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ORIGINAL RESEARCH

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Validity and reliability of the Turkish version of the malocclusion impact questionnaire (MIQ)

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Abstract

Background: The Malocclusion Impact Questionnaire (MIQ) assesses oral health-related quality of life (OHRQoL) in patients aged 10–16 years with malocclusion. This cross-sectional study aims to create a Turkish version of the MIQ (MIQ-T) and evaluate its suitability for Turkish adolescents in determining malocclusion's impact on OHRQoL. **Methods**: The MIQ-T was developed following recommended guidelines. A total of 350 adolescents, aged 10–16 years, were recruited to the study to evaluate the psychometric properties of the questionnaire. For assessing the psychometric properties of the questionnaire, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), content validity, convergent validity, internal consistency and test-retest reliability methods were employed. **Results**: EFA identified three subgroups with a total variance of 65.911%. The CFA showed all fit indices met acceptable standards: Root Mean Square Error of Approximation (RMSEA) = 0.07, The Chi-square Degree of Freedom (CMIN/*df*) = 3.016, Tucker-Lewis Index (TLI) = 0.94, Goodness-of-Fit Index (GFI) = 0.90, and Comparative Fit Index (CFI) = 0.95. Convergent validity coefficients for the two global questions and specific items were 0.690 and 0.680, respectively. Test-retest reliability was 0.890, and the MIQ-T demonstrated strong internal consistency with Cronbach's alpha of 0.915. Split-half reliability analysis showed Cronbach's alpha values of 0.918 and 0.745 for the first and last nine items, respectively. **Conclusions**: These findings suggest that the MIQ-T is a useful tool for assessing the impact of malocclusion on OHRQoL in Turkish adolescents.

Keywords

Validity and reliability; Test-retest reliability; Malocclusion

1. Introduction

Malocclusions have been reported to negatively affect adolescents' self-esteem and emotional development [1]. Even minor dental discrepancies or severe dentofacial deformities can stigmatize adolescents, leading to bullying [2]. Bullying, recognized as the most common form of child abuse [3], has been linked to various mental health issues later in life due to childhood trauma [4]. Hence, it is crucial for public health to understand young patients' perceptions and concerns regarding their appearance.

A new medical model was proposed for broadening disease-centered models to biopsychosocial models that consider patients' emotional status, which is described as a more humanistic and more scientific model in 1960s [5]. Over time, this model became widely adopted in clinical practice and health education settings in contemporary health care delivery [6]. Consequently, oral health-related quality of life (OHRQoL) has gained importance in dental practice [7]. OHRQoL is a multidimensional structure that assesses oral health status subjectively. It includes functional- emotional and social aspects of well-being, as well as self-esteem [1]. Furthermore, it also reflects the effects of treatments in terms of social, psychological and functional well-being in daily life [8]. Studies on dental caries and periodontal diseases have shown that patients' awareness of their conditions does not always correlate with the severity of the disease [9]. Similarly, there may be discrepancies between how orthodontists and patients perceive orthodontic problems [10]. In recent years, orthodontists have questioned whether the success of orthodontic treatment should be measured more by patient satisfaction than by clinical outcomes [11]. This shift highlights the need for a broader model to encompass diverse health issues.

OHRQoL measurements can be performed via hermeneutic and functionalist approaches. The hermeneutic approach involves qualitative scales, while the functionalist approach employs pre-coded scales [12]. Functionalist approaches are categorized into 2 subgroups: condition-specific measures and generic oral health measures [13]. Generic oral health scales, such as the Oral Health Impact Profile (OHIP), measure the status of oral health [14]. The condition-specific scales focus on particular issues, such as the malocclusions.

Since orthodontic malocclusions are not associated with pain or discomfort, the majority of developed questionnaires are not applicable in orthodontics [15]. Even though the majority of developed questionnaires are generic, such as OHIP and the Child Oral Health Quality of Life Questionnaire (CO-HQOL), which evaluate malocclusion and its effects on daily life, they primarily focus on problems such as dental carries and periodontal status [16].

