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Orofacial Esthetic Scale and Psychosocial Impact of Dental Aesthetics Questionnaire: development and psychometric properties of the Finnish version

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ABSTRACT

Objective: To develop the Finnish version of the Orofacial Esthetic Scale (OES-Fi) and the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ-Fi) and estimate the psychometric properties of these instruments applied to adult Finns.

Methods: The English versions of the instruments were translated into Finnish and back-translated. Thereafter, OES-Fi and PIDAQ-Fi were established in a pilot study. The factorial validity was estimated using Confirmatory Factor Analysis (CFI, TLI, SRMR) in independent samples (Test and Validation samples). The measurement invariance of the factorial models was tested using multigroup analysis (Δ CFI). Convergent validity [Average Variance Extracted (AVE)] and reliability [Composite Reliability (CR) and α] were estimated.

Results: A total of 3636 individuals [mean age = 32.0 (SD = 11.6) years, 75% women] participated in the study. After refinements, the factorial model of the instruments showed an adequate fit to the data (CFI ≥ 0.94 , TLI ≥ 0.90 , SRMR ≤ 0.07) and showed measurement invariance in two independent samples ($|\Delta$ CFI| < 0.01). Convergent validity (AVE = 0.54–0.82) and reliability (α = 0.86–0.94) were adequate.

Conclusion: The data obtained using OES-Fi and PIDAQ-Fi were valid and reliable. Thus, these instruments could be useful for evaluating individual satisfaction with orofacial appearance and the psychosocial impact of dental aesthetics in a clinical or research setting.

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Introduction

The role of orofacial appearance in dental treatment has been acknowledged for many decades [1,2]. Although this used to be limited to how conventional dental treatments (focussed on function) could improve aesthetics [1], several treatments are currently available that focus on this purpose (e.g. tooth whitening, orthodontics and veneers) with an increasing demand for them [3]. Thus, it is important to assess the individual's perception of their orofacial appearance in both a clinical and a research context [4,5]. In the clinical context, this information will allow for the elaboration of a patient-centred treatment plan that can satisfy the individual's expectations [4–6]. At the same time, the clinician's role as expert has to be emphasized to bring evidence-based information to the patient-centred concept. In a research context, this will help increase knowledge of the importance

of orofacial appearance on an individual's life and how it can be affected by different cultures, oral conditions and types of treatment [6].

However, the perception of orofacial appearance cannot be directly measured. A standardized way of conducting this assessment is to use specific instruments known as dental patient-reported outcome measures (dPROMs) [4,6,7]. The Orofacial Esthetic Scale (OES) [8] and the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) [9] are dPROMs that are intended to assess orofacial appearance. The OES is a one-factor scale that assesses the direct impact of aesthetics based on satisfaction with specific aspects [8]. In Sweden, it was originally proposed to be applied to prosthodontics patients [8]. The PIDAQ has four factors (Dental Self-Confidence, Social Impact, Psychological Impact, and Aesthetic Concern) and assesses the psychosocial impact of

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dental aesthetics on the individual's life [9]. It was originally proposed in the German language for orthodontic patients [9]. Both instruments were also originally published in English [8,9]. To obtain more evidence about perception of orofacial appearance and the influence of local characteristics and cultural factors, it is necessary for dPROMs to be available in different languages.

For this purpose, the OES and PIDAQ have been translated and adapted for several countries, including Croatia [10,11], Brazil [12,13], Spain [14,15], China [16,17], Republic of Kosovo [18,19], and France [20,21]. Despite translations being available for both instruments, there is no Finnish version of OES and PIDAQ. Although translation and cultural adaptation is the starting point for using these instruments in different countries, these dPROMs are psychometric instruments. Thus, an evaluation of their psychometric properties is necessary when they are being applied to new samples. This is the only way to ensure that the data obtained using these instruments are valid and reliable. Previous studies from different countries have attested to the adequate psychometric properties of OES and PIDAQ for different sample settings, such as dental patients and the general population [11,12,17,22–26].

Although classified as being in the Nordic European cultural cluster, Finland has a different background in relation to the other countries in this cluster, which makes its culture unique [27,28]. Thus, the development of the Finnish version of OES and PIDAQ will not only be of interest to professionals in the country but will also increase knowledge of the influence of local characteristics and cultural factors on the perception of orofacial appearance. A comparison of this perception with other countries will also be possible. The aims of this study were to develop the Finnish version of the Orofacial Esthetic Scale (OES-Fi) and the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ-Fi), and to estimate the psychometric properties of these instruments when applied to adult Finns.

Methods

Study design and participants

This was a cross-sectional study with a non-probabilistic sample. Finnish individuals over 18 years of age were included in the study. Initially, students and staff from Tampere University and the University of Oulu were invited to participate in the study. The snowball strategy was then used to recruit participants.

The minimum sample size was calculated based on the proposal of Hair et al. [29]. They recommend a minimum of 5–10 individuals per model parameter to be estimated. Considering the largest model to be tested in this study has 54 parameters (first-order factorial model of the PIDAQ), the minimum sample size required was 270–540 individuals. A higher number of participants was recruited to reach the minimum sample size in each subsample of interest (Test Sample, Validation Sample, Dental Patients and General Population) and to increase the representativeness of the data for the study population.

