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ORIGINAL SCIENTIFIC PAPER
*IZVORNI ZNANSTVENI RAD*

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# Assessment of Relationship between Intelligence Quotient and Orthodontic Treatment Need

# *Procjena odnosa između kvocijenta inteligencije i potrebe za ortodontskom terapijom*

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**Abstract**

**Objective:** Low cognitive ability may reduce the ability to understand the importance of oral health and to perform the necessary practices to maintain proper oral hygiene. Early loss of primary teeth following high caries risk may lead to malocclusion of permanent dentition. This study aimed to evaluate the relationship between the cognitive levels of adolescents and their orthodontic treatment needs. **Material and Methods:** Between January 2018 and May 2018, 200 adolescents aged 10 – 15 who applied to the Pediatric Dentistry Clinic of Marmara University and sought orthodontic treatment were invited to participate in the study. The orthodontic treatment needs of 150 adolescents who agreed to participate were evaluated with the Index of Orthodontic Treatment Need - Aesthetic Component and their cognitive levels were evaluated with the Raven Standard Progressive Matrices (SPM) Test. P-value < 0.05 was considered statistically significant. **Results:** The mean age (± standard deviation) of 126 adolescents (77 females and 49 males) who completed the SPM test was 11.8 (± 1.3). There was no consistency between the intellectual level and the need for orthodontic treatment (Kappa value = 0.071, p-value = 0.081). There was no correlation between malocclusion severity and intelligence quotient scores of adolescents (ρ [rho] = -0.089, p = 0.322). According to Multiple logistic regression results, there was no difference between 'borderline need' (p = 0.059) and 'great need' (p = 0.881) from 'no need' for orthodontic treatment in adolescents with different intelligence quotients. **Conclusions:** The results showed no evidence for an association between malocclusion and intelligence quotient.

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## Introduction

People have a combination of different personality traits, one of which is the individual intelligence known as the Intelligence Quotient (IQ). Deviations in the individual intelligence profile affect intellectual development, behavioral skills, and cognitive skills (1). Low cognitive ability may weaken the ability to understand the importance of oral health and the need to perform proper oral hygiene, such as nutrition and brushing habits, especially at young age (1-2). In 2014, it has been shown that the prevalence of caries is higher in children with borderline cognitive intelligence (3). Caries and subsequent early loss of primary teeth may cause malocclusion in the permanent dentition. Studies have shown that mentally retarded individuals with low IQ (70

## Uvod

Ljudi imaju kombinaciju različitih osobina, a jedna od njih je individualna inteligencija poznata kao kvocijent inteligencije (IQ). Odstupanja u individualnom profilu inteligencije utječu na intelektualni razvoj te biheviorale i kognitivne vještine (1). Osobito u mladoj dobi, niske kognitivne sposobnosti mogu oslabiti sposobnost razumijevanja važnosti oralnoga zdravlja i potrebe za provođenjem pravilne oralne higijene, kao što su prehrana i navike četkanja zuba (1–2). U 2014. pokazalo se da je prevalencija karijesa veća kod djece s graničnom kognitivnom inteligencijom (3). Karijes i kasniji rani gubitak mliječnih zuba mogu prouzročiti nepravilnu okluziju u trajnoj denticiji. Istraživanja su pokazala da mentalno retardirane osobe s niskim kvocijentom inteligen-

scores or less) have poor oral health, larger numbers of untreated malocclusions, and an increased need for treatment (2-5). Moreover, it has been suggested that deviations in dentofacial appearances, such as incisors crowding and median diastemas, have a profound negative impact on perceived intelligence by other individuals (6).

Spearman's two-factor theory of intelligence consists of two factors: factor g and factor s. The factor g represents general intelligence, while the factor s represents specific ability (7). Raven Standard Progressive Matrices Test (SPM) is a test that can be administered individually or on a group, assessing nonverbal reasoning ability and general intelligence (Spearman's g factor) (8-9).

SPM offers several advantages. It has a short application and is not affected by individual's socio-economic status, language, or literacy status. It also minimizes cultural bias. Moreover, the test evaluates the ability to think clearly and make sense out of events (9-10).

The Index of Orthodontic Treatment Need (IOTN) objectively evaluates patients with malocclusion who need treatment most in terms of dental health and perceived aesthetic impairment (11). The scores of the components are not combined, the two components (aesthetic component and dental health component) are evaluated separately, and it is determined whether the patient needs orthodontic treatment. It has been reported that the need for orthodontic treatment is between 7.9% and 10.9% in different countries according to the aesthetic component (AC) index (12).

This study aimed to investigate the relationship between the cognitive levels of adolescents and their orthodontic treatment needs. The null hypothesis of this study was that there is no difference in the need for orthodontic treatment in adolescents with different cognitive levels.

