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Smile Aesthetics Satisfaction Scale: development and validation of a new brief five-item measure of satisfaction with smile aesthetics in adults and the elderly

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Objective: To create and validate a brief questionnaire designed for the assessment of satisfaction with smile aesthetics and to test its efficiency as a patient-centred outcome measure of aesthetic interventions in dentistry. **Materials and methods:** A team of three specialists – two from prosthodontics and one psychologist – used a self-evaluation scale consisting of five elements in order to rate self-perceived smile aesthetics. A total of 671 subjects (63% female), 18–86 years of age, were included in the investigation. The internal consistency, validity and stability of the questionnaire, along with the responsiveness induced by the tooth-whitening procedure, were evaluated. The relationship between self-perceived satisfaction with the smile aesthetics and the clinical status of the dentition was assessed. **Results:** The questionnaire had one dimension accounting for 64.3% of variance and showed a high level of reliability (Cronbach $\alpha = 0.859$). It measured a construct similar to concern with tooth appearance and the desire to improve this appearance ($r = -0.403$ and $r = -0.353$, respectively; $P < 0.001$). High test–retest reliability was demonstrated (intraclass correlation coefficient = 0.985). The questionnaire was able to detect an increase in satisfaction with smile aesthetics as a result of the tooth-whitening procedure ($P = 0.016$). Clinical predictors of greater satisfaction with smile aesthetics were greater tooth display when smiling, decreased chroma and the absence of gingivitis, as well as absence of crowded, fractured and restored teeth in the anterior segment. **Conclusions:** A new questionnaire, titled the Smile Aesthetics Satisfaction Scale (SASS), showed good psychometric properties and its use can be recommended.

Key words: *Dental aesthetics, psychometrics, quality of life, reliability, validity*

INTRODUCTION

Facial aesthetics and physical appearance have great potential to affect one's social life. Self-perceived facial appearance is frequently related to concern regarding other people's opinions and reactions. Therefore, even small imperfections in dental aesthetics might lead to a fear of negative public reactions and cause appearance-based insecurity[1].

Appearance of lips and teeth are two main characteristics that define the overall facial appearance. Investigations that analysed eye movements in face-to-face interactions showed that the eyes of the observer primarily focus on the other person's eyes, mouth and perioral region, while just a small fraction of time is spent observing other facial characteristics[2]. Observers are often inclined to attribute more pleasing characteristics to those who have aligned teeth than to those with imperfections in tooth alignment[3,4]. Poorer dentofacial appearance may result in negative connotations by the observer regarding one's personality and psychological characteristics, whereas individuals with a more attractive dental and smile appearance are often perceived as socially more competent and psychologically more adaptive, as well as eventually viewed as more intelligent[2,4]. Patients' self-reports on the elements of aesthetics that are a source of major concerns are of key importance to the clinician and

enable her/him to form a treatment strategy. There are many questionnaires published in the literature that aim to assess particular characteristics and features of the patient, dimensions of their personality and the perception of dentofacial aesthetics. The large number of variables makes it difficult to obtain an adequate number of accurate responses owing to the time it takes to fill out such a questionnaire. Furthermore, clinicians need a significant amount of time to process the data obtained, which in turn significantly reduces the time spent on communicating with patients. Therefore, the aim of this investigation was to create a new psychometric instrument that would be simple and brief, without losing its reliability in assessment of what is important to patients when restoring deteriorated smile aesthetics, primarily through prosthetic rehabilitation. Our assumption is that the new instrument will be one dimensional, have a high internal consistency and measure the construct similar to dental self-confidence, aesthetic concern and the desire to improve the smile appearance. In addition, we hypothesised that crowded and dark-colored teeth will be the source of greatest facial dissatisfaction. The questionnaire will have good stability throughout the period with no dental intervention. It will be able to detect changes in patient satisfaction from aesthetic dental interventions, such as tooth whitening.