Study variables

For sample characterization, the following demographic information was collected: age, sex, marital status, socioeconomic status (estimated according to Classification of Socioeconomic Groups 1989 [30]), monthly income, whether the individual is currently a dental patient and whether the individual has sought or received any aesthetics dental treatment. The responses to these questions were self-reported by the participants.

Measurement instruments

The orofacial appearance and psychosocial impact of dental aesthetics were evaluated using the Orofacial Esthetic Scale (OES) [8] and the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) [9], respectively.

The OES is a one-factor scale (Orofacial Appearance) comprising seven items (Supplemental File 1) intended to assess satisfaction with specific orofacial aesthetics components. This instrument also has one item, which has not been considered in the factorial model, for assessing satisfaction with overall orofacial appearance (Supplemental File 1, item 8). OES has an 11-point rating scale ranging from 0 (very dissatisfied) to 10 (very satisfied).

The PIDAQ originally comprised 23 items distributed in four factors: Dental Self-Confidence (Supplemental File 1, items 4, 7, 12, 17, 21, and 23), Social Impact (Supplemental File 1, items 2, 5, 9, 13, 14, 15, 19, and 22), Psychological Impact (Supplemental File 1, items 3, 6, 10, 11, 16, and 20) and Aesthetic Concern (Supplemental File 1, items 1, 8, and 18). For the present study, an additional item was added to the Dental Self-Confidence factor, as proposed by Campos et al. [26], which considers tooth colour (Supplemental File 1, item 24). Based on the theory of this instrument and the high correlation found among the first-order factors in the previous study [26], a hierarchical model with the second-order factor called *Psychosocial Impact* was also considered. The response scale is a 5-point Likert-type scale ranging from 0 to 4 (0: I do not agree, 1: I agree a little, 2: I somewhat agree, 3: I agree a lot, 4: I totally agree).

Development of the OES-Fi and the PIDAQ-Fi

Before beginning the translation process for the instruments, the content of the items was analyzed by the researchers (LAC, JADBC and TP) to verify the adequacy of the content for the sample and context. It was decided to change the wording of item 22 of the PIDAQ from “I sometimes worry about what members of the opposite sex think about my teeth” to “I sometimes worry about what people with whom I would like to have a relationship think about my teeth”. Two independent translators (native speakers of Finnish with English proficiency, MK, A-SS) then translated the English version of the instruments into Finnish. The translations were compared by the researchers (LAC and TP) who prepared a preliminary Finnish version of the instruments [32]. These versions were back-translated into English by another

independent translator. Two researchers (LAC and TP) compared the original, preliminary and back-translated versions and found them to be conceptually identical with the original versions, taking into account the Finnish context.

A pilot study was conducted with these preliminary versions to estimate the Incomprehension Index (II). This index aims to verify any difficulties by the participants in understanding the item's content. If the values of II for the items are lower than 15%, the version is considered adequate [33].

Psychometric indicators of OES-Fi and PIDAQ-Fi

The sensitivity of OES-Fi and PIDAQ-Fi were estimated using the mean, median, standard deviation, skewness and kurtosis of the responses to the items. Skewness and kurtosis absolute values below 3 and 10, respectively, were indicative of non-severe violation of normal distribution [34], attesting to the psychometric sensitivity of the item and meeting one of the assumptions of subsequent analyses [35]. Multivariate normality was evaluated using the ratio of multivariate kurtosis and the critical ratios (ku_m/cr). Values of ku_m/cr lower than 3 were indicative of multivariate normality [35].

To evaluate the construct validity of OES-Fi and PIDAQ-Fi, the factorial, convergent and discriminant validities were estimated. For these, the total sample was randomly divided into two subsamples (Test Sample and Validation Sample).

The factorial models of the OES and PIDAQ tested were the original models proposed by Larsson et al. [8] and Klages et al. [9], respectively. The factorial validity was estimated using Confirmatory Factor Analysis (CFA). The maximum likelihood (ML) estimation method was used for OES and the robust weighted least squares mean and variance adjusted (WLSMV) estimation method was used for PIDAQ. The choice of estimation methods was based on the number of points on the instruments' response scale [34]. The fit of the models to the data was assessed using the comparative fit index (CFI), the Tucker–Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). The factor loadings of the items (λ) were also estimated. Values of CFI and TLI ≥ 0.90 , RMSEA < 0.10 , SRMR ≤ 0.08 and $\lambda \geq 0.50$ were indicative of an acceptable fit of the model to the data [35,36]. If the model did not show an adequate fit to the data, the modification indices (estimated using the Lagrange Multiplier [LM] method) with values above 11 were inspected to check for any correlations between errors of items [35]. Also, after fitting the first-order factorial model of PIDAQ to the data, the second-order hierarchical model was tested.

To certify the keeping of the factorial models in the independent samples (Test and Validation), the fit of the models was tested in Test and Validation subsamples. First, a confirmatory factor analysis was performed for each subsample and then a multigroup analysis using the CFI difference (ΔCFI) was performed to verify the measurement invariance of the factorial models. For OES-Fi, the ΔCFI for factor loadings (ΔCFI_λ), intercepts (ΔCFI_i) and residuals (ΔCFI_{res}) was considered. For PIDAQ-Fi, the ΔCFI between configurational and metric models (ΔCFI_{M1-M0}) and between metric and

scalar models (ΔCFI_{M2-M1}) was considered. Measurement invariance was assumed when values of $|\Delta CFI|$ were less than 0.01.