To address this gap, Benson *et al.* [17, 18] recently developed a questionnaire called MIQ. The MIQ is a disease-/condition-specific tool that is used to evaluate malocclusion-related OHRQoL in patients aged 10–16 years. The MIQ has been validated in several languages, including English [18], Chinese [19], Spanish [20] and Arabic [21], with unifactor model solutions, whereas the Chinese version has three factor model solutions. Given the growing awareness of the importance of oral health outcomes in shaping public health programs [9], adapting a questionnaire as a valuable tool is both practical and cost-effective for policymakers. Therefore, this cross-sectional study aims to evaluate the Turkish version of the MIQ and its effectiveness in assessing malocclusion's impact on OHRQoL in Turkish preadolescents and adolescents.

2. Methods

This study was approved by the Akdeniz University Ethics Committee (approval no. KAEK-714) in September 2023. All participants' parents signed the informed consent, and verbal consent was obtained from the patients themselves. The study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for preparing and reporting results [22].

2.1 Participants

The study included 350 patients from the Akdeniz University Faculty of Dentistry and a public hospital in Antalya, between September 2023 and February 2024.

Inclusion criteria were patients aged 10–16 years, seeking orthodontic treatment, with no mental health conditions, and possessing satisfactory knowledge of Turkish and adequate reading skills. Exclusion criteria included severe skeletal discrepancies, cleft lip or palate, cognitive disorders, and a history of orthodontic treatment. Participants completed the questionnaire at their first appointment before orthodontic treatment began. An experienced orthodontist conducted extraoral and intraoral examinations to determine characterization variables. Based on the recommendation of Nunnally *et al.* [23], a minimum sample size of 300 was deemed necessary for meaningful reliability estimates. To increase accuracy, the final sample size was set at 350. The study group was selected by simple random sampling method and to evaluate test-retest reliability, 50 patients were randomly selected.

2.2 The MIQ

Benson *et al.* [17, 18] developed the MIQ. The survey includes two general and seventeen specific items. The global items are as follows:

- Question 1: "Overall, how does the appearance of your teeth, as they are now, upset you?"
- Question 2: "Overall, how does the appearance of your teeth, as they are now, affect your life in a negative way?"

Responses for these global items are rated on a 5-point scale: "not at all", "a little", "somewhat", "quite a bit" and "very much". The 17 specific items are scored on a 3-point scale, ranging from 0 to 2. The items include both positive (*e.g.*, happy, confident, normal, good-looking) and negative (*e.g.*, sad, nervous, shy) attributes. For scoring, the negative items are reverse scored [18].

2.3 Translation and cross-cultural adaptation

A non-commercial end-user license agreement was signed, and approval for the MIQ-T was obtained. The cross-cultural adaptation process consisted of five steps [24]. Initially, two independent dentists, who were native Turkish speakers and fluent in English, translated the original questionnaire into Turkish. Subsequently, two other independent dentists who were fluent in English translated the Turkish version back into English. In the third stage, two dentists and an English teacher compared the original English and back-translated versions, after which the first version of the MIQ-T was created. After ensuring concurrence, the Turkish version was tested on a small group of 20 children, as suggested [19]. In the final stage, there was not irrelevant words detected between languages and differences in the way of thinking. Thus the final version was created without further modifications based on feedback from the adolescents.

2.4 Application of the scale

The questionnaire is a self-administered tool given to the participants during their first orthodontic clinic appointment. Participants completed the questionnaire in a separate room without a time limit. The scale was administered only once, at the beginning of treatment.

2.5 Statistical analysis

2.5.1 Validity analysis

Prior to performing EFA and CFA, the Kaiser-Meyer-Olkin (KMO) test was performed to assess sampling adequacy by using the overall correlation of the data. Bartlett's test was performed to determine whether the correlation matrix was an identity matrix (*i.e.*, whether correlations between variables were zero). A KMO value between 0.8 and 1.0, and a Bartlett's test p-value of < 0.05, confirmed that the sample was suitable for analysis [25]. EFA and CFA were employed to assess structural validity and the consistency between the MIQ-T model and the data. EFA is considered a way of building a theory of construct measurement, whereas CFA could be considered a way of testing a theory of construct measurement [26]. Thus, EFA was performed first, using varimax rotation to determine structural validity. Factor loadings of over 0.30 were considered acceptable [27].