MATERIALS AND METHODS

The initial idea of this new questionnaire was to create a short scale for assessment of satisfaction with smile aesthetics, which would detect the exact aesthetic component and the extent to which it causes concern among patients. A three-member team, comprising two specialists in prosthodontics and one psychologist, was formed, with the initial list of the elements of dentofacial aesthetics agreed upon based on their experience and a literature review. In order to rank the self-perceived satisfaction with smile aesthetics (formulated as: 'Are you satisfied with…?'), self-assessment in relation to five elements (tooth appearance, tooth colour, tooth shape, tooth position/alignment and the appearance of the gingiva) was used via a three-point Likert scale (1 = not satisfied, 2 = moderately satisfied and 3 = completely satisfied). This type of scale was chosen as it offers clarity and patients understand them better than scales with more points.

In a cross-sectional study, an initial sample of 700 Caucasian subjects (439 female), 18–86 years of age, were recruited among patients who visited the Dental Clinic of the University Medical Centre in Rijeka for regular check-ups or dental treatment, patients scheduled for regular health controls at the Public Health Centre and blood donors from the Transfusion Medicine Center. As a result of missing data, 29 subjects were excluded. In the final analysis, 671 subjects (63% female), 18–86 years of age (median age: 45 years, interquartile range: 30–61 years), were included. All subjects had six maxillary anterior teeth present (intact teeth, colour-matched composite restorations, veneers or crowns), while the exclusion criteria applied were: untreated periodontal disease; caries lesions; significant occlusal wear; active orthodontic treatment with fixed edgewise appliances; participants undergoing prosthetic rehabilitation and thus currently fitted with temporary crowns; participants undergoing endodontic treatment; participants with splints for the treatment of temporomandibular disorders; and participants with craniofacial syndromes.

The sample size was based on recommendations for factor analysis, which regard 500 subjects as very good and 1,000 subjects as excellent[5]. It was also calculated that 650 subjects would be a sufficient sample size for exploring the relationship between a new psychometric instrument and 12 smile aesthetics predictors in hierarchical multiple regression using the following parameters: anticipated small effect size of Cohen's $f^2 = 0.02$; power $\beta = 0.8$; probability level $\alpha = 0.05$; and two steps (seven predictors in the first step and five in the second). Taking dropouts into account, it was decided to recruit 700 participants.

Clinical examination performed by the single examiner (VL) measured the height and width of the maxillary anterior teeth using a precise calliper (Fowler Ultra; Swiss Instruments Limited, Mississauga, ON, Canada), as well as tooth and gingival display in a posed smile. The plaque score was measured using the method of Silness and Loe[6]. The following features were noted: existence and type of restoration (healthy tooth without filling(s); composite filling(s); ceramic veneer; faceted crown; metal ceramic crown; and full ceramic crown), and fracture marks on the upper anterior teeth and crowded teeth[7,8]. Subjects self-reported the presence of bleeding gums (on a scale from 1 = never to 4 = always). Tooth colour was assessed by a single examiner (VL) using the Chromascop Shade Guide (Ivoclar Vivadent, Schaan, Liechtenstein). In order to test the examiner's accuracy, colour evaluated according to the guide was compared with the colour obtained using a spectrophotometer (Spectroshade Micro; MHT, Verona, Italy) on the sample of 31 subjects, with the weighted Cohen's kappa (κ_w) being 0.737 [95% confidence interval (95% CI): 0.525–0.949], indicating good accuracy. The same measurements were repeated on the same subjects after 1 week, and the κ_w was 0.821 (95% CI: 0.635–1.000), indicating very good precision. All the Chromascop Shade Guide colours were screened using a spectrophotometer in order to

quantify the lightness and chroma, while only CIE $L^*a^*b^*$ values were used for statistical analysis[9]. L^* was used as a measure of lightness, while chroma values were calculated using the formula $C^* = [(a^*)^2 + (b^*)^2]^{1/2}$. Accuracy and precision of the spectrophotoshade was checked by comparison with the standard Chromascop Shade Guide and by repeated measurements, then quantified by measurement of intraclass correlation coefficients (ICCs).

Validation of a new psychometric instrument was performed according to the criteria set out in the Consensus-based Standards for the Selection of health status Measurement Instruments (COSMIN)[10,11].