## Materials and methods

### Ethical approval and study population

The participants in this cross-sectional study were adolescents (females or males) aged 10 to 15 who applied to the Pediatric Dentistry Clinic, Faculty of Dentistry, at XX University between January 2018 and May 2018. The exclusion criteria were as follows: children with orthodontic treatment, children with a history of dental and/or craniofacial trauma, children with cleft lip and palate and craniofacial anomalies and children with systemic disease. 200 adolescents seeking orthodontic treatment were invited to participate in the study taking account of attrition. The study was conducted in accordance with the principles of medical research involving human subjects stated in the Declaration of Helsinki. The study protocol was assessed and approved by the XX University School of Dentistry Clinical Research Ethics Committee with approval number XX.

### Assessment of the need for orthodontic treatment

One well-trained pediatric dentist with four years of clinical experience and an orthodontist with thirteen years of clinical experience evaluated participants according to the IOTN-AC index. The AC index consists of a 10-image scale (Figure 1) to evaluate malocclusion, and grade 1 represents

cije (70 bodova ili manje) imaju loše oralno zdravlje, više malokluzija i češće im je potrebno liječenje (2 – 5). Štoviše, sugerirano je da odstupanja u dentofacijalnom izgledu, kao što su zbijenost sjekutića i središnja dijastema, negativno utječu na percipiranu inteligenciju drugih pojedinaca (6).

Spearmanova dvofaktorska teorija inteligencije sastoji se od dvaju faktora – faktora **g** i faktora **s**. Faktor **g** označava općuinteligenciju, a faktor **s** specifičnu sposobnost (7). Ravenov test standardne progresivne matrice (SPM) test je koji se može provoditi pojedinačno ili u grupi, a njime se procjenjuje sposobnost neverbalnog zaključivanja i opća inteligencija (Spearmanov **g**-faktor) (8 – 9).

SPM ima nekoliko prednosti. Kratak je i na njega ne utječe socijalno-ekonomski status, jezik ili pismenost pojedinca. Također minimizira kulturnu pristranost. Štoviše, testom se ocjenjuje sposobnost jasnog razmišljanja i izvlačenja smisla iz događaja (9 – 10).

Indeks potrebe za ortodontskom terapijom (IOTN) objektivno ocjenjuje pacijente s malokluzijom kojima je liječenje najpotrebnije zbog zdravlja zuba i percipiranoga estetskog oštećenja (11). Bodovi komponenti se ne zbrajaju, dvije komponente (estetska komponenta i komponenta dentalnoga zdravlja) ocjenjuju se odvojeno te se utvrđuje treba li pacijentu ortodontska terapija. Zabilježeno je da je potreba za ortodontskom terapijom između 7,9 i 10,9 % u različitim zemljama prema indeksu estetske komponente (AC) (12).

Cilj ovog istraživanja bio je istražiti odnos između kognitivnih razina adolescenata i njihovih potreba za ortodontskom terapijom. Nulta hipoteza glasila je da nema razlike u potrebi za ortodontskom terapijom kod adolescenata različitim kognitivnim razinama.

## Materijali i metode

### Etičko odobrenje i proučavanje populacije

Sudionici ovoga presječnog istraživanja bili su adolescenti u dobi od 10 do 15 godina koji su se prijavili u Kliniku za dječju stomatologiju Stomatološkog fakulteta Sveučilišta XX. između siječnja 2018. i svibnja 2018. Kriteriji za isključenje bili su sljedeći: djeca u ortodontskoj terapiji; djeca s poviješću dentalne i/ili kraniofacijalne traume; djeca s rascjepom usne i nepca i kraniofacijalnim anomalijama te djeca sa sistemskim bolestima. Uzimajući u obzir odustajanje, u istraživanje je pozvano 200 djece koja su tražila ortodontsku terapiju. Istraživanje je provedeno u skladu s načelima medicinskih istraživanja koja uključuju ljude, a koja su navedena u Helsinškoj deklaraciji. Protokol istraživanja ocijenilo je i odobrilo Etičko povjerenstvo za klinička istraživanja Stomatološkog fakulteta Sveučilišta XX – broj odobrenja XX.

### Procjena potrebe za ortodontskom terapijom

Jedan dobro educirani dječji stomatolog s četiri godine kliničkog iskustva i ortodont s trinaest godina kliničkog iskustva ocjenjivali su sudionike prema IOTN-AC indeksu. Indeks AC sastoji se od ljestvice s 10 slika (slika 1.) za ocjenu malokluzije – tako se ocjena 1 daje za najbolju dentalnu este-

