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PSIHOSOCIAL IMPACT OF MALOCCLUSION AMONG KOSOVAR ADOLESCENTS

DOCTORAL THESIS

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Associate Professor Blerim Kamberi DDM, PhD

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Sveučiliste u Zagrebu

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PSIHOSOCIJALNI UTJECAJ MALOKLUZIJE U ADOLESCENATA NA KOSOVU

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I dedicate this thesis to my pride and joy, my daughter Aria.

SUMMARY

PSIHOSOCIAL IMPACT OF MALOCCLUSION AMONG KOSOVAR ADOLESCENTS

Epidemiological studies on malocclusion demonstrate that malocclusion has a high prevalence rate. Various studies show that, apart from oral diseases, malocclusion affects quality of life, specifically dimensions of emotional and social wellbeing, thus investigation of the impact of malocclusion in psychosocial aspects among adolescents is of great importance. The aim of this research was threefold: to evaluate the psychosocial impact of malocclusion, to determine its relationship with the severity of malocclusion, and to assess the influence of gender and age in this relationship in Kosovar adolescents.

400 adolescents aged 12-15, with similar distribution regarding the gender and age and with minor to severe malocclusion, were included in the study. One investigator, who was already trained and calibrated in the usage of the dental health DHC and esthetic component AC of Index of Orthodontic Treatment Need (IOTN) and dental esthetics index (DAI), assessed a subject's orthodontic treatment needs. Psychosocial impact of dental esthetics questionnaire (PIDAQ) was used to evaluate the psychosocial impact of malocclusion. PIDAQ was used as dependent variable, whereas dental aesthetic index (DAI), dental health (DHC) and aesthetic component (AC) of Index of Orthodontic Treatment Need (IOTN), gender and age were used as independent predictive variables. The sample was divided in three categories according to IOTN DHC (Grade 1 and 2, Grade 3, Grade 4 and 5) , three categories according to IOTN AC (Grade 1,2,3 Grade 4,5,6,7 and Grade 8,9,10) and two categories according to DAI (DAI $\leq$25 and DAI $\geq$25).

There were significant differences in dental self-confidence, social impact, psychological impact, and aesthetic concern subscales across categories of IOTN-DHC, IOTN-AC and DAI $p<001$. For same severity level, females scored worse compared to males in PIDAQ subscales $p<0.01$. In terms of age, 12-year-olds had slightly higher scores in Social Impact, Psychological Impact and Aesthetic Concern domains. A significant difference in PIDAQ mean scores among ages was observed only in the Dental Self-confidence subscale, while mean scores in other subscales did not differ significantly among the age groups $p<0.05$. The results of this study revealed that the

adolescents with malocclusion experienced a negative physical and psychological impact on quality of life.
Keywords: Malocclusion, Psychosocial well-being, Quality of Life, Gender, Age

PROŠIRENI SAŽETAK

PSIHOSOCIJALNI UTJECAJ MALOKLUZIJE U ADOLESCENATA NA KOSOVU

Cilj istraživanja

Epidemiološke studije malokluzije pokazale su da malokluzija ima visoku prevalenciju. Brojna su istraživanja pokazala da malokluzija zubi može utjecati na međuljudske odnose i mentalnu dobrobit te da može dovesti do osjećaja inferiornosti, naglašavajući da malokluzija poglavito utječe na dimenzije emocionalne i socijalne dobrobiti poput narušavanja socijalne interakcije i/ili psihološke dobrobiti. Zadovoljstvo fizičkim izgledom bitna je sastavnica samopoštovanja i mnogi adolescenti imaju manjak samopoštovanja. Uzimajući u obzir načelo opće dobrobiti, istraživanje utjecaja malokluzije na psihosocijalne aspekte u adolescenata je od velike važnosti. Cilj je ovog istraživanja bio procijeniti psihosocijalni utjecaj malokluzije, utvrditi njegovu povezanost s težinom malokluzije te procijeniti ulogu varijabli spola i dobi u kosovskih adolescenata.

Materijali i metode

U ispitivanje je uključeno 400 adolescenata u dobi od 12 do 15 godina, slične raspodjele s obzirom na spol i dob i s laganom do teškom malokluzijom. Jedan istraživač, koji je već bio kvalificiran i kalibriran za uporabu komponente dentalnog zdravlja (DHC), estetske komponente (AC) indeksa potreba za ortodontskim liječenjem (IOTN) i indeksa stomatološke estetike (DAI), procijenio je potrebe subjekta za ortodontskim liječenjem. Upitnik za psihosocijalni utjecaj dentalne estetike (PIDAQ) korišten je za procjenu psihosocijalnog utjecaja malokluzije. PIDAQ je korišten kao ovisna varijabla, dok su zubni estetski indeks (DAI), zubno zdravlje (DHC), estetska komponenta (AC) indeksa potrebe za ortodontskim liječenjem (IOTN) i spol korišteni kao neovisne varijable.

Uzorak je podijeljen u tri kategorije prema IOTN DHC-u (klasa 1 i 2, klasa 3, klase 4 i 5), tri kategorije prema IOTN AC-u (klase 1,2,3, klase 4,5,6,7 i klase 8, 9,10) i dvije kategorije prema DAI -u(DAI ≤25 i DAI ≥25).

Rezultati

Raspodjela uzorka prema spolu za IOTN i DAI indeks pokazala je da je prevalencija malokluzije bila veća kod muškaraca nego kod žena; više muškaraca nego žena bilo je kategorizirano u klase 4 i 5, 8-10 i 36≤ IOTN-DHC, IOTN-AC i DAI. S obzirom na dob, prema subljestvici dentalno zdravlje indeksa potrebe za ortodontskim liječenjem (IOTN - DHC), dvanaestogodišnjaci su imali najveći postotak teške malokluzije (30,75%), dok su 13 i 15-godišnjaci imali najmanji postotak. Kada se procjenjivalo estetskom komponentom indeksa potrebe za ortodontskim liječenjem (IOTN-AC) i zubno-estetskim indeksom DAI, 14-godišnjaci su imali najveći postotak teške malokluzije.

Utvrđena je značajna razlika na subljestvicama: dentalno samopouzdanje, socijalni utjecaj, psihološki utjecaj i estetska zabrinutost za sve kategorije IOTN-DHC, IOTN-AC i DAI ($p<0.01$). Svi ispitanici koji su kategorizirani u gornjim kvartilima svakog indeksa postigli su lošiji rezultat u svim potkategorijama PIDAQ, ukazujući na činjenicu da je veća malokluzija povezana s većim utjecajem.

U pogledu PIDAQ domena među kategorijama IOTN-DHC, opažene su značajne razlike među spolovima za DSC i PI domenu u odnosu na klasu 3. Ženski ispitanici su postigli lošiji rezultat u svakoj od tih domena. Sve u svemu, muški i ženski rezultati značajno su se razlikovali u PIDAQ domenama prema malim i umjerenim malokluzijama. Promatranjem IOTN-AC indeksa za sličnu rodnu usporedbu među PIDAQ domenama, utvrđene su značajne razlike u njegovoj AC domeni i stupnju 1,2 i 3, što je opisalo utjecaj koji su manje malokluzije (procijenjene pomoću IOTN-AC) imale na samopercepciju adolescenata, kada su uspoređeni muški i ženski spol.

S obzirom na dob, dvanaestogodišnjaci su postizali nešto više rezultate u domenama Društveni utjecaj, Psihološki utjecaj i Estetska zabrinutost. Značajna razlika u prosječnim rezultatima PIDAQ-a među dobima zabilježena je samo u subljestvici samopouzdanja zuba ($p <0,05$), dok se

prosječni rezultati u ostalim subljestvicama nisu značajno razlikovali među dobnim skupinama. IOTN-DHC je bio prediktorska varijabla ukupnih i pojedinačnih PIDAQ rezultata. Dob je bila neovisna varijabla odnosa između PIDAQ rezultata i IOTN-DHC klasa za DSC i AC subljestvice. Za subljestvicu AC rod je bio prediktorska varijabla u linearnom modelu.

Zaključak

Ovo je istraživanje pokazalo da su adolescenti s malokluzijom osjetili negativan fizički i psihosocijalni utjecaj na kvalitetu života. Studija je također pokazala da, uz izraženost malokluzije, spol i dob značajno utječu na razinu utjecaja malokluzije na psihosocijalnu dobrobit ispitanika. Sve u svemu, ispitanici ženskoga spola su postigli lošije rezultate u svim PIDAQ potkategorijama, što ukazuje da su iskusili negativniji psihosocijalni utjecaj od ispitanika muškoga spola. Mlađi uzrasti (12-godišnjaci) su postigli nešto više rezultate, u domenama Društveni utjecaj, Psihološki utjecaj i Estetska zabrinutost. Značajna razlika u prosječnim rezultatima PIDAQ-a među dobima zabilježena je samo u subljestvici samopouzdanja zuba ($p < 0,05$), dok se prosječni rezultati u ostalim subljestvicama nisu značajno razlikovali među dobnim skupinama. Rezultati ovog istraživanja otkrili su da su adolescenti s malokluzijom imali negativan fizički i psihološki utjecaj na kvalitetu života.

Ključne riječi
Malokluzija, psihosocijalna dobrobit, kvaliteta života, spol, dob.

List of abbreviations

Abbreviation Term

COHIP	Child Oral Health Impact Profile
CPQ	Child Perception Questionnaire
DAI	Dental Aesthetic Index
HRQoL	Health Related Quality of Life
ICON	Index of Complexity, Outcome and Need
IOTN	Index of Orthodontic Treatment Need
IOTN-AC	Index of Orthodontic Treatment Need-Aesthetic Component
IOTN-DHC	Index of Orthodontic Treatment Need-Dental Health Component
OHRQoL	Oral Health Related Quality of Life
OHIP	Oral Health Impact Profile
PAAR	Peer Assessment Rating Index
PIDAQ	Psychosocial Impact of Dental Aesthetic Questionnaire
QoL	Quality of Life
WHO	The World Health Organization

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1.INTRODUCTION

Malocclusion is not a disease but rather a deviation from normal development that may be considered aesthetically unsatisfactory (1).

It is defined as an occlusion in which there is a deviated relationship between the arches in any of the planes or in which there are anomalies in tooth position, number, form, and development beyond normal limits (2).

Epidemiological studies on malocclusion prevalence demonstrate that malocclusion has the third-highest prevalence among oral pathologies, second to dental caries and periodontal disease, and, therefore, ranks third among worldwide public health dental disease priorities (3). Its prevalence varies depending on the country studied but the ranges are between 20% to 88. 1 % (4). According to studies undertaken by McLain and Proffit, 70% of the population in the US was reported to be affected by some form of malocclusion (5), whereas Holmes reported that one-third of 12 year-olds in the United Kingdom would benefit from orthodontic treatment (6). Similar statistics were found in French Canadian children, where 50% of children were reported to have one or more teeth in minor or major displacement (7).

The etiology of a malocclusion involves different factors such as genetic, environmental, and specific causes (8). Genetics has long been known to be one of the most dominant causes of malocclusion because human traits such as tooth size, arch dimensions, tooth shape anomalies and numbers, overjet, inter-arch variations, etc., are known to be influenced by genes (9). Another reason why genetics is attributed to malocclusion is racial, ethnic, and regional inter-mixture.

Environmental causes include factors such as masticatory function, sucking habits, tongue posture, and respiratory patterns.

Among specific causes, disturbances in embryologic development, skeletal growth disturbances, muscle dysfunction, etc., are factors that contribute to malocclusion. With all these factors affecting a normal occlusal development, it is no surprise that malocclusion has become a worldwide problem.

Malocclusion differs from the majority of medical conditions; therefore, approaches to the treatment/ management are different.