Structural validity was evaluated by exploratory factor analysis and principal component analysis with Varimax rotation. Internal consistency was tested using Cronbach's alpha and inter-item correlations, while convergent validity as a measure of construct validity was assessed using Pearson and point-biserial correlations. For the purpose of comparison, validated Croatian versions of the Oral Health-Related Quality of Life (OHRQoL) instruments, namely the Oral Impacts on Daily Performance (OIDP) and the Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ), were used[12,13]. In addition, convergent validity was tested by analysing correlations with the answers to questions pertaining to patient concerns over tooth appearance (hiding the teeth when smiling: 0 = no, 1 = yes), self-perceived elements of appearance and the position of the maxillary anterior teeth, and the desire expressed for general improvement in tooth appearance, tooth whitening and orthodontic treatment. The ability of the instrument to detect differences between subjects with and without crowding, tooth fractures and restorations present was tested using the Independent Samples *t*-test. Responsiveness testing, performed by the Paired Samples *t*-test in 19 subjects, evaluated whether the new instrument could detect changes induced by in-office tooth whitening with photoactivated whitening gel containing 38% hydrogen peroxide (Signal Easy Lamp Plus and Signal Fast professional plus set, Signal; Unilever, Buenos Aires, Argentina), for 30 minutes. Tooth colour was assessed by spectrophotometry before and after the whitening procedure, with the difference caused by whitening calculated using the formula $\Delta E^* = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{1/2}$. Test–retest reliability was assessed by ICCs; measurement error was evaluated by repeating the assessment of tooth color in 30 subjects within a 1-week interval of the first measurement, without any dental intervention.

Hierarchical multiple linear regression analysis was used to assess the predictive value of clinical predictors of the satisfaction with smile aesthetics. All statistical analyses were performed using the commercially available IBM SPSS 22 software (IBM Corp., Armonk, NY, USA), with the level of statistical significance set at $P < 0.05$.

This investigation was approved by the Ethics Committee of the Medical Faculty University of Rijeka and the Ethics Committee of the University Medical Centre in Rijeka, and was conducted in full accordance with World Medical Association Declaration of Helsinki. Signed, informed consent was obtained for all subjects.

RESULTS

The distribution of subjects regarding the level of education was as follows: elementary school education, 5.4%; high school graduates, 72.3%; bachelor's degree, 3.7%; and higher university degree, 18.6%. Distribution of tooth colour and dental status of the subjects is listed in *Tables 1* and *2*.

Factorial analysis demonstrated that this specific scale, based on the assessment of five elements of satisfaction, was one dimensional, thereby measuring general satisfaction with smile aesthetics, and may be used as a summary score of answers to all five items. Principal component analysis extracted one factor, which accounted for 64.3% of variance in all manifested variables. Each item had rather high saturation at the first principal component (0.720–0.870). Elements of the questionnaire showed strong reliability in terms of internal consistency (Cronbach $\alpha = 0.859$), while the mean correlation among the elements was 0.551 (range: 0.441–0.687). An increase in internal consistency could not be produced by eliminating any item. The name chosen for this instrument was the Smile Aesthetics Satisfaction Scale (SASS); on this scale, values range from a score of five to a maximum of 15.

Table 1 Colour distribution

Colour according to the Chromascop Shade Guide	*n*	%
120	106	15.8
140	42	6.3
220	28	4.2
230	20	3.0
130	165	24.6
210	52	7.7
240	17	2.5
330	6	0.9
310	73	10.9
530	4	0.6
340	14	2.1
410	49	7.3
430	30	4.5
520	5	0.7
320	6	0.9
420	45	6.7
440	8	1.2
510	1	0.1
Total	671	100.0

Table 2 Overview of the dental status of study subjects for a particular tooth

Tooth		Intact tooth	Composite filling	Composite veneer	Ceramic veneer	Faceted crown	Metal ceramic crown	Full ceramic crown
13	*n*	401	77	0	0	96	90	7
	%	59.8	11.5	0	0	14.3	13.4	1
12	*n*	336	134	0	1	94	96	10
	%	50.1	20	0	0.1	14	14.3	1.5
11	*n*	340	117	1	1	96	98	18
	%	50.7	17.4	0.1	0.1	14.3	14.6	2.7
21	*n*	337	133	1	0	93	89	18
	%	50.2	19.8	0.1	0	13.9	13.3	2.7
22	*n*	350	131	0	0	97	86	7
	%	52.2	19.5	0	0	14.5	12.8	1
23		411	75	0	0	98	83	4
	%	61.3	11.2	0	0	14.6	12.4	0.6