After checking the fit of the OES-Fi model, Pearson's correlational analysis (r) was performed between the Orofacial Appearance factor and item 8 of this scale, which refers to assessment of satisfaction with overall orofacial appearance.

The Average Variance Extracted (AVE), proposed by Fornell and Larcker [37], was estimated for each first-order factor to attest to the convergent validity. Values of AVE ≥ 0.50 were indicative of adequate convergent validity [35]. The discriminant validity was estimated using correlation analysis between the factors [37]. The discriminant validity was considered adequate when AVE values of the correlated factors were above or equal to the squared correlation between factors (AVE_i and $AVE_j \geq r_{ij}^2$) [35,37].

The concurrent validity of the OES-Fi and PIDAQ-Fi was evaluated using Pearson's correlational analysis (r) between Orofacial Appearance factor (OES-Fi) and first-order factors of the PIDAQ-Fi (Dental Self-Confidence, Social Impact, Psychological Impact and Aesthetic Concern). To assess the divergent validity of these instruments, the Finnish version of the Satisfaction With Life Scale (SWLS) [31] was used. SWLS is a one-factor scale comprising 5 items and the response scale is a 7-point Likert-type. The data obtained with this instrument in the sample of the present study were valid and reliable (Confirmatory Factor Analysis: CFI = 0.98, TLI = 0.97, RMSEA = 0.106, SRMR = 0.023, and $\lambda \geq 0.64$; Cronbach's alpha coefficient = 0.90). The divergent validity was assessed using the correlation (Pearson's correlational analysis – r).

The reliability was assessed using Cronbach's alpha coefficient (for OES) or ordinal alpha coefficient (for PIDAQ), and was considered adequate if ≥ 0.70 [35]. To verify whether the OES-Fi and PIDAQ-Fi discriminate between individuals undergoing dental treatment (Dental Patient) and those not undergoing dental treatment (General Population), the fit of the models and the measurement invariance, as described above, were verified in these subsamples. If invariance was observed, the mean scores of the OES-Fi and PIDAQ-Fi factors were compared between these groups.

The distribution of the scores was estimated by the skewness and kurtosis. Absolute values below 3 and 10, respectively, were indicative of non-severe violation of normal distribution [34]. Factor scores, estimated as a mean of the responses given to the items, were used to test differences between groups. Factor scores showed a distribution close to the normal distribution (skewness $\leq |1.9|$ and kurtosis $\leq |3.5|$). The homoscedasticity of the factor scores in the different groups was evaluated using Levene's test. If the data showed homoscedasticity, the comparisons were performed using a t -test with equal variances. If the data showed heteroscedasticity, the comparisons were performed using Welch's t -test. The significance level adopted was 5%.

The analyses were performed using IBM SPSS Statistics 22 (IBM Corp., Armonk, NY) and the "lavaan" [38] and "semTools" [39] packages of the R program (R Core Team, 2016).

Procedures and ethical aspects

The individuals were invited to participate in the study via email. The invitation email described the aims of the study and included a link to an online questionnaire. The questionnaire contained the measurement instruments and was created using LimeSurvey software (LimeSurvey GmbH, Hamburg, Germany; URL <http://www.limesurvey.org>) on the server of Tampere University. At first, the participants answered the demographic questions. The measurement instruments (OES-Fi and PIDAQ-Fi) were then presented in random order between the participants. All responses to the OES-Fi and PIDAQ-Fi were mandatory. Data collection was carried out between 16 June and 30 July 2020.

Approval for data collection was obtained from the Data Protection Officer at Tampere University, in accordance with the European Union's General Data Protection Regulation. This approval was attached to the invitation email.

Results

Development of the OES-Fi and PIDAQ-Fi – pilot study

Thirty-seven individuals participated in the pilot study. Of those, 67.6% were female, 62.2% single/cohabiting, 32.4% married and 5.4% divorced. Four individuals (10.8%) were currently receiving dental care, one was undergoing dental treatment to improve aesthetics. The mean age was 31.2 (standard deviation = 11.0) years and 51.4% of the

participants had already received dental treatment for the purpose of improving aesthetics. Regarding socioeconomic status, 24.3% were upper-level employees in administrative, managerial, professional and related occupations, 2.7% were lower-level employees in administrative and clerical occupations, 18.9% were manual workers and 54.1% were students. The monthly income of 70.3% of the participants was less than or equal to €5000.

All OES-Fi items presented an Incomprehension Index between 0.0 and 2.7%. Understanding of the content of the items was considered adequate and the version tested in the pilot study was considered to be the final version of OES-Fi (Supplemental File 1). Regarding PIDAQ-Fi, items 6 and 19 presented $II = 2.7%$, item 22, $II = 5.4%$, item 8, $II = 8.1%$ and items 1, 17 and 18 presented $II = 10.8%$. Although II was less than 15%, the researchers (LAC and TP) inspected the contents of these items and identified no need for adjustments. The other items of PIDAQ-Fi presented $II = 0.0%$. The final version of this instrument is shown in Supplemental File 1.