Both EFA and CFA were performed on the same dataset to expand the study groups. After performing EFA, the model-

data consistency was evaluated through CFA, using the maximum likelihood approach. The parameters for evaluating the fit of the model and the data were the GFI, TLI, CFI, RMSEA, incremental fit index (IFI), normed fixed index (NFI), adjusted goodness-of-fit index (AGFI), chi-square (CMIN) and CMIN/df.

Content validity was assessed via expert consultation, using a 4-point scale (1: unrelated, 2: weakly related, 3: strongly related, 4: most strongly related) with ten healthcare professionals from Akdeniz University Faculty of Dentistry. The item-level content validity index (I-CVI) was calculated for each item and adjusted using the modified kappa statistic (K*) [28].

To assess convergent validity, the total score evaluated from the seventeen specific items and two global questions were compared. The correlation between global questions and the MIQ scores were assessed using Kendall's Tau correlation analysis. The correlations were considered 0–0.20 as slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial and 0.81–1 as excellent [29]. Previous studies on the MIQ's Chinese version reported a substantial correlation between global questions and specific items [19]. Therefore, a moderate to substantial positive correlation was expected.

2.5.2 Reliability analysis

Three weeks after the initial survey, the MIQ-T was re-administered to a randomly selected group of 50 patients to assess test-retest reliability. Internal consistency was measured using the total score of the 17 specific items, with Cronbach's alpha values calculated for each subgroup. The Cronbach's alpha is required to be between 0.70 and 0.95 [30]. In addition, split-half reliability analysis was employed to assess the reliability of the scale. AMOS 23.0 and SPSS (IBM, version 25, Armonk, NY, USA) software were used for the statistical analysis. The p-value < 0.05 was considered statistically significant.

3. Results

The study's flowchart is shown in Fig. 1. A total of 350 adolescents participated, with a 100% response rate. All participants reported that the MIQ-T was simple, not time-consuming, and easy to understand. Demographic data and participants' malocclusion characteristics are presented in Table 1. The average household income of 41,000 TL indicates that most participants were from middle-income families. The study included 213 girls and 137 boys, with an average age of 12.79 years. Most participants (58.85%) were in middle school. The