The impact that malocclusion has on individuals' health can be divided into two main pillars: the first one is oral disease/functional limitation, and the second one is a psychological impact. It is

well known that the presence of malocclusion causes difficulties in maintaining oral hygiene, causing individuals with malocclusion to be more prone to periodontal disease or dental cavities (10). Different studies report that as a result of crowding the contact points between adjacent teeth are irregular, thus making maintenance of oral hygiene difficult. This indeed increases the accumulation of plaques which predisposes the development of dental caries and periodontal disease (11, 12)

In a study of Helm and Petersen, it was shown that crowding, extreme maxillary overjet, and cross-bite increase the risk for periodontal disease (13). In another study 'Intraarch and interarch relationships of the anterior teeth and periodontal conditions' Ngom et al also reported that malocclusion was a risk factor for periodontal disease (14).

The studies of Kolawole and Folayan showed that crowding and buccal cross bite were associated with caries, whereas increased overjet and anterior open bite were associated with gingivitis (15).

The frequency and risk of traumatic dental injuries has been shown to be higher in individuals who have an increased overjet (16–18). In a recent systemic review and meta-analysis of Arraj et al. the association between increased overjet and dental trauma was confirmed. According to the study, children with ≥3mm overjet in the primary dentition could be considered as having risk for dental trauma, whereas in the early secondary dentition, the threshold for trauma is an overjet ≥5mm (19).Another study has shown that protrusion of the maxilla and retrusion of the mandible can increase the risk for trauma to the maxillary incisors (20).

On the other hand, there are pros and cons regarding the association between the posterior cross-bite and temporo-mandibular disorders (TMD). While some studies have found a significant association between posterior cross bites and temporomandibular disorders (21–23) some other studies did not find any associations (24–26). A study by Thilander and Bjerklin aimed to update the bibliography regarding the concept of 'temporomandibular disorder' and 'posterior cross-bite' and to find out if there was an association between the signs of TMD and a type of the posterior cross-bite. The results revealed that there was an association between a unilateral posterior cross-bite with mandibular deviation and some signs and symptoms of TMD (TMJ muscular pain, clicking, and headache) (27).

The second impact of malocclusion on individuals' health without a doubt is the psychological one. Various studies show that, apart from oral diseases, malocclusion affects quality of life, specifically dimensions of emotional and social wellbeing, thus interfering with psychological welfare in general (28–31).

Patients in industrialized countries are motivated to seek orthodontic treatment based on the impact that malocclusion has physically, but also psychologically and socially, indicating the need to understand the psychosocial impact of malocclusion (32).

While acknowledging the impact of malocclusion on physical health such as mastication and speech difficulties, the physical effects of malocclusion on oral health will not be considered in this dissertation since they are beyond the scope of this study. We will focus only on the aspect of the psychological effect of malocclusion and its impact on quality of life.

Malocclusion has a negative social and psychological effect, thus impacting the Oral Health Related Quality of Life (OHRQoL)(28–31,33).The review performed by Zhang et al. showed that malocclusion affects the self-concept, which means that it affects how individuals perceive themselves socially in terms of attractiveness and acceptance, but also in terms of perceived intelligence (32). It is common for individuals with malocclusion to develop strategies such as hiding their teeth, avoiding smiling, developing social anxiety and emotional insecurity, and having fear and difficulty regarding personal relationships (34, 35). Such effects are further strengthened with an increase in the severity of the malocclusion. Another systematic review and meta-analysis performed by Sun et al (36) showed that malocclusion has an impact in all scores of Oral Health Impact Profile and more severe malocclusion indicated higher physical disability, physical pain, psychological discomfort and disability as well as social disability.

Young people with unsatisfactory dental esthetics are generally sadder than those without such problems (28). All these issues have become particularly significant when dealing with adolescents since they are more aware of the appearance of their teeth and have greater esthetic concerns about their teeth, as compared to others (28). Adolescents are more concerned about acceptance by peers and, thus, their oral health status can have an exaggerated effect on their self-worth and self-confidence. Indeed, children and adolescents with malocclusions can be the target of teasing and name-calling (29).

Considering findings from different studies, it is clear that malocclusion affects Oral Health-Related Quality of Life and identifying the risk factors for potential psycho-social problems is important to improve overall Quality of Life in adolescents and to reduce negative impacts of malocclusion on daily life. OHRQoL is defined as an individual's assessment of how functional factors, psychological factors, social factors, and the experience of pain/discomfort in with oro-facial concerns affect his or her well-being (37). Thus, it is of great importance to use tools for measuring the OHRQoL to assess the psychosocial aspect of malocclusion.

There are different tools for assessing the psychosocial aspect of malocclusion but in this study, we are going to use the Psychosocial Impact of Dental Aesthetic Questionnaire (PIDAQ), which offers information regarding the impact of malocclusion in psychological and social aspects exclusively. This questionnaire, which was originally developed for adults, was used for the purpose of this study to measure the psychosocial impact of malocclusion on adolescents.

Knowledge of this aspect is important since it can help us better understand the expectations of adolescent patients and choose the appropriate approach to address their concerns. Information about how malocclusion affects these patients may offer an evaluation of patients' perceived need and priority for treatment as individuals with malocclusion (particularly in the anterior region) may require orthodontic treatment mainly motivated by personal concerns about appearance and social and psychological effects (38, 39).

Besides, the information from studies that assess the psychosocial impact of malocclusion could be further used to justify demands for orthodontic treatment, as they will serve as evidence for different third parties in determining the need for orthodontic treatment.

Since the contemporary orthodontics approach and goal is not just the rehabilitation of the patients but their overall well-being, new golden measurements such as patients' concerns regarding their teeth, their feelings about themselves, and their level of confidence while smiling should be taken into account when deciding about orthodontic treatment. Furthermore, the majority of orthodontic patients are adolescents who generally expect that orthodontic treatment will give them the appearance of confidence, thus boosting their level of self-esteem. Therefore, understanding the impact of malocclusion in this category is of great importance.

Even though this topic has gained considerable attention in recent years in developed countries, where most studies regarding the psychosocial aspects of malocclusion have been carried out, the

relationship between malocclusion, esthetic impact, and quality of life remain uninvestigated in underdeveloped and developing countries such as Kosovo.

Kosovo has been facing challenges in addressing the dental health needs of patients as an outcome, and adequately assessing the treatment need and malocclusion impacts as an initial objective.

While the country has dental professionals at a level to effectively cover the population needs, access is not equally distributed in terms of location and economic/financial means. Private practices are not affordable for the most vulnerable population, while affordable services are underfinanced at the institutional level. On the other hand, policies in place for establishing preventive care, oral health education, and prioritization of patients based on malocclusion levels are not up to date with the international indices and tools.

Being a part of this system and actively engaged in serving patients of all ages, I have witnessed the negative impacts of the lack of standards and protocols for treating malocclusion based on assessment results with well-recognized indices, anomaly indications, and most importantly, based on the psychosocial well-being of patients. The latter has been demonstrated to be measured with the PIDAQ questionnaire as a valid, reliable and replicable tool for many settings. As a result, the study presents the work conducted in assessing the validity and reliability of the psychosocial impact of dental esthetics questionnaire in Kosovar adolescents and applying PIDAQ in assessing the impact of malocclusion on adolescents' psychosocial well-being and ORHQoL. The results of this study can be utilized for reforming the patient assessment, prioritization, and treatment system while serving as a policy base for resource management at the institutional level.

This cross-sectional study was carried out in public schools in Kosovo. It was conducted in the following three phases:

1. Translation and validation of PIDAQ questionnaire which was implemented among adult participants,

2. Assessment of applicability and validity of PIDAQ among adolescents, and

3. Analysis of the psychological and social aspects of malocclusion on adolescents.

The purpose of this dissertation is to assess the psychosocial aspects of the impact of malocclusion, to determine its relationship with the severity of malocclusion, and to assess the influence of gender and age in this relationship among Kosovar adolescents aged 12-15 years.

The objective of this research is threefold:

- To evaluate the psychosocial impact of malocclusion
- To determine its relationship with the severity of malocclusion and
- To assess the influence of gender in this relationship using PIDAQ as a dependent variable and Index of Orthodontic Treatment Need (IOTN), gender, and age as an independent predictive variable.

The null hypotheses of this study are:

1. Malocclusion does not have any psychosocial impact on adolescents
2. The severity of malocclusion does not have any psychosocial impact on adolescents
3. There are no differences among genders for the same severity level of malocclusion.

The alternative hypotheses of the study are that malocclusion may have an impact on adolescents in Kosovo and its impact may increase with the severity of malocclusion. A degree of psychosocial impact for the same severity level of malocclusion may be different depending on gender.

1.2 Literature review

The World Health Organization defines health as "a complete state of physical, mental, and social well-being and not just the absence of disease and infirmity' (3).

This definition of health follows the contemporary concepts of health and health-related quality of life. Furthermore, the definition of Oral Health Related Quality of Life is: "standard of health of the oral and related tissues which enables an individual to eat, speak and socialize without active disease, discomfort or embarrassment and which contributes to general well-being" (40, 41). From these two definitions, it is clear that good oral health does not mean purely the absence of oral diseases and the presence of dysfunction; it also includes aspects such as quality of life. Therefore, oral health is an essential component of an individual's overall health and oral diseases and conditions can have adverse effects on the life of an individual.

Contemporary orthodontics, likewise contemporary medicine, is shifting from the traditional clinical criteria toward a more patient-centric oral healthcare approach. Thus, it is crucial to implement subjective measurements of the orthodontic treatment need.

Orthodontic clinicians measure oral health in an objective way using different methods and occlusal indices such as Index of Orthodontic Treatment Need (IOTN) (42), Dental Aesthetic Index (DAI)(43), Peer Assessment Rating Index (PAR)(44), Index of Complexity, Outcome and Need (ICON)(45) etc. Sometimes, professional viewpoints may disregard patients' emotional and social experiences (34), and, as a result, the need has emerged for more subjective measurement or patient-based outcomes measurements, as oral disorders can have a significant impact on one's physical, social, and psychological well-being (46,47).

Furthermore, some studies have shown that orthodontics is a field of dentistry with the most profound weak correlation between objective oral health measures and subjective oral health needs (48, 49).

To explain these differences in correlation, the concept of Oral Health-Related Quality of Life (OHRQoL) was introduced to the orthodontic literature. OHRQoL can also be defined as "the absence of negative effects of oral conditions on social life and a positive sense of dentofacial satisfaction" (37, 50, 51).

These definitions led to the development of a multidimensional approach to OHRQoL, including physical, psychological, and social functioning, which helps complete the whole meaning of oral health. OHRQoL aims to capture subjective oral health accurately.

The impact of oral diseases and disorders on OHRQoL can be assessed using quantitative evaluations such as questionnaires. Different questionnaires are frequently used in the assessment of OHRQoL, and they offer information concerning patients' perceptions of their welfare with particular oral conditions.
The Oral Health Impact (OHIP) has been shown to have good psychometric properties (52, 53). Child Perception Questionnaire (CPQ), which was further developed into the Child Oral Health Impact Profile (COHIP), has shown good psychometric properties as well (54, 55).
However, none of these questionnaires were developed specifically for malocclusion and/or orthodontics, while the OHIP was not developed for children/adolescents either.

Recently, Klages et al. have developed a specific questionnaire to evaluate orthodontics-related OHRQoL- the PIDAQ (56). Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) is a multidimensional calculator of orthodontic-specific quality of life outcomes.
This is an important step in contemporary orthodontics since a specific and valid instrument can now be used to assess the orthodontic-specific quality of life measurements.

Over the last decade, patients' perceptions of esthetics during orthodontic treatment planning have become an interesting topic from a psychological perspective (57–59). Also, the use of OHRQoL measurement tools and occlusal indices has been reported to be effective in predicting orthodontic concerns (60–62). These developments indicate that oral health should be defined according to the psychological and social well-being of patients, as well as physical factors. Traditional measures should be supported by the use of measures of OHRQoL.
This transition is similar to the paradigm shift observed in recent years where orthodontic treatment has moved from being purely physical to including the psychosocial aspects.

1.3 Malocclusion and OHRQoL

It has long been recognized that different malocclusions are associated with impaired oral health and/or function. As a result, the impact of malocclusion on Oral Health Related Quality of Life has been the subject of different research.