Psychometric indicators of OES-Fi and PIDAQ-Fi

A total of 3636 Finnish individuals participated in the study. The mean time to complete the demographic questionnaire, OES-Fi and PIDAQ-Fi, was 6.3 (SD = 2.8) min. Table 1 shows the characterization of total sample and subsamples (Test and Validation). The majority of participants were female, single and were not currently receiving dental care. Splitting

Table 1. Participants' characteristics [mean (SD) or n (%)].

	Test sample ($n = 1820$)	Validation sample ($n = 1816$)	Total sample ($n = 3636$)
Age (years)	32.08 (SD = 11.81)	31.84 (SD = 11.48)	31.96 (SD = 11.64)
Sex			
Female	1367 (75.1)	1360 (74.9)	2727 (75.0)
Male	422 (23.2)	427 (23.5)	849 (23.3)
Other/no response	31 (1.7)	29 (1.6)	60 (1.7)
Marital status			
Single	1217 (67.1)	1195 (66.0)	2412 (66.6)
Married/common law/stable relationship	517 (28.5)	526 (29.0)	1043 (28.7)
Divorced	73 (4.0)	89 (4.9)	162 (4.5)
Widower	7 (0.4)	1 (0.1)	8 (0.2)
Socioeconomic status			
Self-employed persons	14 (0.8)	25 (1.4)	39 (1.1)
Upper-level employees in administrative, managerial, professional and related occupations	321 (17.6)	318 (17.5)	639 (17.6)
Lower-level employees in administrative and clerical occupations	145 (8.0)	153 (8.4)	298 (8.2)
Manual workers	228 (12.6)	232 (12.8)	460 (12.7)
Students	1032 (56.7)	1028 (56.6)	2060 (56.6)
Pensioners	10 (0.5)	5 (0.3)	15 (0.4)
Other	70 (3.8)	55 (3.0)	125 (3.4)
Monthly income			
Less than €2500	813 (44.8)	808 (44.6)	1621 (44.7)
€2500–5000	420 (23.2)	405 (22.4)	825 (22.8)
€5001–7500	254 (14.1)	261 (14.4)	515 (14.3)
€7501–10000	149 (8.2)	168 (9.3)	317 (8.7)
€10001–12500	57 (3.1)	53 (2.9)	110 (3.0)
More than €12500	120 (6.6)	116 (6.4)	236 (6.5)
Are you receiving dental treatment?			
Yes	312 (17.1)	286 (15.7)	598 (16.4)
No	1508 (82.9)	1530 (84.3)	3038 (83.6)
Have you sought or received any aesthetics dental treatment?			
I have never sought aesthetics dental treatment	1064 (58.9)	1080 (59.9)	2144 (59.5)
I recently sought aesthetics dental treatment	38 (2.1)	39 (2.1)	77 (2.1)
I have received aesthetics dental treatment	671 (37.2)	636 (35.3)	1307 (36.2)
I am currently receiving aesthetics dental treatment	33 (1.8)	48 (2.7)	81 (2.2)

each sample into two (Test Sample and Validation Sample) showed no differences in these characteristics.

The descriptive statistics of the responses given to the OES-Fi and PIDAQ-Fi items by the subsamples (Test, Validation, General Population and Dental Patient) are shown in Table 2. All responses given to the OES-Fi items presented adequate values of sk and ku for CFA, while responses to the PIDAQ-Fi, items 9, 13, 14, and 15 presented non-acceptable sk and ku for the Test, Validation and General Population subsamples. Thus, these items were not considered in the subsequent analyses of these subsamples. The data showed multivariate normality for both instruments ($ku_m/c.r.$: OES-Fi ≤ 0.92 ; PIDAQ-Fi ≤ 2.89).

The factorial model of OES-Fi did not show an adequate fit to the Test Sample ($\lambda = 0.55-0.89$, CFI = 0.852, TLI = 0.778, RMSEA = 0.210, and SRMR = 0.075). When inspecting the LM, a high value was observed between the errors of item 1 (it1. Your facial appearance) and 2 (it2. Appearance of your facial profile) (LM = 640.130). After inserting a correlation between the errors of items 1 and 2, an adequate fit of the model was obtained (Table 3). This refined factorial model of OES-Fi also showed an adequate fit to the Validation Sample data (Table 3). It is observed that only the RMSEA did not present the suggested threshold value (< 0.10). This occurs because in simple factorial models with few degrees of freedom, the RMSEA is overestimated [12,40]. In such cases, the SRMR is an alternative index to the RMSEA for decision making regarding the factorial model fit [12]. There was a strong correlation between the OES-Fi factor (Orofacial Appearance) and the response given to item 8 of the OES-Fi ($r = 0.87$; $p < .001$). The convergent validity and reliability were adequate for the data of both subsamples. There was measurement invariance between these samples ($\Delta CFI_\lambda = 0.000$, $\Delta CFI_i = 0.000$; $\Delta CFI_{res} = -0.001$), indicating the adequate external validity of the results.