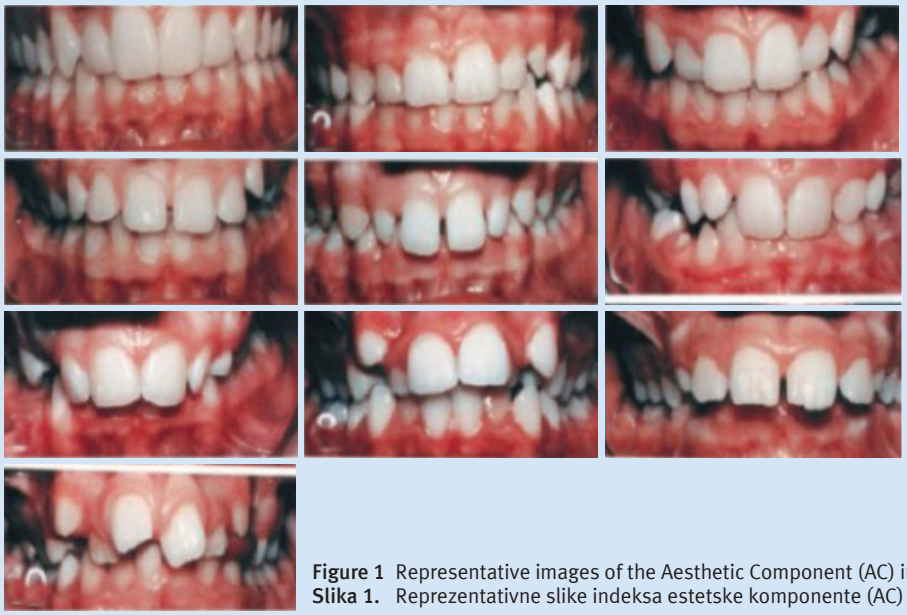

**Figure 1** Representative images of the Aesthetic Component (AC) index (12-14)
**Slika 1.** Reprezentativne slike indeksa estetske komponente (AC) (12 – 14)

the best dental aesthetics, while grade 10 represents the worst dental aesthetics (12-14). Aesthetic component grading is divided into three main groups according to treatment needs: Grades 1 – 4: no need for orthodontic treatment; grades 5 – 7: the borderline need for orthodontic treatment; and grades 8 – 10: great need for orthodontic treatment (15).

### Assessment of the intelligence quotient

The cognitive abilities of adolescents were evaluated with the SPM Test. It contains 5 sets (A, B, C, D, E) of 12 items each, 60 items in total. These items are geometric analogy problems that contain a set of geometric shapes, each item missing an input. Participants choose the correct answer from eight alternatives. The first missing item in the first set is obvious. The following items get complicated. Sets and items must be given to all participants in the same order. The obtained raw SPM scores were converted to percentiles to measure performance compared to norms (7). Percentiles were divided into six groups according to the Current Wechsler classification: intellectually superior: 95% and above; definitely above the average in intellectual capacity: 95% – 75%; intellectually average: 75% – 25%; definitely below the average in intellectual capacity: 25% – 5%; intellectually impaired: 5% and below (9).

### Sample size calculation

Since there has been no previous study evaluating the relationship between intellectual profile and malocclusion level, a pilot study evaluating 45 participants was conducted to calculate the sample size. The sample size calculation applied with the G*power Version 3.1.9.6 program was based on the pilot study, with 95 confidence (1-α), 85% test power (1-β), d=0.318 effect size, and 37 samples to be taken in each group of the need for orthodontic treatment (no need, the borderline need, great need). The total number of samples was determined as 111. After the research protocol had been explained to the children and their parents or caregivers, informed consent documents were read. Children and their

tiku, a ocjena 10 za najlošiju (12 – 14). Ocjenjivanje estetske komponente podijeljeno je u tri glavne skupine prema potrebi za liječenjem: ocjene od 1 do 4: nema potrebe za ortodontskom terapijom; stupnjevi od 5 do 7: granična potreba za ortodontskom terapijom i razredi od 8 do 10: velika potreba za ortodontskom terapijom (15).

### Procjena kvocijenta inteligencije

Kognitivne sposobnosti adolescenata procijenjene su SPM testom. Sadržava 5 setova (A, B, C, D, E) od po 12 predmeta, ukupno 60 predmeta. To su problemi geometrijske analogije koji sadržavaju skup geometrijskih oblika, pri čemu svakoj stavki nedostaje komponenta. Sudionici biraju točan odgovor između osam mogućnosti. Prva stavka koja nedostaje u prvom setu je očita. Sljedeće postaju složenije. Kompleti i predmeti moraju biti dodijeljeni svim sudionicima istim redoslijedom. Dobiveni neobrađeni SPM rezultati pretvoreni su u percentile za mjerenje učinka u usporedbi s normama (7). Percentili su podijeljeni u šest skupina prema Current-Wechslerovoj klasifikaciji: intelektualno superiorni: 95 % i više; definitivno iznad prosjeka u intelektualnom kapacitetu: 95 do 75 %; intelektualni prosjek: 75 do 25 %; definitivno ispod prosjeka u intelektualnom kapacitetu: 25 do 5 %; intelektualno oštećeni: 5 % i manje (9).

