.3%	45.8-65.3%	4.2-16.0%	

*DHC – Dental Health Component **IOTN -Index of Orthodontic Treatment Need

Table 2. *Distribution of subjects by AC* component of IOTN** index, graded by therapist*

AC (T)		0	1-2	3-4	5-7	8-10	Σ
Full sample	n	13	25	44	72	57	211
	%	6.2	11.8	20.9	34.1	27.0	100.0
	Confidence interval	2.9-9.4%	7.5-16.2%	15.4-26.3%	27.7-40.5%	21.0-33.0%	
Female	n	7	16	23	37	29	112
	%	6.3	14.3	20.5	33.0	25.9	100.0
	Confidence interval	1.8-10.7%	7.8-20.8%	13.1-28.0%	24.3-41.7%	17.8-34.0%	
Male	n	6	9	21	35	28	99
	%	6.1	9.1	21.2	35.4	28.3	100.0
	Confidence interval	1.4-10.8%	3.4-14.8%	13.2-29.3%	25.9-44.8%	19.4-37.2%	

*AC – Aesthetic Component **IOTN – Index of Orthodontic Treatment Need

Table 3. *Distribution of subjects by DHC * component of IOTN** index , graded by subjects*

AC (S)		0	1-2	3-4	5-7	8-10	Σ
Full sample	n	15	19	42	67	68	211
	%	7.1	9.0	19.9	31.8	32.2	100.0
	Confidence interval	3.6-10.6%	5.1-12.9%	14.5-25.3%	25.5-38.0%	25.9-38.5%	
Female	n	7	11	22	38	34	112
	%	6.3	9.8	19.6	33.9	30.4	100.0
	Confidence interval	1.8-10.7%	4.3-15.3%	12.3-27.0%	25.2-42.7%	21.8-38.9%	
Male	n	8	8	20	29	34	99
	%	8.1	8.1	20.2	29.3	34.3	100.0
	Confidence interval	2.7-13.4%	2.7-13.4%	12.3-28.1%	20.3-38.3%	25.0-43.7%	

*AC – Aesthetic Component **IOTN – Index of Orthodontic Treatment Need

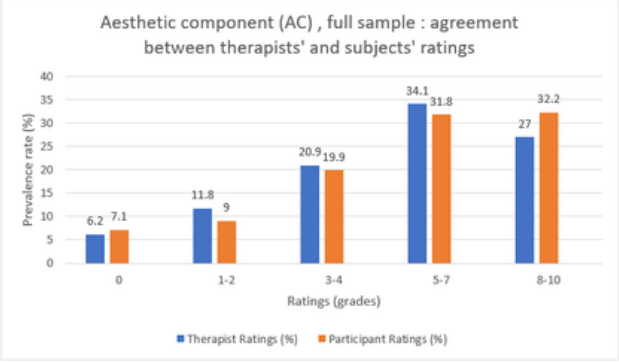

Figure 3. *Agreement between therapists' and subjects' AC ratings, for full sample.*

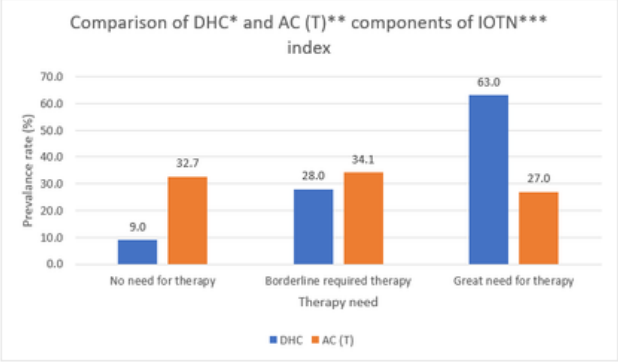

Figure 4. *Comparison between Dental Health Component* grades (No need for therapy—1-2, borderline required therapy—3, great need for therapy— 4-5) and Aesthetic Component grades by therapist** of Index of Orthodontic Treatment Need*** (No need for therapy—1-4, borderline required therapy— 5-7, great need for therapy— 8-10).*

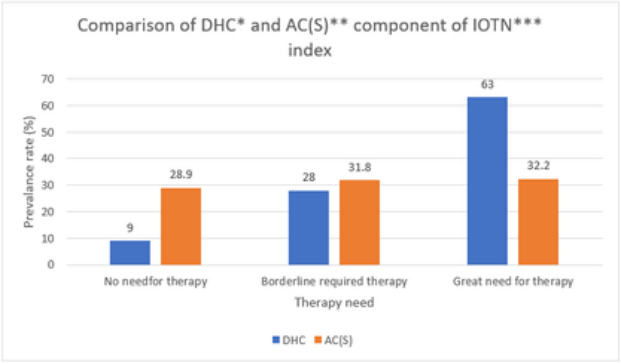

Figure 5. *Comparison of Dental Health Component* grades (No need for therapy— 1-2, borderline required therapy— 3, great need for therapy—4-5) and Aesthetic Component grades by subjects** of Index of Orthodontic Need***(No need for therapy — 1-4, borderline required therapy—5-7, great need for therapy — 8-10).*