Regarding the PIDAQ-Fi, both first- and second-order models (excluding items 9, 13, 14, and 15) presented adequate factorial and convergent validity and reliability for the Test and Validation Samples (Table 3). Discriminant validity was compromised in the Social Impact versus Psychological Impact, Social Impact versus Aesthetic Concern, and Psychological Impact versus Aesthetic Concern factors. These results contribute to the theoretical proposal of a second-order hierarchical model. The factorial models of the PIDAQ-Fi showed measurement invariance between the samples ($\Delta CFI_{M1-M0} = 0.000$, $\Delta CFI_{M2-M1} = -0.001$).

The factorial models of OES-Fi and PIDAQ-Fi showed an adequate fit to the Dental Patient and General Population samples (Table 3) and invariance between these samples (OES-Fi: $\Delta CFI_\lambda = 0.000$, $\Delta CFI_i = 0.000$, $\Delta CFI_{res} = -0.004$; PIDAQ-Fi: $\Delta CFI_{M1-M0} = 0.000$, $\Delta CFI_{M2-M1} = -0.007$). It should be noted that the model with configurational invariance (excluding items 9, 13, 14 and 15) was used to verify the maintenance of the factorial model of PIDAQ for these subsamples.

There was a strong correlation between OES-Fi factor and PIDAQ-Fi factors, indicating adequate concurrent validity of the instruments (Orofacial Appearance versus Dental Self-

Confidence: $r = 0.87$, $p < .001$; Orofacial Appearance versus Social Impact: $r = -0.69$, $p < .001$; Orofacial Appearance versus Psychological Impact: $r = -0.77$, $p < .001$; Orofacial Appearance versus Aesthetic Concern: $r = -0.74$, $p < .001$). It was observed a weak correlation of the SWLS factor with the OES-Fi factor and the first-order factors of the PIDAQ-Fi, indicating adequate divergent validity of OES-Fi and PIDAQ-Fi (SWLS versus Orofacial Appearance; SWLS versus Dental Self-Confidence: $r = 0.87$, $p < .001$; SWLS versus Social Impact: $r = -0.69$, $p < .001$; SWLS versus Psychological Impact: $r = -0.77$, $p < .001$; SWLS versus Aesthetic Concern: $r = -0.74$, $p < .001$).

The comparisons of the factor scores of the OES-Fi and PIDAQ-Fi between the Dental Patient and General Population sample is shown in Table 4. Dental patients showed less satisfaction with their orofacial appearance (significantly lower OES-Fi scores) and a greater psychosocial impact of dental aesthetics (significantly lower Dental Self-Confidence score and significantly higher Social Impact, Psychological Impact and Aesthetic Concern scores) than the General Population.

Discussion

This study developed and estimated the psychometric properties of the OES-Fi and PIDAQ-Fi. The results point to the adequate validity and reliability of the data obtained using these instruments when applied to adult Finns and a discriminatory capacity between dental patients and the general population.

The present study was proposed due to the need to assess the perception of orofacial appearance in different cultures and contexts in light of the various dental treatments that focus on improving aesthetics. dPROMs are instruments that assess patient outcomes, with OES and PIDAQ being widely used in the literature to assess the direct and indirect impact, respectively, of orofacial appearance [8,9].

During the translation process, the researchers evaluated the content of the instruments' items and changed the content of item 15 of the PIDAQ. The original item used the term "opposite sex" to designate anyone with whom the participant would like to have a relationship. The content of item was changed to gender-neutral since retaining the original content was considered to be outdated and could cause discomfort or offence to some of the participants. This serves as a reminder that when any psychometric instrument is applied to a new sample, it is important to form a panel of researchers and specialized professionals to evaluate the content of the items, even if there is already a version of the instrument for the language to be used. It will then be possible to verify whether the content of each item is appropriate for use or whether any changes could be made to apply the instrument to a specific sample in the current context.

After establishing the OES-Fi and PIDAQ-Fi in a pilot study, the psychometric properties of both were estimated. When analyzing the descriptive statistics of the responses given to the items, it was noted that four items (items 9, 13, 14 and 15) from the Social Impact factor of PIDAQ-Fi severely violated the normal distribution. This may be related to the social interaction characteristics of the sample or to the

Table 2. Descriptive statistics of the responses given by the participants of each subsample to the items of the Orofacial Esthetic Scale (OES-Fi) and the items of the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ-Fi) (Test Sample: $n = 1820$; Validation Sample: $n = 1816$; General Population: $n = 3038$; Dental Patient: $n = 598$).