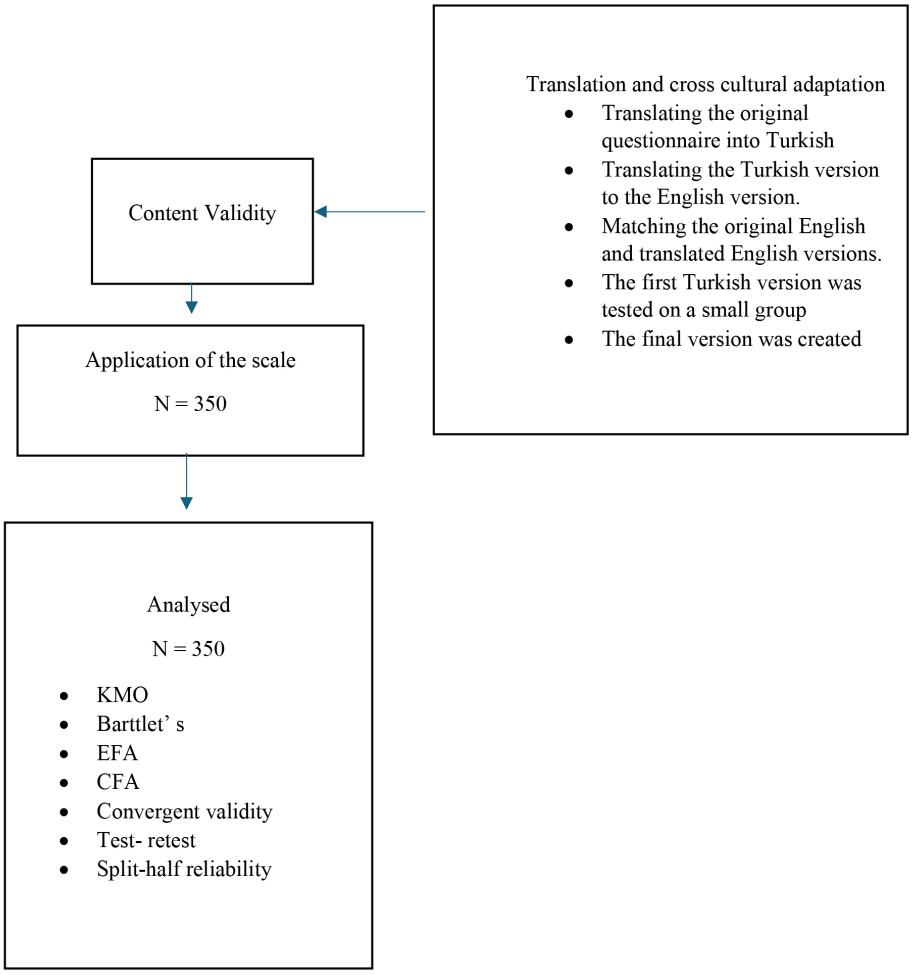

FIGURE 1. The flow chart of the study. KMO: Kaiser-Meyer-Olkin; EFA: exploratory factor analysis; CFA: confirmatory factor analysis.

TABLE 1. Demographic characteristics of the patients.

Groups		Mean (SD)
Age (years)		12.79 (1.9)
Sex		
	Girl	213 (60.85%)
	Boy	137 (39.15%)
School		
	Primary school	58 (16.57%)
	Middle school	206 (58.85%)
	High school	86 (24.57%)
Household income	Mean	41.000 (per month)
Incisor relationship		
	Class I	214 (61.14%)
	Class II division 1	79 (22.57%)
	Class II division 2	31(8.85%)
	Class II subdivision	4 (1.14%)
	Class III	22 (6.28%)
Upper arch		
	Spaced	45 (12.85%)
	No crowding or mild (0–4 mm)	196 (56.0%)
	Moderate (5–8 mm)	91 (26.0%)
	Severe (>8 mm)	18 (5.15%)
Lower arch		
	Spaced	31 (8.86%)
	No crowding or mild (0–4 mm)	257 (73.42%)
	Moderate (5–8 mm)	58 (16.58%)
	Severe (>8 mm)	4 (1.14%)
Malocclusion		
	Mild	207 (59.14%)
	Moderate	121 (34.57%)
	Severe	22 (6.28%)

SD: Standard deviation.

distribution of malocclusion types was as follows: 61.14% had Class 1 malocclusion, 22.57% had Class 2 division 1, 8.85% had Class 2 division 2, and 6.28% had Class 3 malocclusion. Crowding was severe in 5.15% cases, moderate in 26%, and minimal in 56% for the upper arch, and minimal in 73.42% for the lower arch.

Outlier analysis of the entire dataset showed no outliers, and the data were normally distributed (skewness: 0.164, kurtosis: −0.964).

3.1 Validity

The adequacy of the sample size was tested using the KMO test, yielding a value of 0.884, confirming suitability for factor analysis ($p < 0.001$). Bartlett's test further confirmed the appropriateness of the dataset for factor analysis (χ^2 (chi-square) = 4608.057; $p < 0.001$). Using varimax rotation, EFA showed that factor loadings ranged between 0.357 and 0.943, which were appropriate for factor analysis.

The factors are determined based on the number of elbows presented in the scree plot [31]. There were three elbows that were clearly detected in our scree graph. Thus, a three-factor solution was demonstrated according to the scree plot of the MIQ-T (Fig. 2). These factors were labeled as follows: "feel" (five items), "social impact" (nine items) and "worry/concern" (three items) according to the topics questioned by the items. The factors explained 22.835%, 26.853% and 16.223% of the variance, respectively, with a total variance contribution of 65.911%. Table 2 shows that the rotated factor loadings for each item were higher than 0.30.