### Izračun veličine uzorka

Budući da dosad nije bilo istraživanja u kojima autori procjenjuju odnos između intelektualnog profila i razine malokluzije, provedeno je pilot-istraživanje u kojemu se procjenjivalo 45 sudionika kako bi se izračunala veličina uzorka. Izračun veličine uzorka primijenjen s programom G*power Verzija 3.1.9.6 temeljio se na pilot-istraživanju s 95 pouzdanosti (1-α), 85 % snage testa (1-β), d = 0,318 veličine učinka i 37 uzoraka u svakoj skupini, ovisno o tome je li potrebna ortodontska terapija (nema potrebe, granična potreba, velika potreba). Utvrđeno je da je ukupan broj uzoraka 111. Nakon što je protokol istraživanja objašnjen djeci i njihovim roditeljima ili skrbnicima, pročitani su dokumenti o informiranom

parents who agreed to participate were included in the study. 150 adolescents (77 females, 49 males) agreed to participate in the study. Of these adolescents, 24 children were excluded from the study because they did not complete all the items.

### Statistical analyses

Intra- and inter-examiner reliability was assessed with the Cohen's Kappa test. The Kappa values were interpreted according to the categories suggested by Landis and Koch (16). Descriptive statistic parameters were presented as frequency, percentage (%), mean ± standard deviation (mean ± SD), and median (minimum – maximum). The Kolmogorov-Smirnov test was used to determine whether continuous variables were normally distributed; the Independent Sample t-test and Mann-Whitney U test were used to compare two independent groups according to their normality. The Kappa consistency test and multiple logistic regression analysis were used to assess the relationship between categorical variables. The relationship between the intelligence quotient scores and the severity of malocclusion was examined using Spearman's correlation coefficient. Statistical analysis was performed using the SPSS Version 26.0 (IBM Corporation, Chicago, Illinois, United States of America) software, and a p-value < 0.05 was considered statistically significant.

## Results

The mean age (± SD) of 126 adolescents, 77 females (11.9 ± 1.4) and 49 males (11.6 ± 1.2), who completed the SPM test was 11.8 (± 1.3). The intra-examiner Kappa values were 0.896 and 0.904 for two examiners (almost perfect), and the inter-examiner Kappa value was 0.896 (almost perfect). The participants' median AC index (min – max) was 5 (1 – 10). There was no significant difference between females and males in terms of the severity of the malocclusion (p = 0.910) and the need for orthodontic treatment (p = 0.609).

There was no statistically significant difference in the number of correct answers to the intelligence test between females (37.2 ± 8.6) and males (36.8 ± 7.7) (p = 0.841). Raw SPM scores were transformed to percentiles for comparison with norms (Table 1), and there was also no significant difference in intelligence profiles in females and males (p = 0.778).

According to the Current Wechsler classification, 81.7% (n = 103) of participants were intellectually average and

pristanku. U istraživanje su uključena djeca koja su, uz pristanak roditelja, i sama pristala sudjelovati. Ukupno njih 150 (77 djevojčica i 49 dječaka) pristalo je sudjelovati u istraživanju. Od te djece 24 je isključeno jer nisu ispunili sve stavke.

### Statistička analiza

Pouzdanost unutar ispitivača i između njih procijenjena je Cohenovim Kappa testom. Kappa vrijednosti interpretirane su prema kategorijama koje su predložili Landis i Koch (16). Deskriptivni statistički parametri prikazani su kao učestalost, postotak (%), srednja vrijednost ± standardna devijacija (srednja vrijednost ± SD) i medijan (minimum – maksimum). Kolmogorov-Smirnovljev test korišten je da se utvrdi jesu li kontinuirane varijable normalno raspodijeljene; t-test neovisnog uzorka i Mann-Whitneyjev U test korišteni su za usporedbu dviju neovisnih skupina prema njihovoj normalnosti. Kappa testom konzistencije i višestrukom logističkom regresijom procijenjeni su odnosi između kategoričkih varijabli. Odnos između rezultata kvocijenta inteligencije i težine malokluzije ispitan je s pomoću Spearmanova koeficijenta korelacije. Statistička analiza provedena je u softveru SPSS Version 26.0 (IBM Corporation, Chicago, Illinois, Sjedinjene Američke Države), a p-vrijednost < 0,05 smatrala se statistički značajnom.

## Rezultati

Prosječna dob (± SD) 126 adolescenata – 77 djevojčica (11,9 ± 1,4) i 49 dječaka (11,6 ± 1,2) koji su podvrgnuti SPM testu bila je 11,8 (± 1,3). Kappa vrijednosti unutar ispitivača bile su 0,896 i 0,904 za dva ispitivača (gotovo savršene), a među ispitivačima iznosile su 0,896 (gotovo savršene). Medijan AC indeksa (min. – maks.) sudionika bio je 5 (1 – 10). Nije bilo značajne razlike između djevojčica i dječaka u težini malokluzije (p = 0,910) i potrebe za ortodontskom terapijom (p = 0,609).