Item	OES-Fi (Test Sample/Validation Sample/General Population/Dental Patient)					PIDAQ-Fi (Test Sample/Validation Sample/General Population/Dental Patient)				
	Mean	Median	Standard deviation	Skewness	Kurtosis	Mean	Median	Standard deviation	Skewness	Kurtosis
it1	7.2/7.2/7.2/7.1	8.0/8.0/8.0/7.0	1.7/1.6/1.6/1.9	-1.2/-1.1/-1.1/-1.1	1.8/1.8/1.9/1.4	0.5/0.6/0.5/0.7	0.0/0.0/0.0/0.0	0.9/0.9/0.9/1.0	1.7/1.7/1.8/1.4	2.6/2.3/2.7/1.4
it2	6.6/6.6/6.6/6.4	7.0/7.0/7.0/7.0	2.1/2.1/2.1/2.3	-0.8/-0.8/-0.8/-0.7	0.3/0.4/1.4/0.0	0.6/0.7/0.6/0.9	0.0/0.0/0.0/0.0	1.0/1.1/1.0/1.2	1.8/1.6/1.8/1.3	2.2/1.7/2.4/0.4
it3	7.0/6.9/7.0/6.6	7.0/7.0/7.0/7.0	2.0/2.0/2.0/2.3	-0.9/-0.9/-1.0/-0.7	0.6/0.5/0.7/-0.1	1.3/1.3/1.2/1.6	1.0/2.0/1.0/1.0	1.2/1.2/1.2/1.3	0.7/0.7/0.8/0.4	-0.5/-0.5/-0.4/-0.9
it4	6.8/6.8/6.9/6.4	7.0/7.0/7.0/7.0	2.3/2.3/2.3/2.5	-0.9/-0.8/-0.9/-0.7	0.3/0.1/0.3/-0.3	1.8/1.8/1.8/1.6	2.0/2.0/2.0/2.0	1.3/1.2/1.3/1.3	0.0/0.1/0.0/0.3	-1.0/-1.1/-1.1/-1.0
it5	7.4/7.3/7.4/7.1	8.0/8.0/8.0/8.0	2.0/2.1/2.0/2.3	-1.1/-1.1/-1.1/-0.9	1.0/0.9/1.0/0.4	0.4/0.4/0.3/0.6	0.0/0.0/0.0/0.0	0.8/0.8/0.8/1.0	2.6/2.5/2.7/1.8	6.3/6.0/7.4/2.4
it6	6.3/6.2/6.3/5.9	7.0/7.0/7.0/6.0	2.2/2.2/2.2/2.4	-0.7/-0.7/-0.7/-0.5	0.0/0.0/1.1/-0.4	0.3/0.3/0.3/0.5	0.0/0.0/0.0/0.0	0.8/0.7/0.7/0.9	2.6/2.5/2.7/1.8	6.6/6.3/7.8/2.6
it7	7.9/7.8/7.9/7.6	8.0/8.0/8.0/8.0	1.9/1.8/1.8/2.1	-1.3/-1.2/-1.2/-1.1	1.9/1.9/2.0/1.1	2.2/2.1/2.2/1.9	2.0/2.0/2.0/2.0	1.4/1.4/1.4/1.4	-0.2/-0.2/-0.2/0.0	-1.2/-1.2/-1.2/-1.4
it8	7.2/7.2/7.2/6.9	8.0/8.0/8.0/7.0	1.7/1.7/1.6/1.9	-1.1/-1.1/-1.1/-1.0	1.7/1.8/1.9/1.0	0.9/1.0/0.9/1.2	0.0/0.0/0.0/1.0	1.3/1.3/1.2/1.4	1.2/1.1/1.2/0.8	0.1/0.0/0.2/-0.6
it9	-	-	-	-	-	0.3/0.3/0.3/0.5	0.0/0.0/0.0/0.0	0.8/0.7/0.7/0.9	3.1/3.0/3.2/2.2	9.4/9.2/11.1/4.3
it10	-	-	-	-	-	0.6/0.6/0.5/0.9	0.0/0.0/0.0/0.5	0.9/0.9/0.9/1.1	1.8/1.7/1.8/1.3	2.8/2.4/3.1/0.8
it11	-	-	-	-	-	0.9/0.9/0.8/1.1	0.0/0.0/0.1/0.0	1.2/1.2/1.2/1.3	1.2/1.2/1.3/0.8	0.3/0.3/0.6/-0.6
it12	-	-	-	-	-	2.1/2.0/2.0/1.8	2.0/2.0/2.0/2.0	1.2/1.3/1.2/1.3	-0.2/0.0/-0.1/0.1	-1.0/-1.1/-1.0/-1.1
it13	-	-	-	-	-	0.3/0.3/0.2/0.4	0.0/0.0/0.0/0.0	0.7/0.7/0.6/0.9	3.2/3.0/3.2/2.4	11.0/9.2/11.1/5.8
it14	-	-	-	-	-	0.2/0.2/0.2/0.4	0.0/0.0/0.0/0.0	0.6/0.7/0.6/0.8	3.4/3.1/3.6/2.3	12.2/10.2/13.6/4.9
it15	-	-	-	-	-	0.3/0.3/0.2/0.5	0.0/0.0/0.0/0.0	0.7/0.8/0.7/1.0	3.0/3.0/3.2/2.2	9.5/8.6/10.7/4.0
it16	-	-	-	-	-	0.4/0.4/0.4/0.6	0.0/0.0/0.0/0.0	0.8/0.8/0.8/1.0	2.4/2.3/2.5/1.7	5.8/4.9/6.4/2.2
it17	-	-	-	-	-	1.6/1.6/1.6/1.4	2.0/2.0/2.0/1.0	1.2/1.2/1.2/1.2	0.1/0.2/0.1/0.4	-1.0/-1.0/-1.0/-0.9
it18	-	-	-	-	-	0.6/0.6/0.5/0.8	0.0/0.0/0.0/0.0	1.0/1.1/1.0/1.2	2.0/1.9/2.1/1.4	3.2/2.7/3.6/0.8
it19	-	-	-	-	-	1.7/1.8/1.7/2.1	1.0/1.5/1.0/2.0	1.2/1.2/1.1/1.3	1.6/1.5/1.7/1.2	1.5/1.2/1.7/0.0
it20	-	-	-	-	-	2.2/2.1/2.2/1.9	2.0/2.0/2.0/2.0	1.3/1.3/1.3/1.3	0.4/0.4/0.4/0.1	-0.9/-1.0/-0.8/-1.2
it21	-	-	-	-	-	0.5/0.6/0.5/0.8	0.0/0.0/0.0/0.0	1.2/1.2/1.2/1.3	-0.4/-0.2/-0.3/0.0	-0.9/-1.0/-0.9/-1.1
it22	-	-	-	-	-	2.2/2.2/2.2/2.1	2.0/3.0/3.0/2.0	1.3/1.3/1.3/1.3	1.9/1.8/2.0/1.3	3.1/2.6/3.5/0.7
it23	-	-	-	-	-	1.7/1.7/1.7/1.5	2.0/2.0/2.0/1.0	1.2/1.1/1.2/1.2	0.0/0.0/0.0/0.2	-1.1/-1.0/-1.0/-1.2
it24	-	-	-	-	-	-	-	-	-	-1.0/-1.0/-1.0/-1.0