The new questionnaire measures the construct similar to discomfort caused by tooth appearance (hiding one's teeth when smiling), self-perceived alteration in smile aesthetics (poor tooth restorations and misalignment) [$r = -0.403-(-0.379)$], as well as the desire to improve tooth appearance in general, specifically through whitening procedures, or orthodontic or prosthetic therapy [$r = -0.353 - (-0.268)$] ($P < 0.05$; *Table 3*). All correlations were weak, as were correlations between the questionnaire and clinical parameters (*Table 3*). However, it was possible to differentiate, using the questionnaire, subjects with fractured upper anterior teeth from those without such an impediment (11.9 ± 2.9 *vs.* 10.5 ± 3.2; $P < 0.001$), subjects with and without crowding (11.9 ± 2.9 *vs.* 11.0 ± 3.1; $P < 0.001$) and subjects with intact teeth from those with restorations (12.3 ± 2.6 *vs.* 11.2 ± 3.1; $P < 0.001$).

High test–retest reliability was found (ICC = 0.985; *Table 4*) with small measurement error and small mean value of paired differences. When considering the sample size, the percentage of differences between the test and the retest was appropriate within the limits of agreement.

The SASS was demonstrated to be an adequate tool for detecting change in satisfaction with smile aesthetics as a result of the tooth-whitening procedure ($P = 0.016$), particularly in satisfaction with tooth colour ($P < 0.001$). However, the degree of colour change did not show a linear correlation with the increase in patient satisfaction (*Table 5*).

Clinically measurable elements of smile aesthetics accounted for a mere 15.4% of variability in satisfaction when smiling. Satisfaction increased with greater tooth display, i.e. larger proportion of teeth displayed when smiling and lower chroma, and in patients with healthy maxillary anterior teeth without the signs of crowding, fracture or gum disease. The most significant unique contribution was demonstrated by crowding and chroma (3% each) and the existence of fractures, tooth restorations and gum disease (2% each), while tooth display when smiling accounted for 1%. Other elements evaluated (lightness, uneven tooth colour, tooth shape, gingival display when smiling, age, gender and education level) were not found to be significant predictors of satisfaction.

Hierarchical regression analysis was performed in six steps, in a stepwise manner: the order in which hypothetical predictors were entered started with crowding and fracture in the first step, followed by gingivitis and plaque in the second, the presence of restoration-free teeth in the third, colour elements in the fourth, tooth display when smiling, gingival display and tooth shape in the fifth, and age, gender and level of education in the sixth. This stepwise method enabled the inclusion of only statistically significant predictors, adhering to the principle to include previously defined hypothesised predictors, while reducing the overall number of predictors (*Table 6*).

DISCUSSION

The SASS is a good, short, clear and easily understood assessment scale, which points to the level of satisfaction with smile aesthetics. Moreover, it is a good patient-centred outcome measure of aesthetic interventions in dentistry. The validation process was performed according to international criteria, thereby guaranteeing the quality of the psychometric instrument.

The SASS is one dimensional and measures general patient satisfaction with tooth and gingival appearance through several elements, which are most visible during interpersonal communication and social interactions. The scale has a 10-point range, from five to 15. It takes <1 minute to fill out and therefore as it is quickly and easily completed, it may well be one of the quickest self-administered instruments. High reliability demonstrated through internal consistency proves that the items are interrelated. The Cronbach alpha gives a lower bound of the true reliability, thereby making the test psychologically interpretable. Values of 0.7–0.8 are satisfactory, indicating a reliable

Table 3 Pearson and point-biserial correlations with noted constructs for the assessment of convergent validity and clinical parameters