In a cross-sectional study of Sardenberg et al. which was carried out in a population-based sample of 1,204 children, aged 8 to 10 years and attending elementary schools in Brazil, it was demonstrated that the anterior segment spacing and anterior mandibular overjet were significantly associated with the impact on OHRQoL score, and schoolchildren with malocclusion were more likely to experience a negative impact on OHRQoL than those without malocclusion (28).
Another cross-sectional study of Scapini et al., who investigated impacts of malocclusion on adolescents' OHRQoL, concluded that malocclusion harmed adolescents' quality of life, independently of dental caries or traumatic dental injuries (29).

Ukra et al. also investigated whether malocclusion is associated with OHRQoL in New Zealand adolescents and they concluded that a severe malocclusion appears to harm OHRQoL (30).
One systematic review, which included studies performed until December 2007, reported a moderate association between malocclusion/orthodontic treatment need and OHRQoL in adults, adolescents and children (63).

Another systematic review by Talapaneni A.K et al.(64), conducted in 2012, concluded that there is a medium-to-low level of evidence that the untreated posterior cross-bite can cause facial asymmetries, and it is reasonable to believe that such an asymmetry may have an impact on quality of life from a functional as well as an esthetic point of view.

In one systematic review conducted to assess the impact of orthodontic treatment on quality of life of adolescents, it was observed that all studies, except for one study among 10 studies in the review, reported a significant increase in OHRQoL after orthodontic treatment (65). One other aspect that remains largely uninvestigated is the association between the objective and subjective treatment needs. As described above, OHRQoL is one tool used for this purpose.
One particular study was focused to determine the association between ORHQoL and the subjective need for orthodontic treatment. The results of this study revealed that children with a subjective orthodontic treatment need have poorer ORHQoL, in particular girls and children who objectively also had a treatment need (66).
Developing countries are challenged with oral diseases which are aggravated by poverty, low health education, lack of government funding and adequate policies, and lack of adequate systemic interventions for prevention.

The FDI World Dental Federation has identified poor access to adequate care, lack of quality dental materials at affordable prices and insufficient investment in dental care as the culprit of poor dental health situation in developing countries in South America, Africa and Asia. While some countries face a low number of dentists per population, other countries are faced with the migration of skilled dentists to either urban areas or other developed countries, thus leaving the rural areas with a very poor access to dentists.

A delay in access means that routine check-ups that could serve as preventive care are not performed and many patients arrive at the dentist's office too late – ending up with tooth extraction. Furthermore, even timely arrival is not regulated through a system of priority and protocols that should be followed for a cost-effective and efficient treatment; rather a first-come, first-served rule is applied. Over the last ten years, several studies have been conducted to assess the burden of malocclusion on the quality of life of children and adolescents.

A study conducted among 420 Mongolian adolescents found that specific types of malocclusion such as overjet and deep bite were significantly associated with oral symptoms, functional limitations, and social well-being, thus with the Oral Health Related Quality of Life measure (67). The highest percentage of malocclusion was also noted among adolescents of ages 12-14(67). Another comprehensive research considered Malaysian and Finnish patients who needed orthodontic treatment. The study used the IOTN index to assess treatment needs and used OHIP-14 to assess the OHRQoL.

The results of the study showed that the level of malocclusion had a gradient effect on quality of life, with more severe malocclusion having a greater impact on OHRQoL. Furthermore, the patients with limited treatment needs had IOTN based OHIP-14 scores that were on average 5 points higher than those of the patients with no treatment need. This score difference was perceived as very important by patients, while being clinically of lower importance (68).

This finding also documented the limitations of using OHIP-14 IOTN in priority setting for patient treatment but rather documented the role it can have when used in policymaking to document the impact of malocclusion on well-being and quality of life of adolescents.

On the other hand, a study was performed among Indian adolescents, aimed to assess the impact of orthodontic treatment on the psychosocial well-being of patients one year after the treatment, using PIDAQ questionnaire. This study showed a significant improvement in the psychosocial well-being of patients and a reduction in their self-perceived need for orthodontic treatment (69).

1.4 Orthodontic treatment need

An assessment of orthodontic treatment need is done by clinical examination and orthodontic indices, such as the Index of Orthodontic Treatment Need (IOTN) (42) and the Dental Aesthetic Index (DAI)(43). These indices have been developed to prioritize the functional need for orthodontic treatment.

1.4.1 Index of Orthodontic Treatment Need(42)

The Index of Orthodontic Treatment Need (IOTN) is used to assess the need for orthodontic treatment. The British Orthodontic Society believes that if treatment has to be rationed, the IOTN is an objective and reliable way to select those patients who will benefit the most from treatment. As such, this study has used use the IOTN index to determine the severity of the malocclusion. This index is composed of 2 parts: the dental health component (DHC) and the esthetic component (AC). The accurate use of IOTN requires a specialist training and the assessment of dental health need for orthodontics usage. A simplified summary of the IOTN assessment is provided below.

IOTN-DHC	5	4	3	2	1
Missing teeth	5h = extensive hypodontia + restorative implications >1 tooth missing perquandrant pre-restorative orthodontic treatment 5s = submerging primary teeth 5i = impeded eruption/impaction	4h less extensive hypodontia requiring orthodontic treatment for pre-restorative or space closure			
Overjet	5a=OJ> 9mm 5m=ROJ > 3.5mm + masticatory and speech difficulties	4a=OJ 6.1-9 mm 4b ROJ >3.5mm with no masticatory and speech difficulties	3a OJ=3.6-6mm+incopetent lips 3b= ROJ 1.1-3.5mm	2a= OJ 3.6-6.6mm+ competent lips 2b=ROJ0.1-1mm	
Crossbite		4c=x-bites+ > 2mm discrepancy between RCP and ICP 4l=posterior lingual x-bite	3c= x- bite + 1.1-2mm discrepancy between RCP and ICP	2c= x-bite with up to 1mmdiscrepancy etween RCP and ICP	
Displacement of contact point		4d= contact point displacement > 4mm 4t= partially erupted teeth, tipped and impacted against adjacent teeth 4x=supplemental teeth	3d= contact point displacement 2.1-4mm	2d = contact point displacement 1.1-2mm	minor irregularities
Overbite (including open bite)		4e=lateral or anterior open bite > 4mm 4f=increased+complete OB+ gingival or palatal trauma	3e=lateral or anterior open bite 2.1-4mm 3f=increased+complete OB with no gingival trauma	2e=lateral or anterior open bite 1.1-2mm 2f= increased OB >3.5mm and no gingival contact	

Figure 1. IOTN-DHC components according to MOCDO acronym(70)

IOTN-DHC- Index of Orthodontic Treatment Need- Dental health Component

MOCDO-Missing-Overjet-Crossbite-Displacement of contact point-Overbite

The first part of the IOTN is the Dental Health Component (DHC) has 5 Grades defined as follows:

1. Grade 1 is almost perfection

2. Grade 2 is for minor irregularities such as:

- slightly protruding upper anterior teeth
- slightly irregular teeth
- minor reversals of the normal relationship of upper and lower teeth which do not interfere with normal function.

3. Grade 3 is for greater irregularities, which normally do not need treatment for health reasons including:

- upper front teeth that protrude less than 4 mm more than normal

- reversals of the normal relationship of upper teeth which only interfere with normal function to a minor degree; by less than 2 mm.
- irregularity of teeth which are less than 4 mm out of line
- open bites of less than 4 mm
- deep bites with no functional problems

4. Grade 4 is for more severe degrees of irregularity and these do require treatment for health reasons, including:

- upper front teeth that protrude more than 6 mm
- reversals of the normal relationship of upper teeth which interfere with normal function greater than 2 mm
- lower front teeth that protrude in front of the upper teeth more than 3.5 mm
- irregularity of teeth which are more than 4 mm out of line
- less than the normal number of teeth (missing teeth) where gaps need to be closed
- open bites of more than 4 mm
- deep bites with functional problems
- more than the normal number of teeth (supernumerary teeth)

5. Grade 5 is for severe dental health problems, such as:

- when teeth are not housed in the mouth normally because of obstruction by crowding, supernumerary teeth, or any other cause.
- a large number of missing teeth.
- upper front teeth that protrude more than 9 mm
- lower front teeth that protrude in front of the upper teeth more than 3.5 mm and where there are functional difficulties too
    - craniofacial anomalies such as cleft lip and palate.

The second part of the IOTN is the Aesthetic Component (AC). An evaluation with the IOTN-AC index is performed using 10 images of smile attractiveness, scored from 1= almost perfect smile to 10 = the most severe smile.

Figure 2. The Aesthetic Component (AC) of the IOTN (Brook and Shaw , 1989)(71)
IOTN-Index of Orthodontic Treatment Need

1.4.2 Dental Aesthetics Index

The Dental Aesthetics Index was initially developed in the USA. It is based on aesthetic aspects of occlusion that have the potential to cause psychosocial or social dysfunction. DAI's evaluation criteria are based on specific criteria, including: dentition (absence of incisor, canine and premolars), space (crowding in the incisor region, spacing in the region of incisors, diastema, anterior jaw misalignment, anterior mandibular misalignment), occlusion (anterior maxillary overjet, anterior mandibular overjet, vertical anterior open bite) and anteroposterior molar relationship.

DAI score is calculated using the regression equation of 10 occlusal traits: (visible missing teeth x 6) + (crowding) + (space) + (diastema x 3) + (anterior maxillary misalignment) + (anterior

mandibular misalignment) + (anterior maxillary overjet x 4) + (anterior mandibular overjet x 4) + (anterior vertical open bite x 4) + (anteroposterior molar relationship x 3) + 13.

To determine the treatment need based on the DAI score, patients are categorized into four groups, including those with score of ≤25 (normal or mild occlusion with little or no need for treatment), scores of 26-30 (defined as malocclusion with elective need for treatment), scores of 31- 35 (severe malocclusion with highly desirable need for treatment), and the score of ≥36 (very severe or disabling malocclusion with mandatory treatment (43,72)

Components of DAI	Weight
Number of visole missing teeth	6
Crowding on incisal segments: 0= no crowding, 1=1 segment with crowding , 2=2 segments with crowding	1
Spacing on incisal segments: 0=no spacing , 1=1 segment with spacing, 2=2 segments with spacing	1
Median spacing in mm	3
Greater maxillary anterior misalignmt in mm	1
Greater mandibular anterior misalignmt in mm	1
Maxillary overjet in mm	2
Mandibular overjet in mm	4
Anterior open bite in mm	4
Molar relationship greater deviation from normal to mesial or distal : 0=nomral, 1=½ cusp to mesial or to distal, 2=1 or more cusps to mesial or to distal	3
CONSTANT	13
Total	Score DAI

Figure 3. Classification and components of DAI(72)

DAI-Dental Aesthetic Index

1.5 The psychosocial impact of the dental aesthetics questionnaire (PIDAQ)

PIDAQ is a specific questionnaire composed of 23 questions which is used to provide information on adult's OHRQoL.

The instrument was developed at the University of Mainz in Germany. It is composed of four subtypes, representing four areas that are divided into one positive and three negative domains.

The domains of the questionnaire are Dental Self Confidence (DSC) (6 items), Social Impact (SI) (8 items), Psychological Impact (PI) (6 items) and Esthetic Concern (AC) (3 items). The response options are as follows: 0 = not at all; 1 = a little; 2 = somewhat; 3 = strongly; and 4 = very strongly. Each subscale score can be calculated separately and is obtained by summing the item scores. DSC is a positive domain meaning that the higher the score is the more satisfied the subject is with their teeth. Whereas, higher scores in SI, PI and AC as negative domains, show the non-satisfaction of subjects with the appearance of their teeth.

PIDAQ is described as an instrument with good psychometric properties and has widely been used and translated into several languages.

Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ)*(56)

Dental Self Confidence

1. I am proud of my teeth
   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

2. I like showing my teeth when I smile
    a) not at all
    b) a little
    c) somewhat
    d) strongly
    e) very strongly

3. I am happy about seeing my teeth in the mirror
    a) not at all
    b) a little
    c) somewhat
    d) strongly
    e) very strongly

4. Other people like my teeth
    a) not at all
    b) a little
    c) somewhat
    d) strongly
    e) very strongly

5. I am content with the look of my teeth
    a) not at all
    b) a little
    c) somewhat

d) strongly
e) very strongly

6. I like my tooth position

a) not at all
b) a little
c) somewhat
d) strongly
e) very strongly

Social Impact

1. When I smile, I sometimes try not to reveal my teeth completely

a) not at all
b) a little
c) somewhat
d) strongly
e) very strongly

2. If I don't know someone well, I imagine what they might think about my teeth.

a) not at all
b) a little
c) somewhat
d) strongly
e) very strongly

3. I sometimes fear others might tease me because of my teeth.

a) not at all
b) a little
c) somewhat
d) strongly
e) very strongly

4. I occasionally feel a little self-conscious toward others because of my teeth

a) not at all
b) a little
c) somewhat
d) strongly
e) very strongly

5. I would sometimes like to put my hand in front of my mouth in order to hide my teeth.

a) not at all
b) a little
c) somewhat
d) strongly
e) very strongly

6. I sometimes have the feeling that people are giving me funny looks when they see my teeth

a) not at all
b) a little
c) somewhat
d) strongly
e) very strongly

7. Stupid jokes about my teeth upset me, even if they are only said in fun
   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

8. I sometimes fear that other boys (or girls) might think my teeth are ugly

   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

Psychological Impact

1. I sometimes envy friends whose teeth are more beautiful.

   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

2. If I compare my own teeth with others ‘, I may get upset

   a) not at all
   b) a little
   c) somewhat
   d) strongly

e) very strongly

3. I sometimes feel ashamed because of my tooth position

   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

4. I think that most of my friends have more beautiful teeth
   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

5. The look of my teeth sometimes makes me a bit unhappy
   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

6. I sometimes wish my teeth would look better
   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

Aesthetic Concern

1. I don't like my teeth when I look at myself in the mirror
   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

2. I dislike seeing my teeth on pictures of me

   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

3. I don't like my teeth when I see myself in a video

   a) not at all
   b) a little
   c) somewhat
   d) strongly
   e) very strongly

*Item entries of the PIDAQ youth form

2. MATERIAL AND METHODS

2.1 Translation and Validation of PIDAQ

Most questionnaires, including the PIDAQ, are written in English. When they are used in other countries, they need to be translated and adapted appropriately, taking into account the cultural and social aspects of the new region where they are to be used, while preserving their psychometric properties.

2.1.1 Translation and Validation of PIDAQ in the adult population of ages 18-30

To use the PIDAQ questionnaire for the assessment of the psychosocial impact of malocclusion in adolescents in Kosovo, it needed first to be translated and validated in the Albanian cultural context.

In the first phase three dentists, fluent in English and Albanian (one of them being familiar with OHRQoL instruments), translated the English version of PIDAQ into Albanian, independently.

Later on, each translation was checked interchangeably and an initial draft of the PIDAQ was generated. Next, the Albanian version was independently back translated into English by a professional translator.

A committee of three orthodontists and one dentist, all of them fluent in English, compared the original, translated, and back translated versions, finally proposing a second draft.
To analyze the accuracy of the questions in Albanian contextual relationship, the second draft of the Albanian PIDAQ questionnaire was administered to 10 subjects who were not selected for the main study. According to derived findings, a few linguistic modifications were made and the final Albanian Version of PIDAQ was developed.

To assess the validity and reliability of the questionnaire, in the first phase, overall 130 participants (62% females), aged 18-30 (with mean age 24.3 ± 3.7) were selected from 5 different private practices of two cities in Kosovo, Pristina and Gjilan, representing a diverse sampling pool, and sticking to the fact that 50% of inhabitants in Pristina have migrated from all around the country.

All subjects participating in the study were volunteers and they provided written consent. The selection of participants was done between January and June 2017. The PIDAQ questionnaires were delivered while subjects were waiting for their annual dental check-ups, orthodontic treatment, or visiting their private practice dentists.

2.1.2 Validity and reliability of the translated version of PIDAQ among adolescents

After translation and validation among Kosovar adults aged 18 – 30 years, the PIDAQ questionnaire has been validated among Kosovar adolescents. In the second phase, a convenience sample of 200 adolescents (84 M, 116 F), aged between 12 and 15 years and selected randomly with systematic sampling, completed the PIDAQ at school. Subsequently, the adolescents were examined for malocclusion based on IOTN-AC and DAI. Next, 20 randomly selected participants re-answered the questionnaire to assess the test-retest reliability of the PIDAQ questionnaire. The second research study, entitled "Validity and Reliability of Psychosocial Impact of Dental Aesthetics Questionnaire in Kosovar Adolescents" has been accepted for publication in the International Journal of Adolescent Medicine and Health. DOI: 10.1515/ijamh-2019-0038

2.2 Sample selection for assessment of the psychosocial impact of malocclusion

458 adolescents aged 12 to 15 years were examined for malocclusion. Out of this number, 36 subjects were excluded due to prior history of orthodontic treatment. 18 subjects were excluded because of caries in their anterior teeth and 4 subjects because of white spots in anterior teeth.
400 adolescents (180 M, 220 F) completed the PIDAQ at school and were classified for malocclusion based on IOTN-DHC, IOTN-AC and DAI indices. The examination was performed by a single examiner, who had been previously trained, and calibrated for the use of the indices. Subjects were also asked to rate their smile using IOTN-AC (self IOTN-AC).

2.3 Ethical consideration

This research was approved by the Research Ethics Committee of Dental School at the University of Zagreb, Croatia.

Ethical approval was also obtained from the Education Directory in each municipality of the Republic of Kosovo. An informed consent letter was delivered to subjects' parents during periodic parental meetings in the selected schools, and it was included in the study.

2.4 Confidentiality

Study data were collected by the researcher and were only used for the purpose of this research and for educational purposes. The data of the subjects have not been and will not be revealed. No name, address or questionnaire responses were given to assistant staff. Access to the subject's dental records and responses of the questionnaire were provided only to the researchers engaged in this study.

2.5 Informed consent process

As described above, the informed consent letter was delivered to the subjects' parents during regular parental meetings in the school that were selected for the study. Only the subjects whose parents have signed the informed consent letter were invited to participate in this study.

2.6 Study Design

This study is a cross-sectional study because it was carried out at a specific point in time.

2.6.1 Sampling Design

To obtain a representative sample, subjects were chosen in proportion to the distribution of the schools in different cities in Kosovo (Pristina, Gjilan, Kamenice, Viti, and Prizren). The selection of subjects was divided into two phases. In the first phase, a total number of schools (235) in five cities were categorized based on the number of students as either large (n=L), medium (n=M), or small (n=S) size school. Next, 10 schools were randomly selected. In the second phase, classes were again randomly selected from the previously selected 10 schools.

2.6.2 Selection Criteria

Subjects aged 12- 15 years were selected for the study. During sampling, the following exclusion criteria were used: 1) history of orthodontic treatment, 2) missing or fractured teeth in the anterior region, 3) pigmented spots in the anterior region, and 4) craniofacial anomaly.

2.6.3 Sample Size

According to the statistics of the Directory of Education in the Republic of Kosovo, there are approximately 130,000 adolescents aged 12-15 years in Kosovo. The sample size for the study was calculated using the given standard error of 5%, a 95% confidence interval and 80% power, which resulted in 374 subjects. This number was approximated to 400 subjects.

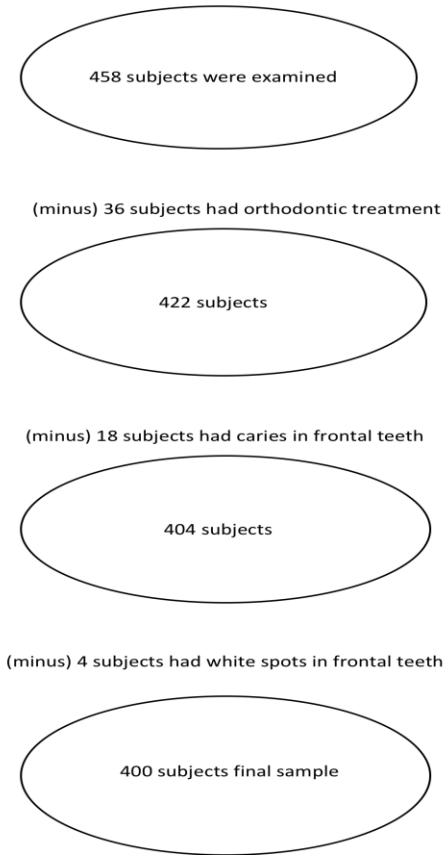

Figure 4. The flow of sample selection.

2.6.4 Recruitment

The sample recruited for this study was independent of the sample used for translation and validity assessment of the PIDAQ Questionnaire in the first study.

2.6.5 Data Collection procedure

All data collected during this study were stored in the researcher's personal computer. Access to this information was provided only to the researcher and her mentors, and it was used solely for the purpose of this study. The obtained results will be published as a scientific research publication without the possibility of revealing the identity of the individual respondents.

2.7 Analytical approach

Data analysis was performed using the Statistical Package for Social Sciences (version 12, SPSS Inc., Chicago, Illinois, USA).

2.7.1 Assessing the validity and reliability of the Albanian version of PIDAQ questionnaire

For the first study, and following COSMON guidelines, the construct validity of PIDAQ questionnaire was determined by evaluating structural validity. As proposed by COSMON guidelines, confirmatory factor analysis was performed to assess the structural validity of the PIDAQ questionnaire.

To test discriminant validity, each domain of the PIDAQ was compared with the level of malocclusion assessed by the investigator according to IOTN-DHC and IOTN-AC using the Kruskal Wallis test and Bonferroni post hoc analysis for multiple comparisons. The reliability of the PIDAQ questionnaire was assessed via internal consistency, test-retest reliability and measurement error.

The internal consistency of the Albanian version of PIDAQ was assessed by calculating the Cronbach's alpha coefficients for the subtypes and average inter-item correlations for the PIDAQ subtypes. Test-retest reliability was evaluated using intra-class correlation coefficients (ICC) and measurement error from a retest assessment performed three weeks later on 20 patients with no dental intervention. A paired-samples t-test was used to test the differences in participant's answers following treatment, and to assess the psychosocial impact of orthodontic treatment.

In the second study, the internal consistency was assessed by calculating the Cronbach's alpha coefficients for the PIDAQ subscales. Discriminant validity was tested by comparing the severity of the psychosocial impacts of dental esthetics assessed by PIDAQ subscales between subjects with minor and major malocclusions assessed by DAI (non-parametric Mann Whitney test) and IOTN-AC (the Kruskal-Wallis test).

To analyze the impact of malocclusion on the psychosocial aspect based on gender, all DAI samples with the presence of malocclusion (DAI ≥ 26) were grouped by gender. The statistical significance was calculated using the Mann-Whitney test. The level of significance was set at 5 %. Test re-test reliability was assessed using the intra-class correlation coefficient (ICC) with a two-way random effect model.

2.7.2 Assessing the psychosocial impact of malocclusion and gender-based differences of the impact of malocclusion

The normality of data distribution was assessed using the Kolmogorov-Smirnov test. Since the p-value was >.001 for each item, it was concluded that the sample data had a non-normal distribution. Therefore, non-parametric tests were used during the calculation of mean differences (i.e. Mann Whitney test).

To test the discriminant validity of our constructs, we have compared the severity of the psychosocial impact of dental esthetics assessed by PIDAQ subscales between subjects with minor and major malocclusion assessed by DAI (Mann Whitney test), IOTN-DHC (Kruskal-Wallis test), and IOTN-AC (Kruskal-Wallis test). Discriminant validity of PIDAQ domains in the Dental Health Component of Index of Orthodontic Treatment Need (IOTN) was performed by grouping index grades into three categories (score 1-2, score 3, and score 4-5). Aesthetic Component of the Index of Orthodontic Treatment was grouped into three categories (score 1-3, score 4-7 and score 8-10), and DAI was dichotomized into two groups with scores ≤ 25 and ≥ 26).