Nije bilo statistički značajne razlike u broju točnih odgovora na testu inteligencije između djevojčica (37,2 ± 8,6) i dječaka (36,8 ± 7,7) (p = 0,841). Neobrađeni SPM rezultati transformirani su u percentile za usporedbu s normama (tablica 1.), a također nije bilo značajne razlike u profilima inteligencije kod djevojčica i dječaka (p = 0,778).

Prema Current-Wechslerovoj klasifikaciji 81,7 % (n = 103) sudionika bilo je prosječnih intelektualnih kapaciteta, a

**Table 1** The intelligence quotient scores by gender and need for orthodontic treatment
**Tablica 1.** Kvocijent inteligencije boduje se prema spolu i potrebi za ortodontskom terpijom

| | **Intelligence quotient scores Mean ± SD Rezultati kvocijenta inteligencije Srednja vrijednost ± SD** |
|---|---|
| Total • Ukupno | 61.7 ± 13.7 |
| Sex • Spol | |
| Female • Ženski | 62.0 ± 14.4 |
| Male • Muški | 61.3 ±12.9 |
| Aesthetic Component Index • Indeks estetske komponente | |
| No need • Nema potrebe | 63.1 ± 14.4 |
| Borderline need • Granična potreba | 57.5 ± 14.2 |
| Great need • Velika potreba | 64.5 ± 10.9 |
| SD: standard deviation • standardna devijacija | |

**Table 2** The relationship between the intellectual level and the need for orthodontic treatment
**Tablica 2.** Odnos intelektualne razine i potrebe za ortodontskom terapijom

| | Intellectually average • Intelektualno prosječan | Above the average in intellectual capacity • Intelektualni kapacitet iznad prosjeka | Total • Ukupno | |
|---|---|---|---|---|
| No need • Nema potrebe n (%) | 47 (45.63%) | 13 (56.52%) | 60 (47.62%) | Kappa value • Kappa vrijednost = 0.071 |
| Borderline need • Granična potreba n (%) | 29 (28.16%) | 4 (17.39%) | 33 (26.19%) | |
| Great need • Velika potreba n (%) | 27 (26.21%) | 6 (26.09%) | 33 (26.19%) | p-value • p-vrijednost = 0.081 |
| Total • Ukupno n (%) | 103 (100) | 23 (100) | 126 (100) | |

n: number • broj

**Table 3** Multiple logistic regression based on the need for orthodontic treatment and intelligence quotient scores
**Tablica 3.** Višestruka logistička regresija temeljena na potrebi za ortodontskom terapijom i rezultatima kvocijenta inteligencije

| | Odds ratio • Omjer izgleda | 95% confidence interval • 95 % interval pouzdanosti | p-value • p-vrijednost |
|---|---|---|---|
| No need • Nema potrebe | Reference • Referencija | | |
| Borderline need • Granična potreba | 0.970 | 0.940 – 1.001 | 0.059 |
| Great need • Velika potreba | 1.002 | 0.971 – 1.035 | 0.881 |

18.3% (n = 23) above the average in intellectual capacity. There was no statistical difference between these groups in terms of the severity of the malocclusion (p = 0.590). When the Kappa test was applied between the intellectual level and the need for orthodontic treatment, no consistency was detected (Table 2).

No correlation was observed between the severity of malocclusion and the intelligence quotient scores of the adolescents (ρ [rho] = - 0.089, p = 0.322). The relationship between the need for orthodontic treatment and the intelligence quotient scores was analyzed by multiple logistic regression, the results are presented in Table 3.

## Discussion

For patients who need orthodontic treatment, it is crucial that a pediatric dentist detects malocclusions early. After that, he/she applies preventive treatments and refers them to the orthodontist. There is a high prevalence of malocclusion in patients with mental retardation at different IQ levels, with accompanying motor disorders, diet habits, oral hygiene status, high caries level, dental anomalies, and the contribution of these factors (1). Healthy individuals with a low intelligence quotient may also be weaker in understanding the importance of oral hygiene and performing the necessary practices. It has been reported that healthy individuals with lower intelligence quotients have larger numbers of dental caries (2). Moreover, Vellappally et al. (17) reported that caries and malocclusion were prevalent in mentally retarded patients aged 12-18 years, but there was no correlation between caries and malocclusion. Based on this idea, this study aimed to evaluate the orthodontic treatment needs of adolescents with different cognitive levels. To our best knowledge, there is no study in the literature evaluating the relationship between cognitive level and the need for orthodontic treatment.

18,3 % (n = 23) iznad prosjeka. Nije bilo statistički značajne razlike između tih skupina kad je riječ o težini malokluzije (p = 0,590). Kada je primijenjen Kappa test, nije otkrivena povezanost između intelektualne razine i potrebe za ortodontskom terapijom (tablica 2.).

Nije uočena korelacija između težine malokluzije i rezultata kvocijenta inteligencije djece [ρ (rho) = - 0,089, p = 0,322]. Odnos između potrebe za ortodontskom terapijom i rezultata kvocijenta inteligencije analiziran je višestrukom logističkom regresijom, a rezultati su u tablici 3.