Variables		SASS 11.5 ± 3.0 (5–15)
Hiding teeth when smiling (0 = no; 1 = yes)	*r*	−0.403
0 = 89.3%; 1 = 10.7%	*P*	<0.001
Self-perceived poor restorations (0 = no; 1 = yes)	*r*	−0.391
0 = 90.9%; 1 = 9.1%	*P*	<0.001
Self-perceived tooth fractures (0 = no; 1 = yes)	*r*	−0.208
0 = 85.1%; 1 = 14.9%	*P*	<0.001
Self-perceived tooth misalignment (0 = no; 1 = yes)	*r*	−0.374
0 = 75.4%; 1 = 24.6%	*P*	<0.001
Desire for better dental aesthetics (0 = no; 1 = yes)	*r*	−0.353
0 = 37.6%; 1 = 62.4%	*P*	<0.001
Desire for tooth whitening (0 = no; 1 = yes)	*r*	−0.298
0 = 36.8%; 1 = 63.2%	*P*	<0.001
Desire for orthodontic therapy (0 = no; 1 = yes)	*r*	−0.268
0 = 44.3%; 1 = 55.7%	*P*	<0.001
Desire for prosthetic rehabilitation (0 = no; 1 = yes)	*r*	−0.347
0 = 44.1%; 1 = 55.9%	*P*	<0.001
OIDP	*r*	0.023
4.3 ± 6.3 (0–35)*	*P*	0.599
Social impact of dental aesthetics	*r*	0.026
10.2 ± 5.5 (0–30)*	*P*	0.508
Psychological impact of dental aesthetics	*r*	0.027
9.6 ± 4.6 (0–23)*	*P*	0.488
Aesthetic concerns	*r*	0.043
4.0 ± 2.2 (0–12)*	*P*	0.268
Dental self-confidence	*r*	0.007
13.1 ± 7.3 (0–24)*	*P*	0.852
Gum display on tooth 11 when smiling (mm)	*r*	0.012
0.77 ± 1.06 (0–7)*	*P*	0.374
Tooth shape 11 (width to height ratio)	*r*	0.013
0.90 ± 0.13 (0.5–1.6)*	*P*	0.365
Visibility of tooth 11 crown when smiling (visible to total crown height ratio)	*r*	0.086
0.78 ± 0.21 (0–1)*	*P*	0.013
Lightness (*L*)	*r*	0.220
70.74 ± 3.13 (63.5–75.7)*	*P*	<0.001
Chroma	*r*	−0.229
19.35 ± 3.24 (16.1–27.3)*	*P*	<0.001
Crowding (0 = no; 1 = yes)	*r*	−0.151
0 = 62.9%; 1 = 37.1%	*P*	<0.001
Harmonious colours of anterior teeth	*r*	−0.066
0 = 21.3%; 1 = 78.7%	*P*	0.087
Intact teeth with no restorations (0 = restoration present on at least one anterior tooth; 1 = intact tooth)	*r*	0.175
0 = 67.8%; 1 = 32.2%	*P*	<0.001
Fracture(0 = absent; 1 = visible on at least one anterior tooth)	*r*	−0.190
0 = 75.7%; 1 = 24.3%	*P*	<0.001
Visible plaque (0 = absent; 1 = visible on at least one anterior tooth)	*r*	−0.090
0 = 8.9%; 1 = 91.1%	*P*	0.020
Self-reported gingivitis (0 = never, rarely; 1 = often, always)	*r*	−0.187
0 = 87.5%; 1 = 12.5%	*P*	<0.001

OIDP, Oral Impacts on Daily Performance; SASS, Smile Aesthetics Satisfaction Scale.
*Mean ± standard deviation (minimum–maximum).

scale, which allows comparison between groups. In clinical applications, the range 0.90–0.95 is the desirable goal. However, an exceedingly high value, approximating 1, may indicate the redundancy of some items[14–16]. It may be concluded, then, that the instrument presented allows comparison between groups, but also on an individual level, in clinical settings.