Table 3 presents the fit indices for the three-factor model from CFA: RMSEA = 0.07, NFI = 0.93, CFI = 0.95, IFI = 0.95, GFI = 0.90, TLI = 0.94, AGFI = 0.86, CMIN = 322.72 and CMIN/*df* = 3.016. The CFA multifactor model for MIQ-T is shown in Fig. 3. The extraction values for each specific

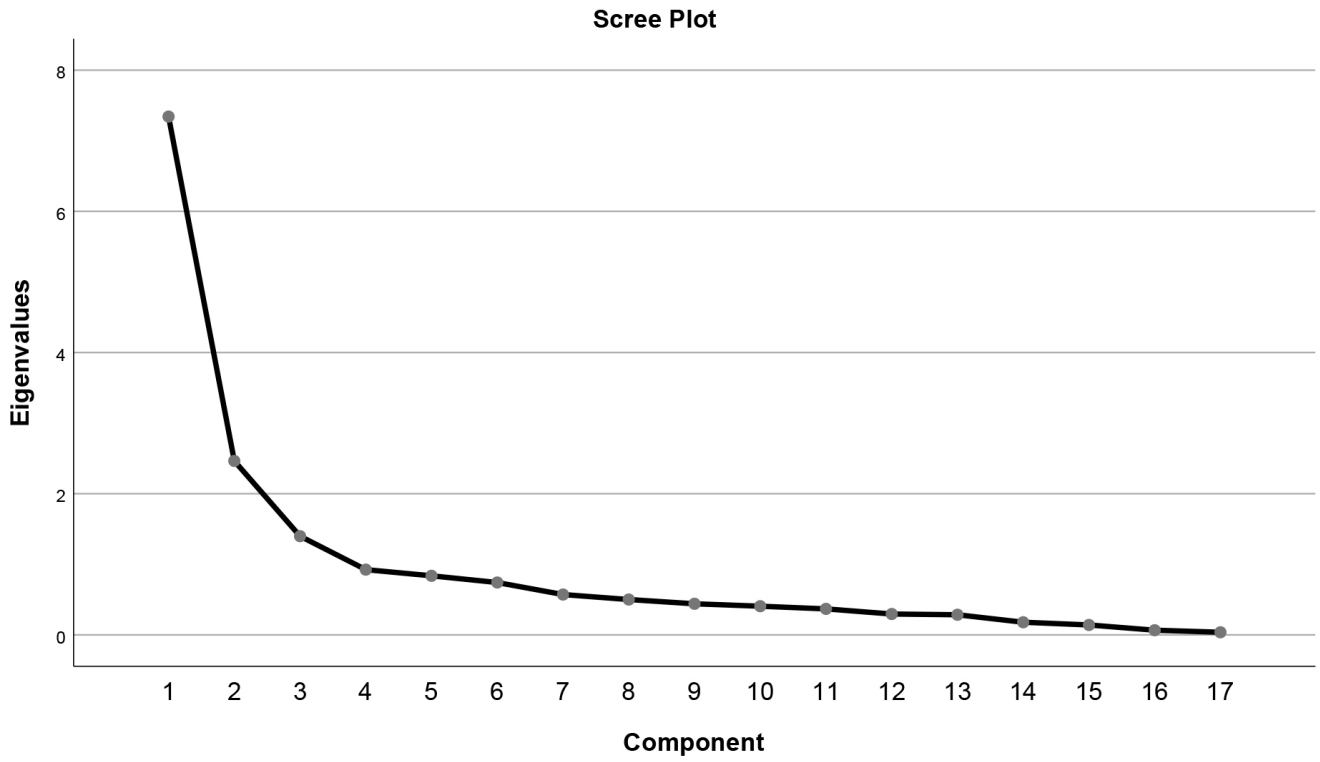

FIGURE 2. Scree plot of the MIQ/T.