Table 3. Fit of the factorial model of the Orofacial Esthetic Scale (OES-Fi) and Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ-Fi) applied to different subsamples (Test, Validation, General Population and Dental Patient).

Sample/subsample	n	CFA ^a									
		CFI	TLI	RMSEA	SRMR	λ	r_{e1-e2}	r^2	β	α	AVE ^d
OES-Fi^e											
Test Sample	1820	0.95	0.92	0.129	0.044	0.54–0.89	0.59	–	–	0.89 ^b	0.54
Validation Sample	1816	0.95	0.92	0.129	0.042	0.52–0.89	0.63	–	–	0.89 ^b	0.55
General Population	3038	0.95	0.92	0.126	0.042	0.52–0.89	0.61	–	–	0.88 ^b	0.54
Dental Patient	598	0.94	0.90	0.142	0.045	0.56–0.89	0.62	–	–	0.89 ^b	0.56
PIDAQ-Fi, first order											
Test Sample ^f	1820	0.97	0.96	0.093	0.050	0.64–0.96	–	0.60–0.85	–	0.88–0.93 ^c	0.67–0.80
Validation Sample ^f	1816	0.97	0.96	0.096	0.050	0.64–0.94	–	0.65–0.87	–	0.87–0.94 ^c	0.65–0.82
General Population ^f	3038	0.97	0.96	0.094	0.049	0.64–0.95	–	0.41–0.86	–	0.88–0.93 ^c	0.66–0.81
Dental Patient ^g	598	0.96	0.95	0.095	0.065	0.60–0.95	–	0.53–0.83	–	0.91–0.94 ^c	0.67–0.80
Dental Patient ^f	598	0.97	0.96	0.101	0.057	0.61–0.95	–	0.49–0.87	–	0.86–0.94 ^c	0.63–0.81
PIDAQ-Fi, second order											
Test Sample ^f	1820	0.97	0.96	0.093	0.052	0.64–0.96	–	–	0.85–0.95	0.88–0.93 ^c	0.67–0.80
Validation Sample ^f	1816	0.97	0.96	0.095	0.052	0.64–0.94	–	–	0.87–0.96	0.87–0.94 ^c	0.65–0.82
General Population ^f	3038	0.97	0.96	0.094	0.051	0.64–0.94	–	–	0.76–0.95	0.88–0.93 ^c	0.66–0.81
Dental Patient ^g	598	0.96	0.95	0.097	0.070	0.60–0.95	–	–	0.84–0.97	0.91–0.94 ^c	0.67–0.80
Dental Patient ^f	598	0.97	0.96	0.101	0.060	0.61–0.95	–	–	0.87–0.97	0.86–0.94 ^c	0.63–0.81

^aCFA: confirmatory factor analysis, CFI: comparative fit index, TLI: Tucker-Lewis index, RMSEA: root mean square error of approximation, SRMR: standardised root mean square residual, λ : factor loading, r_{e1-e2} : correlation between errors of item 1 and item 2; r^2 : square correlation coefficient between the factors, β : absolute value of β estimate

^b α : Cronbach's alpha coefficient

^c α : ordinal alpha coefficient

^dAVE: average variance extracted

^eWith correlation between errors of items 1 and 2

^fItems 9, 13, 14, and 15 excluded due to the violation of the assumption of normal distribution of responses to items or to obtain configurational invariance between the subsamples

^gComplete model

Table 4. Comparison of the factor scores of the Finnish version of the Orofacial Esthetic Scale (OES-Fi) and Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ-Fi) between the General Population sample (n = 3038) and the Dental Patient sample (n = 598).