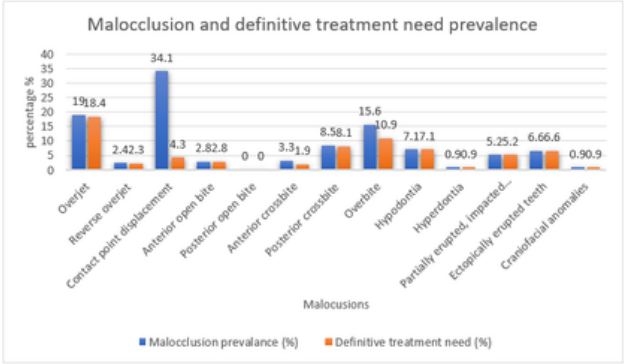

Figure 6. *Analysis of malocclusion prevalence within the sample and the proportion of subjects with a definitive treatment need.*

DISCUSSION

The evaluation of the need for orthodontic treatment is a key step in planning and providing dental services, particularly in settings with limited resources (3). The results of this study, indicating that 63% of participants required orthodontic treatment based on the DHC component of the IOTN index, provide significant insight into the prevalence of malocclusions in the Serbian population. These findings differ substantially from a 2005 study conducted in Serbia, where the need for orthodontic therapy was identified in only 27.4% of participants (9). This percentage is higher compared to similar studies conducted in Italy (24.4%), France (21.3%), and the United Kingdom (35%) (11-13). These differences may be attributed to the broader age range (9–25 years) included in this study, whereas most previous studies focused on younger age groups.

Similar research highlights the relationship between the defined need for orthodontic treatment and its actual application in various European countries. A study conducted in Perugia, Italy, found that 27.55% of patients had a DHC score of 4 or 5, which is considerably lower than the 63% recorded in this study in Serbia. However, 72% of patients who received orthodontic treatment did not belong to this priority group, suggesting a need for better resource allocation toward patients with higher health risks (14). In contrast, in the United Kingdom, 35% of participants were identified as needing treatment, but it was actually administered to only 8% of them (13).

Recent studies further support the importance of using the IOTN index in assessing orthodontic treatment needs. Al-Hummayani and Taibah (2018) found that 24.3% of young adults in Saudi Arabia had a severe or extreme need for treatment, with the most common malocclusions being crowding (48.8%) and increased overjet (21.8%) (15). Similarly, Bhagyalakshmi et al. examined the perception of aesthetic need for orthodontic treatment and recorded a high level of agreement between children, parents, and orthodontists, underscoring the significance of subjective factors in treatment decision-making (16). Additionally, Kadu et al. observed in a study of schoolchildren in southwestern Maharashtra that most participants had aesthetic scores indicating a need for treatment (17). These results further support the role of the IOTN index as a standardized tool for assessing orthodontic needs across different demographic groups (16).

In the present study, the most frequently recorded malocclusion was contact point displacement (34.1%), likely due to lack of space, which can be explained by jaw-to-tooth size discrepancies, early loss of primary teeth, migration of first permanent molars, and their rotation (18). Increased overjet (18.4%) and increased overbite (10.9%) were also identified as common issues, which may lead to serious health consequences, highlighting the importance of early intervention during the mixed dentition phase, when treatment is most effective and least complex (19).

A crucial aspect of this study is the discrepancy between treatment need assessment based on the DHC and AC components of the IOTN index. While 63% of participants required treatment based on the DHC component, the AC component results varied: 27% according to therapists and 32.2% to participants' self-assessments. These findings suggest that more patients may require orthodontic treat-

ment than indicated by either their own or their therapist's subjective assessment. The discrepancies in the AC component highlight subjective factors in the perception of dental aesthetics, as patients are often more critical of their own appearance (20). Similar findings have been reported in Bosnia and Herzegovina, where there was significant agreement between children and dentists regarding the need for orthodontic treatment based on the AC component of the IOTN index; however, children were frequently more critical of their own appearance (10).

The results emphasize the importance of using both components of the IOTN index in clinical decision-making, especially in borderline cases with a DHC score of 3, where the aesthetic component plays a crucial role (21). All participants with an AC score ≥ 5 should be considered for treatment, further confirming the importance of a combined assessment (4).

This study provides valuable insights into the prevalence and nature of malocclusions among young individuals in Serbia. However, further research is needed to evaluate the functional, psychosocial, and subjective factors that may influence the need for orthodontic treatment. The integration of the IOTN index into routine orthodontic practice could enhance diagnostic objectivity and facilitate optimal resource allocation, particularly in healthcare systems with limited access to these services (22,23).

The results of this study confirm that the IOTN index is a reliable tool for assessing the need for orthodontic treatment. According to the DHC component, treatment was required for 63% of participants, whereas the AC component showed variability in assessments (27% according to therapists and 32.2% according to participants), highlighting differences in subjective perception.

The most common malocclusions were contact point displacement (34.1%), increased overjet (18.4%), and increased overbite (10.9%). These findings emphasize the importance of a combined evaluation of DHC and AC components in treatment decision-making.

The application of the IOTN index in daily orthodontic practice could improve diagnostic objectivity and allow for more efficient resource allocation in orthodontic treatment.

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Author's contribution

Conceptualization, methodology, & investigation: A.C., I.J., A.A., R.M., and T.Č.; Writing – original draft, review, & editing: A.C., I.J., A.A., R.M., and T.Č.; All authors have read and approved the published version of the manuscript.

Statement of Ethics

Ethical approval was not required for this study, as it did not involve biomedical interventions, experiments on humans or animals, or clinical trials.

Statement of Competing Interest

The authors declare no relevant conflicts of interest.

Statement of Data Availability

Not applicable.

Statement of Generative AI Use

No generative AI was used.

Conflicts of interest

The authors declare no conflict of interest.

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