TABLE 2. The exploratory factor analysis results for the MIQ/T.

	Varimax rotation factor loadings*	Explained variance
1. Happy	0.879	22.835
2. Good looking	0.889	
3. Confident Factor 1 (Feel)	0.823	
4. Normal	0.872	
5. Sad	0.605	
6. Nervous	0.509	26.853
7. Shy	0.616	
8. Smiling	0.836	
9. Laughing	0.822	
10. Seeing photographs Factor 2 (Social Impact)	0.752	
11. Talking in public	0.694	
12. Others nicer teeth	0.562	
16. Cover with hand	0.642	
17. Biting some foods	0.357	
13. Being bullied	0.851	16.223
14. Making friends Factor 3 (Worry/Concern)	0.924	
15. Fitting in with friends	0.943	
Kaiser-Meyer-Olkin = 0.884	Total variance explained	
Bartlett sphericity test; $\chi^2 = 4608.057$, $p < 0.001$*	65.911	

**Statistical significance.*

TABLE 3. Presentation of the fit indices in CFA for the three factor model.

RMSEA	NFI	CFI	IFI	GFI	TLI	AGFI	CMIN	CMIN/*df*
0.07	0.93	0.95	0.95	0.90	0.94	0.86	322.72	3.016

RMSEA: Root Mean Square Error of Approximation; NFI: Normed Fixed Index; CFI: Comparative Fit Index; IFI: Incremental Fit Index; GFI: Goodness-of-Fit Index; TLI: Tucker-Lewis Index; AGFI: Adjusted Goodness-of-Fit Index; CMIN: Minimum Chi-square; CMIN/df: The Chi-square Degree of Freedom.