The Pearson correlation coefficients and respective significance tests were performed to assess the relationship between the PIDAQ domains with each of the IOTN-DHC, IOTN-AC, DAI, and Self-AC indices.

Linear regression models were employed to study the linear relationship between the PIDAQ data

as the dependent variable and the IOTN components, gender, and social age as independent predictive variables. Gender-based differences for each category of IOTN and DAI indices and each subscale of the PIDAQ domain were calculated using non-parametric tests for mean differences (i.e. Kruskal Wallis).

3.RESULTS

3.1 Descriptive Statistics

The study sample consisted of 400 participants, with 180 (45%) boys and 220 (55%) girls aged 12-15 years. The majority of the participants were 14 years old (29.75 %), while 20.75% of them were 15 years old. The composition of the sample according to age and gender is presented in Table 1.

Table 1. Distribution of sample according to age and gender

Age	Male (%)	Female (%)	Total (%)
12	10.5	15.75	26.25
13	11.25	12	23.25
14	14.25	15.5	29.75
15	9	11.75	20.75
Total	**45**	**55**	**100**

The distribution of the sample based on gender, for both the IOTN and DAI indices demonstrates that the prevalence of malocclusion was higher among males than females; a larger number of males than females were categorized in grades 4 and 5, 8-10, and 36≤ of IOTN-DHC, IOTN-AC, and DAI respectively. A detailed prevalence of malocclusion based on gender is presented in Table 2.

Table 2. Gender-based distribution of malocclusion according to IOTN and DAI indices

IOTN-DHC	Gender	
	M (%)	F (%)
Grades 1-2	16.75	25.5
Grade 3	14.5	18.5
Grade 4	12.5	10.25
Grade 5	1.25	0.75
IOTN-AC		
Grades 1-3	31.5	42
Grades 4-5	9.25	10.25
Grades 6-7	2.25	1.5
Grades 8-10	2	1.25
DAI		
≤25	25.75	34.75
26-30	0.75	11.25
31-35	6.5	4.25
36≤	5.25	5

IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component; DAI- Dental Aesthetic Index

When the prevalence of malocclusion was analyzed in terms of age, according to the dental health of the index of orthodontic treatment need (IOTN – DHC), 12-year-olds had the highest percentage of a severe malocclusion (30.75%), while 13 and 15-year-olds had the lowest percentage.

When assessed with the aesthetic component of the index of orthodontic treatment need (IOTN-AC) and dental esthetic index DAI, 14-year-olds had the highest percentage of severe malocclusion with 1.75% for IOTN-AC, and 4.25 % for DAI respectively. A detailed prevalence of malocclusion based on age is presented in Table 3.

Table 3. Age-based distribution of malocclusion according to IOTN and DAI indices

	Age			
IOTN-DHC	**12 (%)**	**13 (%)**	**14 (%)**	**15 (%)**
Grades 1-2	9.75	12.25	12	8.25
Grade 3	9.75	6	10.5	6.75
Grade 4	6	4.5	6.5	5.75
Grade 5	30.75	0.5	0.75	0
IOTN-AC				
Grades 1-3	19.75	17.75	22.25	13.75
Grades 4-5	5	4	5	5.5
Grades 6-7	1	0.75	0.75	1.25
Grades 8-10	0.5	0.75	1.75	0.25
DAI				
≤25	15.5	16.25	17.75	10.75
26-30	5.5	3	4	6.25
31-35	3	2.25	3.75	1.75
36≤	2.25	1.75	4.25	2

IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component; DAI- Dental Aesthetic Index

3.2 Results of non-parametric multivariate analysis of variance

The test of gender-based difference across each category of IOTN revealed that there is a significant difference between categories for IOTN-DHC and DAI indices and no significant difference across categories of IOTN-AC index. When looking at age groups, no significant difference was noted between age groups for both IOTN and the DAI indices (Table 4).

Table 4. Gender and age-based differences across IOTN-DHC, IOTN-AC, and DAI indices

Index	**Gender diff.**	**Age diff.**
	Statistic test	
IOTN-DHC	0.02[a]	0.25[b]
IOTN-AC	0.13[a]	0.50[b]
DAI	0.03[a]	0.11[b]

[a]Mann Whitney test for mean differences; [b]Kruskal Walls test for mean differences; IOTN-DHC-Index of orthodontic treatment need-Dental health component; IOTN-AC- Index of orthodontic treatment need-Aesthetic component; DAI Dental Aesthetic Impact

The analysis of mean scores for each domain of the PIDAQ questionnaire (without the association of malocclusion severity) based on gender revealed that males and females have generally similar

scores in the four domains, and no statistically significant gender-based difference across the PIDAQ domains was noted. However, when age alone was considered, 12-year-olds had slightly higher scores in Social Impact, Psychological Impact and Aesthetic Concern domains. A significant difference in PIDAQ means scores among ages was noted only in the Dental Self-confidence subscale.

Tables 5 and 6 present descriptive statistics of the PIDAQ domains according to gender and age group.

Table 5. PIDAQ domain scores according to gender

PIDAQ domain	Gender				Statistics test, *p*-value*
	M (n=180)		F (n=220)		
	Mean	SD	Mean	SD	
DSC	10.34	6.57	10.32	6.56	0.255
SI	7.43	7.3	7.47	7.32	0.507
PI	9.55	5.83	9,59	5.84	0.268
AC	3.99	3.42	4.02	3.43	0.105
Total PIDAQ mean	1.35	0.54	1.43	0.53	0.083

* Mann-Whitney test of significance according to gender; DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire

Table 6. PIDAQ domain scores according to age

PIDAQ domain	Age								Statistics test*
	12 (n=105)		13 (n=93)		14 (n=119)		15 (n=83)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
DSC	10.21	6.47	10.24	6.5	10.32	6.57	10.32	6.55	<0.05
SI	7.62	7.32	7.49	7.29	7.45	7.33	7.46	7.31	0.697
PI	9.68	5.77	9.56	5.81	9.55	5.85	9.58	5.83	0.187
AC	4.08	3.38	4.01	3.4	4.00	3.43	4.02	3.42	0.326
Total PIDAQ mean	1.38	0.55	1.35	0.46	1.41	0.56	1.43	0.55	0.908

* Kruskal-Wallis test of significance according to age; DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire

To analyze whether there are significant gender-based differences across categories of malocclusion as assessed with IOTN-DHC, we analyzed each PIDAQ domain separately for 3 categories of IOTN-DHC. The results revealed significant differences for the Dental Self-Confidence domain concerning Grade 3 of IOTN-DHC. Social Impact domain and Grade 1 and 2 of IOTN-DHC, Psychological Impact domain and Grade 3 IOTN-DHC, and Aesthetic Concern domain and Grade 1 and 2 of IOTN-DHC. Overall, males and females scored differently in the PIDAQ domain for minor or moderate malocclusion.

Table 7. Gender-based differences for each IOTN-DHC category across PIDAQ domains

PIDAQ Domain	IOTN DHC														
	Grade 1 and 2 (n=169)					Grade 3 (n=132)					Grade 4 and 5 (n=99)				
	F (mean)	F (SD)	M (mean)	M (SD)	p-value	F (mean)	F (SD)	M (mean)	M (SD)	p-value	F (mean)	F (SD)	M (mean)	M (SD)	p-value
Dental self-confidence	2.22	0.98	2.39	0.97	0.2	1.23	0.96	1.66	0.95	0.01	1.11	1.045	1.15	0.92	0.56
Social Impact	0.62	0.7	0.45	0.63	0.04	1.17	0.99	0.91	0.76	0.51	1.5	1.01	1.42	1.01	0.74
Psychological Impact	0.85	0.85	0.98	0.74	0.1	1.92	0.91	1.62	0.87	0.05	2.19	0.99	2.12	0.93	0.86
Aesthetic Concern	1	0.97	0.59	0.72	0	4.36	1.06	4.42	1.03	0.24	2.12	1.07	2.03	1.3	0.67
PIDAQ Mean	1.25	0.44	1.11	0.34	0.01	1.43	0.54	1.34	0.5	0.33	1.66	0.58	1.61	0.62	0.5

Kruskal-Wallis test for IOTN-DHC categories; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component

When looking at the IOTN-AC index for similar gender-based comparison among the PIDAQ domains, significant differences in the Aesthetic Concern domain and Grade 1,2, and 3 of IOTN-AC index are observed, revealing the impact that minor malocclusion (as assessed with IOTN-AC) has on the self-perception of adolescents, females compared to males.

Table 8. Gender-based differences for each IOTN-AC category across PIDAQ domains

PIDAQ Domain	IOTN AC														
	Grade 1,2, and 3 (n=294)					Grade 4,5,6, and 7 (n=93)					Grade 8,9, and 10 (n=13)				
	F (mean)	F (SD)	M (mean)	M (SD)	p-value	F (mean)	F (SD)	M (mean)	M (SD)	p-value	F (mean)	F (SD)	M (mean)	M (SD)	p-value
Dental self-confidence	1.88	1.07	2.08	0.93	0.09	0.97	0.91	1.16	1.09	0.59	0.93	1.36	0.69	0.69	0.94
Social Impact	0.82	0.83	0.63	6.89	0.07	1.3	1	1.39	0.94	0.61	3.2	0.48	2.5	0.55	0.09
Psychological Impact	1.57	0.91	1.36	0.83	0.07	2.19	0.94	2.11	0.93	0.74	3.2	0.43	3.13	0.62	0.94
Aesthetic Concern	1.25	1.06	0.87	0.91	0	1.79	1.13	1.98	1.25	0.48	2.8	0.77	3	1.09	0.62
PIDAQ Mean	1.36	0.49	1.21	0.44	0	1.57	0.55	1.62	0.6	0.64	2.49	0.3	2.25	0.41	0.43

Kruskal-Wallis test for IOTN-AC categories; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component

With the dichotomization of DAI, significant gender-based differences across PIDAQ domains for the two categories of DAI were noted only in the Aesthetic Concern domain, for normal or minor malocclusion, revealing once more the similar evaluation yielded by IOTN-AC and DAI.

Table 9. Gender-based differences for each DAI category across PIDAQ domains

PIDAQ Domain	DAI	
	Normal or minor (n=241)	Malocclusion (n=159)
Dental self-confidence	0.19	0.36
Social Impact	0.10	0.89
Psychological Impact	0.12	0.53
Aesthetic Concern	0.02	0.79

Mann-Whitney test for dichotomous DAI categorization for each subscale; DAI- Dental Aesthetic Index; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire

The analysis of malocclusion indices for each age based on gender revealed that more males than females had malocclusion when evaluated with both IOTN (DHC and AC) and DAI indices. When each age group was considered based on both gender's mean scores in each domain of the PIDAQ

questionnaire, the data revealed that males had generally higher scores than females in Dental Self Confidence, while females had generally higher scores in the social impact, psychological impact, and aesthetic concern domains.