## Rasprava

Za pacijente kojima je potrebna ortodontska terapija ključno je da dječji stomatolog rano otkrije malokluziju, primijeni preventivne postupke i uputi ih ortodontu. Visoka je prevalencija malokluzije kod pacijenata s mentalnom retardacijom s različitim razinama IQ-a, uz popratne motoričke poremećaje, prehrambene navike, stanje oralne higijene, visoku razinu karijesa, dentalne anomalije i doprinos tih čimbenika (1). Zdrave osobe s niskim kvocijentom inteligencije također mogu slabije razumjeti važnost oralne higijene i obavljati potrebne postupke. Zabilježeno je da zdrave osobe s nižim kvocijentima inteligencije imaju više zubnog karijesa (2). Štoviše, Vellappally i suradnici (17) izvijestili su da su karijes i malokluzija prevladavali kod mentalno retardiranih pacijenata u dobi od 12 do 18 godina, ali nije bilo korelacije između karijesa i malokluzije. Na temelju te ideje, cilj ovog istraživanja bio je procijeniti potrebe za ortodontskom terapijom adolescenata s različitim kognitivnim razinama. Koliko znamo, u literaturi ne postoji istraživanje koje bi procjenjivalo odnos između kognitivne razine i potrebe za ortodontskom terapijom.

The IOTN index has two components scored separately as the aesthetic component (AC) and the dental health component (DHC), which determine the need for orthodontic treatment. The DHC index evaluates malocclusion site-specific and considers the most prominent and worst impairment. The DHC index can thereby classify mild local irregularities as a high need for treatment (18). For that reason, the AC index was used in the current study, which provides a generalized and fast evaluation from the photographs of the anterior region. However, it should be noted that some malocclusions that can be diagnosed from the lateral may be missed in the AC index (12). Therefore, the fact that the need for orthodontic treatment was evaluated with a single index is a limitation of this study.

Karaagac et al. (12) stated that according to the IOTN-AC index, approximately 11% of the patients need treatment, and 80% do not need treatment. On the contrary, the results of this study showed that 26% of the participants needed orthodontic treatments. Since the adolescents evaluated in this study were selected from patients seeking orthodontic treatment, the need for orthodontic treatment was high, while 48% of the participants did not need any orthodontic treatments. In support of this idea, approximately 5% of children in the school population aged 11–14 years, and 37% of children seeking orthodontic treatment at the same age had a great treatment need according to the AC index (11). As inferred from this study, the need for orthodontic treatment in the general population of adolescents is low. In order to determine the relationship between the IQ and malocclusion level, it was necessary to reach a certain number of participants at each malocclusion level. Therefore, patients who applied to the Pediatric Dentistry Clinic and sought orthodontic treatment were included in this study. Since individuals with low IQ may be less likely to pay attention to malocclusion aesthetically, including just individuals seeking orthodontic treatment may be considered a limitation of the study. However, given that the study participants were adolescents and that the primary decision-making authorities for healthcare services were their legal guardians, predominantly parents, it can be inferred that the impact of this factor was minimal. In addition, since Balija et al. (19) reported that the prevalence of dental anomalies in orthodontic patients aged 12–16 was similar to that of the general population, the adolescents with dental anomalies were not excluded from the study.

In the present study, the SPM Test was used to assess the cognitive level of adolescents. Since the SPM is a relatively long test consisting of 60 items (20), it was applied to larger numbers of adolescents than the required sample size, considering that there would be adolescents who did not complete the test.

Although there is no study in the literature comparing the IQ with the need for orthodontic treatment, some studies have evaluated its relationship with several malocclusions (21-22). They reported that IQ is not associated with skeletal malocclusion types (Class I, II, or III), facial growth patterns (vertical or horizontal), (21) or occlusion patterns such as crossbite and open bite (22). Similar to these findings, in

IOTN indeks ima dvije komponente koje se boduju zasebno – estetsku komponentu (AC) i komponentu zdravlja zuba (DHC) – a određuju je li potrebna ortodontska terapija. DHC indeks procjenjuje malokluziju specifično za mjesto i uzima u obzir najizraženije i najveće oštećenje. Zato se DHC indeksom mogu klasificirati blage lokalne nepravilnosti kao velika potreba za liječenjem (18). Zbog toga je u ovom istraživanju korišten AC indeks koji daje generaliziranu i brzu procjenu iz fotografija prednje regije. Međutim, treba imati na umu da se neke malokluzije koje se mogu dijagnosticirati s lateralne strane mogu propustiti u AC indeksu (12). Zato je ograničenje ovog istraživanja činjenica da je potreba za ortodontskom terapijom procijenjena samo jednim indeksom.