Factor	Sample	Mean	SD ^a	95% confidence interval		Levene's test		t-test	
				Lower limit	Upper limit	F	p Value	t	p Value
OES-Fi									
Orofacial Appearance	General Population	7.06	1.54	7.01	7.12	23.620	<.001	4.345 ^b	<.001
	Dental Patient	6.73	1.76	6.58	6.87				
PIDAQ-Fi									
Dental Self-Confidence	General Population	1.99	1.01	1.95	2.02	1.468	.226	5.112	<.001
	Dental Patient	1.75	1.06	1.67	1.84				
Social Impact ^c	General Population	0.52	0.77	0.50	0.55	60.974	<.001	6.899 ^b	<.001
	Dental Patient	0.80	0.94	0.73	0.88				
Psychological Impact	General Population	0.82	0.82	0.79	0.85	44.290	<.001	7.186 ^b	<.001
	Dental Patient	1.13	0.96	1.05	1.20				
Aesthetic Concern	General Population	0.65	0.91	0.62	0.69	43.148	<.001	5.507 ^b	<.001
	Dental Patient	0.91	1.07	0.83	1.00				

^aStandard deviation.

^bWelch's t-test.

^cThe mean scores were calculated from the items that belong to this factor (excluding items 9, 13, 14 and 15) in the factorial model with configurational invariance between the samples.

period in which the data were collected. Regarding the sample, in recent years, the Finnish population has shown loneliness [41] and an increase in social isolation [42]. Regarding data collection, it was conducted during the Sars-CoV-2 pandemic period, which required social distancing measures to control the spread of the virus. Thus, since psychometric sensitivity is an assumption and their retention in the factorial model could cause a bias in the results, these items were not included in the subsequent analyses. However, it should be noted that these items must be considered and carefully analyzed in future studies that apply PIDAQ-Fi to new samples.

When estimating the psychometric properties of OES-Fi, the one-factor model was confirmed, as observed in other versions of this instrument [8,12,18,22]. However, it was

necessary to insert a correlation between the errors of items 1 and 2 to fit the model to the data. The suggestion and need to insert the correlation between the errors of these items has already been previously reported in studies that used other versions of OES in the general population [12,22]. It could be speculated that the specification and distinction of the facial profile in relation to the face as a whole is difficult in samples of general populations, since the own facial profile view is not usual. Even so, it is important to have a specific item for this, because, in addition to a facial profile being a feature of therapeutic goal of some dental treatments (such as orthodontics and orthognathic surgery), it becomes possible to identify individuals who are dissatisfied with their facial profile, and provides relevant information for the elaboration of an individualized treatment plan [43].

Regarding the PIDAQ-Fi, the results that fit the factorial model to the data confirm the four-factor structure of PIDAQ, corroborating the findings when PIDAQ is applied to other samples and contexts [11,24–26]. In addition, a high correlation was observed in the present study between three factors of PIDAQ, which compromised the discriminant validity and, considering the theory of the instrument, provides support for the elaboration of a second-order hierarchical model (SOHM). The SOHM showed an adequate fit to the data, as has already been observed in a Brazilian sample [26]. These authors suggested that, after confirming the SOHM, it is possible to obtain a general score for the psychosocial impact of dental aesthetics, in addition to the scores for each first factor. We emphasize that the Dental Self-Confidence factor is positive, while the other factors are negative, i.e. they have a different direction of response scale. Thus, the value of responses given to the Dental Self-Confidence factor should be reversed if the reader wishes to calculate a general score for this instrument.

As observed in this study, the measurement invariance of a factorial model in independent samples is evidence of the maintenance of the model, which is important for supporting the use of the instrument in similar samples. Nevertheless, the invariance between know-groups, such as General Population versus Dental Patient, shows that each instrument operates similarly in these samples, allowing comparison of the factor scores between them. In addition to this invariance, the present study also found that the instruments are able to discriminate between these groups. Dental patients had lower OES-Fi and Dental Self-Confidence factor (PIDAQ-Fi) scores and higher scores for the other factors of PIDAQ-Fi, which represent the greater psychosocial impact of dental aesthetics. This is in accordance with results in the literature [12,17,18] that suggest that this difference is because dental patients already have a degree of dissatisfaction with some aspects of oral health and because they are more aware of the orofacial region, which could increase its impact on their lives.

The data collection strategy and the convenience sample design can be cited as a limitation of this study. Data collection was carried out online. Members of two different universities were invited to participate in the study, following by a snowball strategy. This provided a higher number of participants who are university students and academic staff. Although this sample may not be a real representation of the Finnish population, it should be mentioned that the academic community plays an important role in society, with one of its attributes being the formation and dissemination of ideas and values [44]. Thus, knowledge of the perception of the orofacial appearance of these individuals could help identify the values that are disseminated about this perception. Regarding the convenience sample, it should be noted that this design is usually used in studies that evaluate the psychometric properties of an instrument [12,22,33]. In an attempt to minimize this limitation, we obtained a large sample and estimated the measurement invariance of the models in independent samples, which evidenced the external validity of the results.

Despite the limitations, the present study provides the Finnish version of two instruments for standardized measurement of orofacial appearance and its impact on an individual's life and evidence of their use in different contexts. Thus, it is expected to contribute to both clinical practice and research. In clinical practice, the dentist will have more information to be able to develop a patient-centered treatment plan. In research setting, the standardized method of measurement allows the investigation of the influence of factors in this perception by comparing different samples, contexts and countries.

Conclusion

The data obtained using OES-Fi and PIDAQ-Fi were valid and reliable. Thus, these instruments could be useful for evaluating satisfaction with orofacial appearance and the psychosocial impact of dental aesthetics in a clinical or research context.

Disclosure statement

The authors report no conflict of interest.

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