Table 10. Age and gender-based malocclusion according to IOTN, DAI, and PIDAQ questionnaire

Age	**12**		**13**		**14**		**15**	
Gender	M (n=42)	F (n=63)	M (n=45)	F (n=48)	M (n=57)	F (n=62)	M (n=36)	F (n=47)
IOTN-DHC	3.00 ± 0.98	2.71 ± 0.95	2.69 ± 0.99	2.60 ± 0.89	2.95 ± 0.95	2.71 ± 0.85	2.94 ± 0.98	2.68 ± 0.91
IOTN-AC	2.55 ± 1.78	2.60 ± 1.61	3.02 ± 2.10	2.27 ± 1.33	2.88 ± 1.95	2.65 ± 1.86	3.06 ± 1.75	2.66 ± 1.80
DAI	25.31 ± 7.73	24.62 ± 7.47	24.58 ± 7.47	22.81 ± 6.32	26.23 ± 9.70	26.39 ± 7.62	26.44 ± 6.92	24.11 ± 5.61
DSC	11.74 ± 6.16	10.86 ± 6.93	11.36 ± 6.35	11.31 ± 6.56	10.39 ± 6.10	8.60 ± 6.31	9.19 ± 7.20	9.34 ± 6.58
SI	5.86 ± 6.02	8.18 ± 7.85	8.04 ± 7.04	5.23 ± 4.71	7.18 ± 7.76	9.11 ± 8.15	6.72 ± 7.00	8.36 ± 8.10
PI	8.50 ± 5.54	9.81 ± 6.22	9.20 ± 6.00	8.23 ± 4.61	8.82 ± 5.62	10.73 ± 6.15	10.31 ± 5.95	10.85 ± 5.98
AC	3.36 ± 3.37	3.87 ± 3.12	3.71 ± 3.72	3.79 ± 2.97	3.61 ± 3.46	4.82 ± 3.51	4.42 ± 3.57	4.45 ± 3.66

IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component; DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; DAI- Dental Aesthetic Index; DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire

The Kruskal-Wallis test revealed that there is a significant difference in dental self-confidence, social impact, psychological impact, and aesthetic concern subscales across categories of IOTN-DHC. Table 11 presents the results of the discriminant validity test, as well as descriptive statistics for each grade of IOTN-DHC and each domain of PIDAQ, according to gender. The p-value column indicates the discriminant validity of the PIDAQ domains for categories of IOTN-DHC.

Table 11. Discriminant validity of PIDAQ domains based on IOTN-DHC index

PIDAQ Domain		IOTN-DHC						
		MALE			FEMALE			p value
		Grade 1 and 2	Grade 3	Grade 4 and 5	Grade 1 and 2	Grade 3	Grade 4 and 5	
DSC	Mean	2.39	1.66	1.15	2.22	1.23	1.11	<.01
	St. Dev.	0.97	0.95	0.99	0.98	0.96	1.04	
	Median	2.50	1.83	1.17	2.25	1.17	0.67	
	Interquartile Range	1.33	1.17	1.67	1.63	1.50	1.58	
SI	Mean	0.45	0.91	1.42	0.62	1.17	1.50	<.01
	St. Dev.	0.63	0.76	1.02	0.70	1.00	1.02	
	Median	0.25	0.63	1.31	0.38	0.88	1.38	
	Interquartile Range	0.63	0.94	1.66	0.75	1.34	1.78	
PI	Mean	0.98	1.62	2.12	1.24	1.92	2.19	<.01
	St. Dev.	0.74	0.87	0.96	0.85	0.91	0.99	
	Median	0.83	1.5	2.08	1.17	2.00	2.25	
	Interquartile Range	0.92	1.33	1.67	1.33	1.33	1.67	
AC	Mean	0.59	4.42	2.03	1.00	4.36	2.12	<.01
	St. Dev.	0.72	0.37	1.20	0.98	0.46	1.08	
	Median	0.33	4.44	2.00	1.00	4.46	2.00	
	Interquartile Range	0.83	0.28	2.00	1.58	0.25	1.67	
PIDAQ	Mean	1.11	1.34	1.61	1.25	1.43	1.66	<.01
	St. Dev.	0.33	0.48	0.58	0.41	0.54	0.57	
	Median	1.00	1.26	1.52	1.13	1.28	1.59	
	Interquartile Range	0.37	0.68	0.97	0.38	0.74	0.85	

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component

Significant differences for each PIDAQ domain were also noted across each category of the IOTN-AC index (Table 12).

Table 12 presents the results of the discriminant validity test, as well as descriptive statistics for each grade of IOTN-AC and each domain of PIDAQ according to gender. The p-value column indicates the discriminant validity of the PIDAQ domains for categories of IOTN-AC.

Table 12. Discriminant validity of PIDAQ domains based on IOTN-AC index

PIDAQ Domain		IOTN-AC						
		MALE			FEMALE			p value
		Grade 1,2, and 3	Grade 4,5,6, and 7	Grade 8,9, and 10	Grade 1,2, and 3	Grade 4,5,6, and 7	Grade 8,9, and 10	
DSC	Mean	2.08	1.16	0.69	1.88	0.97	0.93	<.01
	St. Dev.	0.93	1.09	0.69	1.07	0.91	1.36	
	Median	2.00	0.92	0.67	1.83	0.67	0.00	
	Interquartile Range	1.44	1.92	1.46	1.50	1.49	2.33	
SI	Mean	0.63	1.39	2.50	0.82	1.30	3.20	<.01
	St. Dev.	0.79	1.02	0.53	0.92	1.02	0.44	
	Median	0.00	2.00	2.50	1.00	1.00	3.00	
	Interquartile Range	1.00	2.00	1.50	1.00	1.00	0.50	
PI	Mean	1.36	2.11	3.13	1.57	2.19	3.20	<.01
	St. Dev.	0.88	1.02	0.64	1.02	0.95	0.44	
	Median	1.00	2.00	3.00	2.00	2.00	3.00	
	Interquartile Range	1.00	2.00	3.37	1.00	2.00	0.50	
AC	Mean	0.87	1.98	3.00	1.25	1.79	2.80	<.01
	St. Dev.	0.95	1.29	1.06	1.11	1.18	0.83	
	Median	1.00	2.00	3.00	1.00	2.00	3.00	
	Interquartile Range	1.00	2.00	1.75	2.00	2.00	1.00	
PIDAQ	Mean	1.21	1.62	2.25	1.36	1.57	2.49	<.01
	St. Dev.	0.44	0.57	0.42	0.49	0.55	0.30	
	Median	1.06	1.49	2.27	1.24	1.46	2.45	
	Interquartile Range	0.56	0.91	0.34	0.62	0.97	0.49	

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component

With the dichotomization of DAI results, statistically significant differences between the two groups were found in mean scores for dental self-confidence, psychological impact, social impact, and esthetic concern. The results of the discriminant validity test, as well as descriptive statistics for grades of AC and each domain of PIDAQ according to gender are presented in Table 13. The p-value column indicates the discriminant validity of the PIDAQ domains for categories DAI.

Table 13. Discriminant validity of PIDAQ domains based on DAI classification

PIDAQ Domain		DAI				p value
		MALE		FEMALE		
		DAI ≤25	DAI ≥26	DAI ≤25	DAI ≥26	
DSC	Mean	2.22	1.20	2.05	1.01	<.01
	St. Dev.	0.88	1.03	1.03	0.91	
	Median	2.17	1.00	2.00	1.08	
	Interquartile Range	1.50	1.50	1.50	1.53	
SI	Mean	0.54	1.33	0.71	1.43	<.01
	St. Dev.	0.61	0.98	0.76	1.03	
	Median	0.38	1.25	0.50	1.38	
	Interquartile Range	0.75	1.56	0.87	1.75	
PI	Mean	1.13	2.05	1.33	2.21	<.01
	St. Dev.	0.79	0.92	0.87	0.93	
	Median	1.00	2.00	1.33	2.33	
	Interquartile Range	0.67	2.00	0.67	1.54	
AC	Mean	0.77	1.88	1.09	1.96	<.01
	St. Dev.	0.80	1.29	1.00	1.08	
	Median	0.67	1.67	1.00	2.00	
	Interquartile Range	1.33	2.00	1.67	1.75	
PIDAQ	Mean	1.16	1.61	1.29	1.65	<.01
	St. Dev.	0.39	0.60	0.46	0.58	
	Median	1.02	1.50	1.16	1.58	
	Interquartile Range	0.44	1.09	0.36	0.92	

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; DAI- Dental Aesthetic Index

To analyze the relationship between malocclusion indices and domains of the PIDAQ questionnaire, Pearson Correlation coefficients were calculated for each age group. Each group was further categorized according to the dichotomization of DAI scores (≥26 and <25).

12- year-olds

There is a significant negative correlation between the IOTN Self-AC and Dental Self-Confidence domain in the group of 12-year-olds with DAI greater than 25. A significant positive correlation was also noted between all indices and Social Impact domain, IOTN-AC and Psychological Impact domain, and between each index and Aesthetic Concern domain.

Table 14. Associations among malocclusion indices and PIDAQ domains with corresponding p values and correlation coefficients for 12-year-olds with DAI ≥ 25 (N=43)

	IOTN-DHC	IOTN-AC	DAI	SELF IOTN-AC
DSC	.159 -.219	.144 -.227	.726 -.055	<.01 -.590**
SI	.039 .316*	<.01 .494**	.033 .326*	.027 .338*
PI	.152 .223	.012 .380*	.135 .232	.09 .262
AC	.018 .359*	<.01 .517**	.012 .378*	<.01 .430**

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component; DAI-Dental Aesthetic Index; SELF IOTN-AC- Self rated Index of Orthodontic Treatment Need-Aesthetic Component.

13-year-olds

A weak negative correlation was noted between Self-AC and Dental Self-Confidence in the group of 13-year-olds with DAI greater than 25. Significant positive relationships were noted among IOTN-AC and Self IOTN-AC and Social Impact domain, Self IOTN-AC and Psychological Impact domain, and IOTN-DHC, IOTN-AC and Self IOTN-AC and Aesthetic Concern domain.

Table 15. Associations among malocclusion indices and PIDAQ domains with corresponding p values and correlation coefficients for 13-year-olds with DAI ≥ 25 (N=28)

	IOTN-DHC	IOTN-AC	DAI	SELF IOTN-AC
DSC	.818 -.046	.456 -.147	.334 -.189	.021 -.435*
SI	.079 .337	<.01 .480**	.064 .355	<.01 .578**
PI	.32 .195	.088 .328	.116 .304	<.01 .629**
AC	<.01 .477*	.027 .417*	.092 .325	<.01 .653**

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component; DAI-Dental Aesthetic Index; SELF IOTN-AC- Self rated Index of Orthodontic Treatment Need-Aesthetic Component.

14-year-olds

A significant negative correlation was observed between Self-AC and Dental Self-Confidence in the group of 14-year-olds with DAI greater than 25. A significant positive correlation was noted among IOTN-AC and Self-AC and Social Impact domain, IOTN-AC and Self IOTN-AC and Psychological Impact domain, and between IOTN-AC Self IOTN-AC and Aesthetic Concern domain. A weak positive correlation was also noted by IOTN-AC and Psychological Impact and Aesthetic Concern domains.

Table 16. Associations among malocclusion indices and PIDAQ domains with corresponding p values and correlation coefficients for 14-year-olds with DAI ≥ 25 (N=48)

	IOTN-DHC	IOTN-AC	DAI	SELF IOTN- AC
DSC	.147 -.213	.058 -.276	.506 -.098	<.01 -.438**
SI	.279 .159	<.01 .390**	>388 .128	<.01 .517**
PI	.135 .219	.011 .362*	.066 .268	<.01 .487**
AC	.139 .217	.016 .345*	.42 .119	<.01 .492**

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component; DAI-Dental Aesthetic Index; SELF IOTN-AC- Self rated Index of Orthodontic Treatment Need-Aesthetic Component.

15-year-olds

Contrary to the trends observed as age increased, among 15-year-olds with DAI ≥ 25 *a* significant positive correlation was noted only in the Social Impact domain and IOTN-AC and in Aesthetic Concern domain and, also, IOTN-AC. These results point out the importance of aesthetics in the well-being of adolescents, especially as their age increases, impacting their social interactions, self-perception and confidence.

Table 17. Associations among malocclusion indices and PIDAQ domains with corresponding p values and correlation coefficients for 15-year-olds with DAI ≥ 25 (N=43)

	IOTN-DHC	IOTN-AC	DAI	SELF IOTN-AC
DSC	.663 -.071	.154 -.230	.738 .055	.099 -.264
SI	.140 .237	.015 .383*	.396 .138	.079 .281
PI	.056 .305	.125 .247	.299 .168	.462 .120
AC	.061 .299	.018 .293	.522 .104	.152 .231

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component; DAI-Dental Aesthetic Index; SELF IOTN-AC- Self rated Index of Orthodontic Treatment Need-Aesthetic Component.

3.3 Results of linear regression analysis

Table 18 shows that the IOTN-DHC was a predictive variable of the total and subscale PIDAQ scores. Gender and age were the independent predictive variable of the relationship between the PIDAQ scores and the IOTN-DHC grades for the DSC and AC subscales. For the PI subscale, gender was a predictive variable in the linear model.