Karaagac i suradnici (12) navode da prema IOTN-AC indeksu oko 11 % pacijenata treba terapiju, a 80 % ne treba. Za razliku od toga, rezultati ovog istraživanja pokazali su da je 26 % sudionika trebalo ortodontsku terapiju. Budući da su adolescenti procijenjeni u ovom istraživanju odabrani među pacijentima koji su sami tražili ortodontsku terapiju, potreba za liječenjem bila je velika, a 48 % sudionika nije trebalo ortodontsku terapiju. U prilog ovoj tvrdnji navodi se da je oko 5 % djece u školskoj populaciji u dobi od 11 do 14 godina te 37 % djece koja traže ortodontsku terapiju u istoj dobi imalo veliku potrebu za liječenjem prema AC indeksu (11). Kao što se može zaključiti iz ovog istraživanja, mala je potreba za ortodontskom terapijom u općoj populaciji adolescenata. Kako bi se utvrdio odnos između IQ-a i razine malokluzije, bilo je potrebno obuhvatiti određeni broj sudionika na svakoj razini malokluzije. Zato su u ovo istraživanje uključeni pacijenti koji su se javili u Kliniku za dječju stomatologiju i tražili ortodontsku terapiju. Budući da je manje vjerojatno da će pojedinci s niskim kvocijentom inteligencije obratiti pozornost na estetske deficite zbog malokluzije, uključivanje samo osoba koje traže ortodontsku terpiju može se smatrati ograničenjem istraživanja. Međutim, s obzirom na to da su sudionici istraživanja bili adolescenti i da su primarni autoriteti u donošenju odluka o zdravstvenim zahvatima bili njihovi zakonski skrbnici, uglavnom roditelji, može se zaključiti da bi utjecaj toga čimbenika mogao biti neznatan. Uz to, s obzirom na to da su Balija i suradnici (19) izvijestili da je prevalencija dentalnih anomalija kod ortodontskih pacijenata u dobi od 12 do 16 godina bila slična općoj populaciji, djeca s dentalnim anomalijama nisu bila isključena iz istraživanja.

U ovom istraživanju SPM test korišten je za procjenu kognitivne razine adolescenata. Budući da je SPM razmjerno dugačak test koji se sastoji od 60 predmeta (20), primijenjen je na većem broju djece od potrebnog uzorka jer se očekivalo da će biti onih koji ga neće ispuniti.

Iako u literaturi ne postoji istraživanje koje bi uspoređivalo IQ s potrebom za ortodontskom terapijom, neka su istraživanja procijenila njegovu povezanost s nekoliko malokluzija (21 – 22). Istaknuto je da kvocijent inteligencije nije povezan s tipovima skeletnih malokluzija (klasa I, II ili III), obrascima rasta lica (vertikalno ili horizontalno) (21) ili modelima okluzije kao što su križni zagriz i otvoreni zagriz (22). Slično tim nalazima, u aktualnom istraživanju nije pronađena povezanost između ozbiljnosti malokluzije i potrebe za ortodontskim liječenjem pacijenata s različitim razinama IQ-a. Bu-

the current study, no relationship was found between the severity of malocclusion and the need for orthodontic treatment in patients with different IQ levels. Since no significant difference was observed, the null hypothesis of this study was accepted. Additionally, Perillo et al. (23) reported in a study that crowding was a 5-fold higher risk factor and crossbite was a 6-fold higher risk factor for score abnormalities in global self-concept.

Durhan et al. (24) investigated the relationship between intelligence profiles and gingivitis in children aged 10-15 years. They observed that there was no relationship between cognitive status and periodontal status. However, in contrast to this study, Navit et al. (3) stated that the IQ was associated with moderate gingivitis, while the IQ was not associated with dental caries. Dhanu et al. (2) on the other hand, reported that as the IQ level increased, dental caries decreased, but there was no direct relationship between them. Individuals with low intellectual levels may have a poor ability to comprehend and learn the importance of oral health and necessary practices (25-27), thus leading to a higher prevalence of gingivitis. However, this relationship may not be sufficiently strong to cause dental caries, and thus malocclusion.

In this study, healthy adolescents without systemic disease seeking orthodontic treatment who came to the Pediatric Dentistry Clinic for examination were included. Thus, mentally retarded adolescents were not included, and the IQ levels of the adolescents were not in a very wide range. Therefore, another limitation of the study was that patients in every IQ group could not be included in the study. Whether patients are below or above the threshold might make a difference in understanding the importance of oral and dental health and fulfilling their obligations.

## Conclusions

It was observed that there was no relationship between the intelligence quotient level of the patients and the need for orthodontic treatment. However, since there are studies advocating different opinions about the effect of cognitive level on other factors such as caries risk and gingival health, we think that the evidence value of these data should be increased by further studies on the need for orthodontic treatment. There was no significant difference between the genders in terms of the severity of malocclusion and the need for orthodontic treatment.