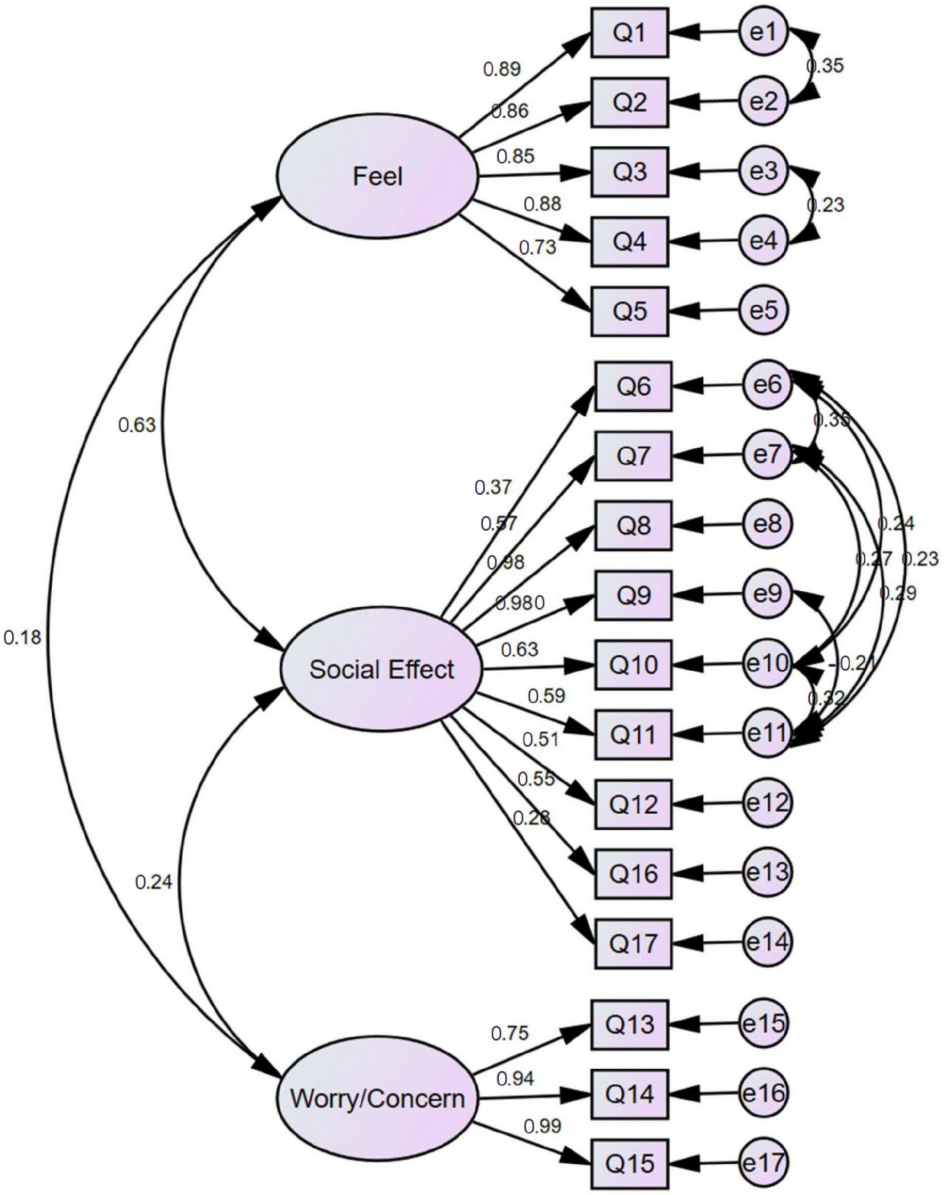

FIGURE 3. The multifactor model for MIQ/T from CFA.

question ranged from 0.37 to 0.99, except for item 17, which had a value of 0.28.

The I-CVI was evaluated and adjusted using the modified kappa statistic (K*), showing a value greater than 0.86 for all items, confirming validity as an evaluation tool [28].

The convergent validity results are shown in Table 4. The convergent validity coefficients of the two global questions and the specific items were calculated as 0.690 and 0.680 for each question, indicating sufficient convergent validity for the questionnaire.

3.2 Reliability

Test-retest reliability was assessed in 50 patients, with a three-week interval between administrations, resulting in $r = 0.890$, indicating strong repeatability.

The internal consistency analysis of the questionnaire was shown in Table 5. Cronbach's alpha for the MIQ-T reported between 0.873 and 0.926. In addition, split-half reliability analysis revealed Cronbach's alpha of 0.918 and 0.745 for the first and last nine questions, respectively.

TABLE 4. Convergent validity of the MIQ/T: correlations between global questions with the subscale scores.

Factor Solution	How much do your teeth bother you?	How much do your teeth affect your life?
Feel		
τ	0.682	0.681
p	<0.001*	<0.001*
Social impact		
τ	0.606	0.602
p	<0.001*	<0.001*
Worry/concern		
τ	0.170	0.155
p	0.001*	0.004*
Total score		
τ	0.690	0.680
p	<0.001*	<0.001*

**Statistical significance.*

TABLE 5. Internal consistency of the MIQ/T.

Factor Solution	No of items	Cronbach's Alfa
Feel	5	0.926
Social impact	9	0.873
Worry/concern	3	0.919
Total score	17	0.915
	Cronbach's Alpha and Intraclass correlation coefficient	
Items (1–9)		0.918
Items (9–17)		0.745
correlation coefficient between two parts		0.702
Spearman Brown Coefficient		0.825
Guttman Split-Half Coefficient		0.739

4. Discussion

Cross-cultural adaptation of a questionnaire can present challenges due to linguistic differences, cultural meanings and diverse ways of thinking [32]. In this study, all participants completed the translated questionnaire within an average of two minutes, without requiring interviews or assistance, as recommended [33]. This suggests that the MIQ-T is well-understood among Turkish adolescents. Similar to the English, Chilean, Chinese and Arabic versions, no ceiling or floor effects were observed, indicating good content coverage.