Table 18. Linear regression models of PIDAQ with IOTN-DHC as predictive variable

Dependent variable	R	Predictive variables	Equation of the model
DSC subscale	0.469	IOTN-DHC: Beta coeff. = -0.614, p=<0.001 Other in the model: Gender - Beta coeff.= -0.247, p=0.012 Age – Beta coeff.= - 0.127, p=0.005	DSC=3.29 - (0.614xIOTN-DHC) – (0.247xFemale) – (0.127xAge)
SI subscale	0.400	IOTN-DHC: Beta coeff. =0.494, p=<0.001 Other in the model: Gender - Beta coeff.= 0.171, p=0.065 Age – Beta coeff.= 0.029, p=0.491	SI=-0.121 + (0.494xIOTN-DHC) + (0.171xFemale) + (0.029xAge)
PI subscale	0.431	IOTN-DHC: Beta coeff. =0.544, p=<0.001 Other in the model: Gender - Beta coeff.= 0.221, p=0.020 Age – Beta coeff.= 0.082, p=0.056	PI=0.372 + (0.544xIOTN-DHC) + (0.221xFemale) + (0.082xAge)
AC subscale	0.45	IOTN-DHC: Beta coeff. =0.646, p=<0.001 Other in the model: Gender - Beta coeff.= 0.289, p=0.007 Age – Beta coeff.= 0.102, p=0.037	AC=-0.258 + (0.646xIOTN-DHC) + (0.289xFemale) + (0.102xAge)
PIDAQ Mean	0.378	IOTN-DHC: Beta coeff. =0.249, p=<0.001 Other in the model: Gender - Beta coeff.= 0.124, p=0.015 Age – Beta coeff.= 0.020, p=0.389	PIDAQ=0.826 + (0.249xIOTN-DHC) + (0.124xFemale) + (0.020xAge)

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; IOTN-DHC- Index of Orthodontic Treatment Need-Dental Health Component

The IOTN-AC was a predictive variable of the total and subscale PIDAQ scores, which is presented in Table 19. Age was an independent predictive variable of the relationship between the PIDAQ scores and the IOTN-AC grades for the DSC and SI subscales. For the AC subscale, gender was a predictive variable in the linear model.

Table 19. Linear regression models of PIDAQ with IOTN-AC as predictive variable

Dependent variable	R	Predictive variables	Equation of the model
DSC subscale	0.397	IOTN-AC: Beta coeff. =-0.778, p=<0.001 Other in the model: Gender - Beta coeff.= -0.191, p=0.060 Age – Beta coeff.= -0.110, p=0.018	DSC=3.102 - (0.778xIOTN-AC) – (0.191xFemale) – (0.110xAge)
SI subscale	0.415	IOTN-AC: Beta coeff. = 0.781, p=<0.001 Other in the model: Gender - Beta coeff.= 0.011, p=0.791 Age – Beta coeff.= 0.781, p=0.011	SI=-0.172 + (0.781xIOTN-AC) + (0.011xFemale) + (0.781xAge)
PI subscale	0.391	IOTN-AC: Beta coeff. =0.746, p=<0.001 Other in the model: Gender - Beta coeff.= 0.176, p=0.068 Age – Beta coeff.= 0.066, p=0.134	PI=0.461 + (0.746xIOTN-AC) + (0.176xFemale) + (0.066xAge)
AC subscale	0.394	IOTN-AC: Beta coeff. =0.854, p=<0.001 Excluded of the model: Gender - Beta coeff.= 0.233, p=0.035 Age – Beta coeff.= 0.083, p=0.098	AC=-0.110 + (0.854xIOTN-AC) + (0.233xFemale) + (0.083xAge)
PIDAQ Mean	0.395	IOTN-AC: Beta coeff. =0.398, p=<0.001 Other in the model: Gender - Beta coeff.= 0.108, p=0.031 Age – Beta coeff.= 0.011, p=0.640	PIDAQ=0.796 + (0.398xIOTN-AC) + (0.108xFemale) + (0.011xAge)

DSC- Dental Self Confidence; SI- Social Impact; PI- Psychological Impact; AC- Aesthetic Concern; PIDAQ- Psychosocial Impact of Dental Aesthetic Questionnaire; IOTN-AC- Index of Orthodontic Treatment Need-Aesthetic Component;

4.DISCUSSION

4.1 Discussion of assessing the validity and reliability of the Albanian version of PIDAQ

Different questionnaires have been developed to measure the quality of life related to specific health issues. Such questionnaires need to be validated for reproducibility in other cultural contexts, by comparison of the original and the translated version of the measuring instrument. Proven good psychometric properties enable the usage of such instruments cross-culturally (73). Through the first study, we aimed to translate and validate the PIDAQ questionnaire in the Albanian language through its administration in a sample of 130 adults aged 18-30 years. We also aimed to assess the psychosocial impact of orthodontic treatment in a limited sample of 20 patients who underwent orthodontic treatment using the validated questionnaire.

Our first study revealed that the Albanian version of the PIDAQ has proper validity and reliability, revealing psychometric properties that are similar to those of the original PIDAQ proposed by Klages et al. (56), thus justifying its use among young Kosovar adults of similar ages.

The highest internal consistency coefficient was noted in the Dental Self Confidence, while the lowest was noted in the Psychological Impact. The lowest average inter-item correlation was also noted in the Psychological Impact, as was the Cronbach's Alpha coefficient. The same results with the lowest internal consistency coefficient in PI were obtained by Bucci et al. and Aglarci et al. (57, 74). The items of the PI relate to the psychological welfare of the subject population. Considering the subject age groups, 18-30, and the low correlation of the PI, followed by the SI, the results can depict the concern of the population with their image, impacting the psychological welfare and social interactions.

The Albanian version of the PIDAQ has also yielded the Cronbach's alpha coefficient between 0.90 and 0.96 for the four subtypes, and intra-class correlation coefficients of 0.98 and 0.99, demonstrating a good reproducibility and a very high reliability. While the Cronbach's alpha coefficients were very similar to those measured from Nepalese and Chinese populations, they were relatively lower than those from Spanish, Brazilian and Turkish populations. (57,75–78)

The discriminant validity of the questionnaire and its subtypes was determined using the treatment need assessed by the orthodontist (IOTN-AC) and the Dental Health Component (IOTN –DHC)

indices. Our results showed that as the treatment need raises, the PI, SI and AC subtype scores raise in the case of the both indices. The DSC subtype scores increase as the treatment needs decrease, considering that the DSC is scored on a positive domain. Each subtype was significantly related to the both indices used.

The similar results were obtained in other scientific papers when using different orthodontic indices. As the level of malocclusion raises using IOTN, DAI or Perception of occlusal scale (POS), the PIDAQ scores raises too (57, 60, 74, 77, 79, 80).

The Albanian version of the PIDAQ demonstrates the ability to detect malocclusion as assessed by IOTN-AC and IOTN-DHC indices.

A possible explanation for the raise in the PI ad SI subtype scores is that the young adolescent population is highly concerned with their image, which in turn impacts their social interactions and their psychological well-being. The malocclusions and treatment need assessment by the orthodontist coincided with the population scoring higher on the PI and SI subtypes, suggesting the impact of malocclusion on dental self-consciousness and the presence of an overall societal culture where facial aesthetics attains much value and emphasis.

Our results were confirmed by the statistics achieved after the orthodontic treatment of the sample group. All the subtypes of the PIDAQ questionnaire revealed the significant differences in the first phase of the orthodontic treatment. These findings suggest that adults are not able to detach their negative perceptions of dental-facial appearance from their social interactions and psychological well-being. Particularly, adults with mild to moderate and severe malocclusion displayed a significant change in scores related to their psychosocial well-being (39).

The same results as ours were obtained by Spalj et al. who reported differences in PIDAQ scores upon orthodontic treatment that improved their dental aesthetics (79).

While our first study yielded positive results with regards to the applicability of the PIDAQ among Kosovar adults for measuring the impact of malocclusion on the quality of life, this research had some sample composition limitations.

Namely, all the participants in the study were recruited from private practice orthodontic centers in urban areas. This introduced several confounding factors that can be summarized as below:

- Patients who visited private practice centers were performing their regular check-ups or were seeking orthodontic treatment. Some studies reveal that subjective self-evaluation and perception of malocclusion may affect the quality of life to a higher extent compared to the objective clinical indices used to assess treatment needs (68). As a result, the PIDAQ questionnaire focused on people who were generally in need of orthodontic treatment rather than on a random sample selection.

- Secondly, considering the cost of dental care in Kosovo and limited access to private practices in rural areas, it is expected that patients visiting private clinics represent a higher income-earning group of society. In light of the GDP per capita in Kosovo, it can be assumed that the sample comprised of higher wage earners and had a limited reach to average low-income earners in Kosovo, representing the majority of the population particularly burdened with orthodontic treatment need.

- Thirdly, the level of health education in general and oral health awareness in specific, possessed by the higher income-earners in Kosovo is expected to be higher due to their easier access to information and health facilities. As a result, information bias is also one limitation we consider in terms of the study sample. The latter may result in a higher impact of malocclusion on the quality of life due to increased self-awareness and self-esteem that follow better economic status and education level (68).

Conceptually, several studies have confirmed that the PIDAQ has reliability and validity satisfactory enough to be used in studies exploring orthodontic-specific aspects of quality of life among adults and adolescents (57, 60, 61, 74, 79, 81). Furthermore, when administered together

with the Oral Health Impact Profile (OHIP-14), it was ascertained that the oral health status did not affect the OHRQoL based on the OHIP-14 score. On the other hand, the PIDAQ showed significant gender-based differences regarding the impact of malocclusion, thus supporting the adequacy of using PIDAQ in condition-specific cases (82).

The second goal of the study was to assess the psychosocial impact of orthodontic treatment with the validated instrument (PIDAQ). The results of our discriminant validity tests explained above demonstrated that PIDAQ subscale scores differed significantly according to the grade determined with the IOTN indices. In addition to that, significant differences were noted in the subjects' psychosocial well-being impact as a result of orthodontic treatment that improved their dental aesthetics. The limitation of our findings with reference to the psychosocial impact of orthodontic treatment was mainly related to the limited sample size, thus demanding further studies to confirm the role of aesthetics on self-esteem and wellbeing of adolescents.

4.2 Discussion of assessing the validity and reliability of the Albanian version of PIDAQ in adolescents in Kosovo

The goal of the second study was testing the validity and reliability of the Psychosocial Impact of Dental aesthetics Questionnaire (PIDAQ) - Albanian version among Kosovar adolescents of ages 12-15 and further assessing the gender-based differences of malocclusion on PIDAQ subscales. Previously, the PIDAQ questionnaire has been translated and validated for its usage in Kosovar adults.

Even though the PIDAQ has been originally developed for the assessment of the psychosocial impact of dental aesthetics in young adults, the studies including Brazilian and Spanish schoolchildren suggested that the PIDAQ might be applicable in adolescents too(61,74,81,83).

The second study also demonstrated that the PIDAQ instrument has a satisfactory internal consistency and reliability when applied among young Kosovar adolescents. The highest internal consistency of the PIDAQ, as assessed by the Cronbach's alpha coefficient, was in the DSC

subtype, whereas the lowest was in the AC subtype. Montiel-Company's results in Spanish adolescents are similar to ours (81). Even though the same highest internal consistency of the Cronbach's alpha coefficient in the DSC and lowest in the AC was found by Mendes-Santos in Brazilian adolescents, their overall values were relatively lower from ours (61).

The discriminant validity of the questionnaire and its subscales were determined using the dichotomous dental aesthetic index categorization. There was a significant difference in the PIDAQ scores for each subscale between 'no' to 'minor and severe malocclusion'. The subjects with severe malocclusion (DAI $\geq$ 26) scored worse in all of the PIDAQ subscales compared to subjects with no or minor malocclusion (DAI $\leq$ 25). These findings are supported by other studies suggesting that malocclusion harms social, emotional and functional aspects (29,59,84–86).