## Conflict of interest statement

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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dući da nije uočena statistički značajna razlika, prihvaćena je nulta hipoteza ovog istraživanja. Nadalje, Perillo i suradnici (23) izvijestili su da je zbijenost pet puta veći čimbenik rizika, a križni zagriz šest puta veći čimbenik rizika za abnormalnosti procjene u globalnom samopoimanju.

Durhan i suradnici (24) istraživali su odnos između profila inteligencije i gingivitisa kod djece u dobi od 10 do 15 godina i uočili da ne postoji odnos između kognitivnog i parodontnog statusa. Međutim, za razliku od ovog istraživanja, Navit i suradnici (3) navode da je IQ povezan s umjerenim gingivitisom, ali nije sa zubnim karijesom. Dhanu i suradnici (2) su s druge strane, izvijestili su da se s povećanjem razine IQ-a zubni karijes smanjivao, ali nije bilo izravne veze među njima. Pojedinci s niskom intelektualnom razinom mogu imati slabu sposobnost razumijevanja važnosti oralnog zdravlja i potrebnih postupaka (25-27), što dovodi do veće prevalencije gingivitisa. Međutim, ovaj odnos možda neće biti dovoljno jak da prouzroči zubni karijes, a time i malokluziju.

U istraživanje su bili uključeni zdravi adolescenti bez sistemskih bolesti koja su tražila ortodontsku terapiju i dolazila su na pregled u Kliniku za dječju stomatologiju. Dakle, ona mentalno zaostala nisu bili uključena, a razine IQ-a adolescenata nisu imale širok raspon. Zato je još jedno ograničenje istraživanja bilo da pacijenti u svakoj IQ skupini nisu mogli biti uključeni u istraživanje. Jesu li pacijenti ispod ili iznad praga, može utjecati na razumijevanje važnosti oralnoga zdravlja i ispunjavanje njihovih obveza.

## Zaključci

Uočeno je da ne postoji povezanost između razine kvocijenta inteligencije pacijenata i potrebe za ortodontskom terapijom. Međutim, s obzirom na to da postoje istraživanja koja zastupaju različita mišljenja o učinku kognitivne razine na druge čimbenike kao što su rizik od karijesa i zdravlje gingive, smatramo da bi dokaznu vrijednost ovih podataka trebalo povećati daljnjim istraživanjima o potrebi za ortodontskom terapijom. Nije bilo statistički značajne razlike između spolova kad je riječ o težini malokluzije i potrebi za ortodontskom terapijom.

## Izjava o sukobu interesa

Autori izjavljuju da nema potencijalnih sukoba interesa u vezi s istraživanjem, autorstvom i/ili objavljivanjem ovog rada.

## Zahvala

Protokol istraživanja ocijenilo je i odobrilo Etičko povjerenstvo za klinička istraživanja Stomatološkog fakulteta Sveučilišta Marmara (broj odobrenja 2017-159).

**Sažetak**

**Svrha rada:** Niske kognitivne sposobnosti mogu smanjiti sposobnost razumijevanja važnosti oralnoga zdravlja i obavljanja potrebnih postupaka za održavanje pravilne oralne higijene. Rani gubitak mliječnih zuba u slučaju visokog rizika od karijesa može rezultirati nepravilnom okluzijom trajne denticije. **Materijali i metode:** Između siječnja 2018. i svibnja 2018., 200 djevojčica i dječaka u dobi od 10 do 15 godina koji su se prijavili u Kliniku za dječju stomatologiju Sveučilišta Marmara i tražili ortodontsku terapiju pozvani su da sudjeluju u istraživanju. Potreba za ortodontskom terapijom njih 150 koji su pristali sudjelovati procijenjena je indeksom potrebe za ortodontskom terapijom – estetska komponenta, a njihove kognitivne razine procijenjene su Ravenovim testom standardne progresivne matrice (SPM). P-vrijednost < 0,05 smatrala se statistički značajnom. **Rezultati:** Prosječna dob (± standardna devijacija) 126 adolescenata (77 djevojčica i 49 dječaka) koji su podvrgnuti SPM testu bila je 11,8 (± 1,3). Nije bilo povezanosti između intelektualne razine i potrebe za ortodontskom terapijom (Kappa vrijednost = 0,071, p-vrijednost = 0,081). Nije bilo korelacije između težine malokluzije i rezultata kvocijenta inteligencije adolescenata [ρ (rho) = -0,089, p = 0,322]. Prema rezultatima višestruke logističke regresije nije bilo razlike između „granične potrebe" (p = 0,059) i „velike potrebe" (p = 0,881) te „nema potrebe" za ortodontskom terapijom kod adolescenata/djece s različitim kvocijentima inteligencije. **Zaključak:** Rezultati ne daju nikakve dokaze o povezanosti malokluzije i kvocijenta inteligencije.

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**MeSH pojmovi:** osobe s mentalnim poteškoćama; indeks potrebe za ortodontskom terapijom; malokluzija; test inteligencije; dijete; adolescent
**Autorske ključne riječi:** Ravenov test progresivnih matrica

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