According to the varimax rotation, the MIQ-T consists of a three-factor structure, and the total variance contribution rate of the three factors was 65.911%, showing an acceptable scale structure. The first factor was "feel", which includes questions regarding emotional status on the basis of the aesthetics of the patient's malocclusion. The second factor was "worry/concern," which includes questions addressing distress related to malocclusion. The third factor was "social impact", which includes questions about the social effects of malocclusion.

EFA established the factor structure, which was confirmed by CFA, showing a close fit between the three-factor model and the data. The two-factor and one-factor models showed poor fit. This was consistent with findings by Li *et al*. [19], who also supported a three-factor solution, while Hope *et al*. [20] reported a weaker one-factor solution. Extraction values ranged from 0.37 to 0.99, except for item 17 (0.28). It has been reported that extraction for each item should be at least 0.20 and ideally above 0.30 for meaningful discussion [34]. Owing to the importance of item 17, we did not exclude it from the questionnaire. The CFA results supported the three-dimensional structure of the MIQ-T, with all fit indices meeting acceptable thresholds, whereas the GFI was evaluated at the lower threshold value according to the following acceptance criteria: IFI >0.90, RMSEA ≤0.08, CFI >0.90, GFI >0.90, TLI >0.90 [35].

Expert consultation confirmed content validity, with values above 0.78 for each item [36]. A substantial correlation was shown between the global oral questions and items of the MIQ-T. The τ value was determined to be good and less than in the UK [18] and slightly higher than in the Chinese [19] and New Zealand [37] studies. The Cronbach's alpha coefficient value of the MIQ-T was 0.926, which was greater than those reported in the UK [18] and New Zealand [37] and slightly lower than

those reported in China [19].

Test-retest reproducibility was 0.89, demonstrating excellent reliability, consistent with the Chinese version (0.893), higher than the UK version (0.78), and lower than the Chilean (0.91) and Arabic (0.958) versions.

Split-half reliability analysis revealed that Cronbach's alpha values for the first nine items and the second nine items were 0.918 and 0.745, respectively. The intraclass correlation coefficient (ICC) values between the first and second nine questions were 0.702, while Spearman Brown and Guttman split-half coefficients were 0.825 and 0.739, respectively, indicating good internal consistency and reliability.

Self-report questionnaires are gaining popularity across scientific fields due to their cost-effectiveness and time efficiency [38]. Developing a new questionnaire can be costly and time-consuming, making adaptation of existing tools a faster and effective alternative [24]. To our knowledge, this is a unique survey that examines the validity and reliability of the MIQ in the Turkish population.

To assess the psychometric properties of the questionnaire, structural validity and internal consistency were confirmed, with a total variance rate of 65.911%, extraction values above 0.30, test-retest reliability of $r = 0.890$, and Cronbach's alpha values between 0.873 and 0.926, objectively indicating that the MIQ-T is a valid and reliable tool for evaluating malocclusion-related OHRQoL in Turkish adolescents. Therefore, it could be useful in preadolescents and adolescents in the Turkish population.

This study has several limitations. First, we did not assess the responsiveness of MIQ-T to treatment-associated changes. Second, EFA and CFA were not conducted on independent samples. Finally, since all the participants involved in the study were from southern Turkey, they might not represent all the adolescents from every region of the country. Therefore, longitudinal studies with regionally diverse samples and independent EFA and CFA are required to evaluate the sensitivity of the questionnaire.

5. Conclusions

According to our results, MIQ-T demonstrates strong validity and reliability for use among Turkish preadolescents and adolescents. It serves as a valuable tool for assessing the impact of orthodontic malocclusion on OHRQoL in adolescents.

AVAILABILITY OF DATA AND MATERIALS

Not applicable. Due to privacy protection and informed consent of patients' parents or primary guardians, the datasets generated and/or analyzed during the study are not publicly available.

AUTHOR CONTRIBUTIONS

BCT—designed the study, analysed the data and wrote the manuscript. GB—administered the survey and collected the data.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study is approved of by the Ethics Committee of the Akdeniz University (ethic approval no: KAEK-714). Participants were included in the study after written informed consent obtained from the all participants' parents.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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