Our results show that, when used in adolescents, the Albanian version of PIDAQ can detect malocclusion, consequently its psychological impact, as the scores of PIDAQ were connected to classification by IOTN and DAI indices.

All the subjects who had higher grades in the both indices (IOTN and DAI), hence classified as having moderate to severe malocclusion, scored lower on DSC subtype, while scoring higher on SI, PI, and AC subtypes.

Similar results as ours were discovered in a study by Gavric et al. They found that with increased malocclusion, the DSC decreased and SI, Pi, and AC increased (87).

The concern of the population with their image was revealed through the gender-based differences of malocclusion on the Aesthetic concern subscale, where females scored significantly worse than males, but no significant difference was noted in the other PIDAQ subscales. This can be attributed to the more prevalent concerns of young adolescents and the societal gender-based perceptions regarding dental aesthetics and their role in general appearance. A study by Bellot-Arcis et al. analyzed gender-based differences of malocclusion and they obtained similar results in DSC and SI subscales but not in AC and PI, that is, we found significant statistical difference only in AC, whereas they found a difference only on PI (86). Lukez et al. also stated that female gender is associated with higher psychological influence of dental aesthetics (88). Santos et al obtained the same results as ours (61).

Discriminant validity of PIDAQ domains in the aesthetic component (AC) of Index of orthodontic treatment need (IOTN) shows that PIDAQ scores vary significantly in the social impact, psychological impact, and aesthetic concern subscales based on the IOTN-AC assessment. The DSC subscale scores increase as the treatment need falls, considering that the DSC is scored on a positive domain. Each subscale was significantly related to the both indices used. These results can be matched again to the concern of the young population about their image, impacting their psychological well-being and social interactions. Similar results can be found in the study of Sardenberg et al. (28).

The results of the study emphasized the importance of increased education and knowledge for early orthodontic treatment considering the significant impact of malocclusion on the psychosocial well-being of the population.

4.3 Discussion of the psychosocial impact of malocclusion among Kosovar adolescents

The study aims at evaluating the psychosocial impact of malocclusion, its relationship with the severity of malocclusion as assessed by IOTN and DAI indices; it also aims at evaluating the gender-based differences in the impact of malocclusion based on severity. We further analyzed age-based differences in the impact of malocclusion on PIDAQ subscales.

The gender-based prevalence of malocclusion among examined adolescents demonstrated that males had a higher prevalence of malocclusion compared to females, with a significant statistical difference for IOTN DHC and DAI index.

Gender-based prevalence of malocclusion among examined adolescents showed that 13.75% of males and 11% of females had 4^{th} and 5^{th} -grade malocclusion based on the IOTN-DHC index, while 16.75% of males and 25.5% of males have 1^{st} and 2^{nd} -grade malocclusion based on the IOTN-DHC index. Similarly, mixed prevalence among males and female participants was noted for the IOTN-AC and the DAI indices as well.

When indices were considered alone without association to PIDAQ subscales, significant gender-based differences across severity levels of malocclusion were noted for the IOTN-DHC and DAI indices, while no significant difference was noted based on IOTN-AC index. Looking at the assessment results with DAI index, 60.5% of participant adolescents had no or minor malocclusion, while 10.75% had malocclusion with a high need for treatment and 10.25% had a definitive need for treatment (handicapping malocclusion). These findings are similar to those of 12-year-old Indian schoolchildren assessed for malocclusion using DAI index (89).

PIDAQ subscales did not reveal significant differences among genders when considered for each domain of the questionnaire, without relation to the malocclusion indices. The prevalence of malocclusion was higher in males than in females with a significant statistical difference, and logically, we would expect males to score lower in PIDAQ subscales than females, but in our results we found no significant statistical difference between PIDAQ subscales among genders and we think that this is because males are prone to be more satisfied with dental appearance than females, the findings that are confirmed by other studies too (86, 90).

The prevalence of malocclusion was higher among 12-year-olds when assessed with IOTN-DHC index, with a particular emphasis on the grade 5 of IOTN-DHC malocclusion, while 14-year-olds had a higher prevalence of malocclusion when assessed both with DAI and IOTN-AC indices. These differences of indices might exist since IOTN-AC and DAI detect only frontal or visible malocclusion, while IOTN–DHC index considers posterior or invisible malocclusion too.

Our results thus show that 14-year-olds have more visible malocclusion, while 12-year-olds have less visible malocclusion, even though the significant age-based difference was not noted based on IOTN and DAI indices. On the other hand, the assessment of malocclusion among 12-15-year-old orphan children in India using the DAI index revealed that malocclusion severity significantly increased with age; however, there was no significant gender-based difference (91).

When it comes to the age-based differences of PIDAQ subscales, the dental self-confidence subscale scores differed significantly across age groups, with the youngest adolescents scoring the

lowest in the DSC subscale. Younger adolescents with malocclusion also scored higher in the Social Impact, Psychological Impact, and Aesthetic Concern domains. Similar results were also found in a study assessing the impact of malocclusion on the quality of life of adolescents aged 8-10 years in Brazil, where the results revealed that adolescents were more concerned with body image, acceptance and approval from people of the same age group (92). However, when PIDAQ scores were analyzed in association with malocclusion severity results were different. According to our results of multiple regressions models to identify predictors of the total PIDAQ scores age predicted the DSC and AC subscale scores. That is, the impact of malocclusion as measured by PIDAQ tended to be worse in older participants.

This data allows us to deduce that for the same severity level younger adolescents are less affected by malocclusion but with increasing age this effect might increase.

This is supported by a study of Bos et al. who reported a decrease in satisfaction in dentofacial appearance with increasing age (93).

The results of our study do not agree with the results of Marques et al. and Twigge et al. where OHRQoL was not age-dependent (31,94). However, one possible explanation might be that Marques et al. used Oral Impacts on Daily Performance (OIDP) and a younger age range, whereas Twigge used ICON and DAI as indices.

When considered in terms of each grade of the IOTN-DHC index, a significant difference between genders was noted for the Social Impact and Aesthetic Concern subscales for grades 1 and 2 of malocclusion, where females scored higher (a greater impact). A significant gender-based difference was noted for Dental Self-Confidence subscale for grade 3 of malocclusion, where females also experienced a greater impact. Combined with the higher prevalence of Grade 1, 2 and 3 of malocclusion based on IOTN-DHC among females, our results point out to the fact that minor irregularities affect females' social interactions and self-perception of attractiveness.

On the other hand, greater irregularities had a greater impact on females' confidence (DSC domain). The IOTN-AC index showed significant gender-based differences for the category with minor malocclusion and in the Aesthetic Concern subscale, where females also had a higher prevalence, depicting the concern of females with self-image and aesthetics. A similar relation was noted for the no or minor malocclusion assessed with the DAI for the Aesthetic Concern subscale,

where females also had a higher prevalence. Our results revealed that at minor levels of malocclusion females tend to be more affected than males on their overall aesthetically related confidence and social interactions.

The subjects who ranked higher the IOTN-DHC and IOTN-AC scored worse on all PIDAQ subscales, which produced significant differences across categories. Similarly, the dichotomization of DAI revealed that the subjects with DAI ≥ 26, scored worse in all PIDAQ subscales compared to subjects with no or minor malocclusion (DAI≤ 25). The results of our analysis indicate the negative impact of malocclusion on the social, emotional, and functional well-being of adolescents, as supported by similar studies (34, 65, 69, 95).

The analysis of the significance of correlation of IOTN-DHC, IOTN-AC, Self-AC and DAI with each subscale of PIDAQ revealed significant differences between a self-perceived malocclusion and an orthodontist assessed malocclusion, which was also reflected in PIDAQ subscales. Specifically, a significant negative correlation between dental self-confidence and Self-AC was found in subjects aged 12 years.

The Social Impact and Aesthetic Concern subscale were significantly related to each index used to assess malocclusion, revealing the concern of the 12-year-olds with their image, as well as its impact on their social interaction, as noted through a significant correlation with the Social Impact domain.

Generally, the adolescents aged 12, who were initially classified in the group of moderate to severe malocclusion with the DAI index, revealed a more significant correlation of the AC and SI subscales of the PIDAQ with malocclusion indices, and in particular with the IOTN-AC index. The similar significant correlations between the Social Impact domain and IOTN-AC and Self IOTN-AC were noted among 13-year-old adolescents.

For the same age group, the significant positive correlation between the Psychological Impact domain and Self IOTN-AC and Aesthetic Concern domain and IOTN-DHC, IOTN-AC, and Self-IOTN-AC indicates the concern of the young adolescents with their image. In particular, the indices that take into account visible malocclusion had the highest correlations with PIDAQ domains.

At the age of 14, self-perceived malocclusion (Self IOTN-AC) has a significant impact on each domain of PIDAQ, while in 15-year-olds, IOTN-AC is significantly correlated to the AC and SI only.

In assessing the significance of the linear relationship between IOTN indices and PIDAQ domains, this study found that each PIDAQ subscale had a significant linear relationship with grades of both the IOTN-DHC and IOTN-AC. The results demonstrate that both the IOTN-DHC and IOTN-AC are reliable indices to assess malocclusion. Similar to other studies, PIDAQ showed significant validity as an increase in the severity of malocclusion was associated to a greater psychosocial impact in subjects (96, 97).

Our study once more confirmed the embodiment of society's aesthetic expectations of females in psychosocial well-being and confidence levels of female adolescents.

Even though PIDAQ subscales alone did not detect significant gender-based differences, in relation to the severity of malocclusion, significant differences were noted for minor to moderate levels of malocclusion, with females scoring worse than males.

One possible explanation of why PIDAQ did not detect any differences might be due to the society's gender perception and expectations of aesthetics, whereby females are expected to adhere to certain beauty standards.

These standards may cause males to not be as concerned as females with their dental appearance, even at the same or slightly higher level of malocclusion.

This research study revealed that adolescents with malocclusion experienced negative physical and psychosocial impacts on their quality of life. However, the extent of this impact and trends varied due to factors such as sample size, potential confounding factors, the specific age-range of participants, and the study design

Our study's results can serve as information on the importance of enhanced education and knowledge for early orthodontic treatment, considering the significant impact of malocclusion on the psychosocial wellbeing of the population. In this regard, results can also be utilized in the

policy-making sector to plan public health care expenditures and services to ensure coverage of early and preventive dental care. Furthermore, studies emphasize the importance of ensuring accessibility to dental care services to prevent negative effects of malocclusion on the psychosocial wellbeing of young Kosovars.

The research study titled ‘Psychosocial impact of malocclusion in adolescents in Kosovo’ has been accepted for publication in Community Dental Health. DOI: 10.1922/CDH_00106Milosevic05.

5.CONCLUSION

- This research study revealed that adolescents with malocclusion experienced negative physical and psychosocial impact on their quality of life.

- It also demonstrated that, apart from severity, gender and age do significantly affect the extent of the impact on the psychosocial wellbeing of subjects.

- Females overall scored worse in all PIDAQ subscales indicating that they experience worse psychosocial impact than males.

- The older the subjects are, the more they experience the psychosocial impact of malocclusion.

- Our research study has also shown that PIDAQ has good validity and reliability for an application with Kosovar adolescents and adults.

- IOTN-DHC, IOTN-AC and DAI indices are reliable and reproducible indices that show the significance of the relationship between malocclusion and its impact on psychosocial well-being of adolescents and adults.

- The use of orthodontic indices to prioritize treatment need of malocclusion in settings with limited sources, such as developing countries, should be a topic to consider in future policy decisions in Kosovo.

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7.CURRICULUM VITAE

Donika Ilijazi Shahiqi was born on June 2nd 1989 in Gjilan, Kosova. She has graduated at the Faculty of Medicine, Department of Dentistry, University of Prishtina ―Hasan Prishtina, Republic of Kosova in 2013 with an excellent average grade of 9.32.

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She is member of the Kosovo Orthodontic Society and has actively been participating in different international scientific conferences. Recently she has contributed in translation of the book 'Endodontic Principles and Practices' in Albanian language.

List of published artices:

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