Numerous psychosocial aspects are involved in the assessment of dentofacial aesthetics and quality of life related to aesthetic deteriorations. By using psychometric instruments, it is possible to gain insights into the complexity of patients' perceptions and their thoughts, feelings and levels of motivation to correct the aesthetic concerns. In-depth psychological analysis requires not only a significant amount of the patient's time, but also specific education and time by the treating clinician. For this very reason, patients' desires and their perceptions of deteriorated dentofacial aesthetics might easily be neglected. The new aesthetic questionnaire was created with this situation in mind because in just a few minutes it provides the therapist with guidelines and signals particular behavioural changes and reactions during and after the therapy.

Table 4 Test–retest reliability (n = 30)

	ICC (95% CI)	ME*	SDC†	Paired differences mean (95% CI)	P	LOA‡
SASS	0.985 (0.969–0.993)	0.293	0.812	0.033 (−0.121 to 0.188)	0.662	−0.778 to 0.844 (83.3%)

*Measurement error (ME) was calculated as the square root of the residual variance.
†Smallest detectable change (SDC) was calculated as 1.96*√2*ME.
‡Limits of agreement (LOA) were calculated as the paired differences mean ±1.96*standard deviation of differences between two measurements (presented with the percentage of differences between test and rates, which are within the limits of agreement).
95% CI, 95% confidence interval; ICC, intraclass correlation coefficient; SASS, Smile Aesthetics Satisfaction Scale.

Table 5 Responsiveness testing (n = 19)

Variable	Mean baseline score – mean follow-up score	Paired differences mean (95% CI)	Ratio of subjects with increased score for ≥1 (%)	Summary score range at baseline	Standardised effect size*	Standardised response mean†	P‡	r§	P§
SASS	11.1–12.1	1.0 (0.2–1.8)	63.2	8–14	0.601	0.612	0.016	0.096	0.696
Colour satisfaction	1.9–2.7	0.8 (0.5–1.2)	73.6	1–3	1.485	1.101	<0.001	0.020	0.934

*Glass' Δ effect size: average difference between the two measurements divided by the standard deviation of the baseline score.
†Standardised response mean: average difference between the two measurements divided by the standard deviation of the differences between the paired measurements.
‡Paired samples t-test.
§Pearson correlation coefficient with corresponding P-value for correlation between change in the Smile Aesthetics Satisfaction Scale (SASS) and colour satisfaction, and change in tooth colour (delta E) as a result of bleaching.

Based on the data derived from these measures, the treating clinician may adjust his/her patient approach depending on the proportional representation of certain components.

The SASS measures a construct similar to concerns over tooth and smile appearance and a general desire to improve dental aesthetics through various procedures. However, the correlations between these measures are not high. In addition, the instrument does not demonstrate a linear correlation with dental self-confidence, aesthetic concern or social or psychological aspects of dental aesthetics. This was quite unexpected because it was believed that the new instrument would explain a significant portion of these constructs, especially dental self-confidence, which contains a fraction of the items used to measure satisfaction with tooth appearance. The reason for this weak correlation may lie in the wide age range of the subjects, with 25% of them being in the age group for whom the PIDAQ was validated (18–30 years), while more than 40% were over 50 years of age[13]. These emotional dimensions are probably not significantly expressed in this older age group regardless of the clinical situation. Furthermore, the SASS does not measure the construct similarly to the OIDP[12]. The OIDP measures the impairment of eight everyday activities caused by dental problems as a summary measure of frequency and degree of impaired activity. However, only a small portion of these activities is directly related to aesthetics: smiling, interpersonal relations and emotions. Despite this, it has been recently reported that the OIDP may be integrated into existing instruments in order to create the dimension called orofacial appearance as a significant dimension of the OHRQoL[17].

Taking into account all the available psychometric instruments, the SASS is most similar to the Orofacial Esthetic Scale (OES) instrument, which has recently been validated in Croatia.[14] However, at the time when this study was conducted, the OES instrument had not been validated, meaning that it was not possible to quantify the degree of correlation directly. However, it may be assumed that these two instruments correlate to a significant degree because the OES contains a large number of elements assessed by the SASS. In our opinion, tooth position is more precisely defined in the SASS compared with the formulation concerning the 'appearance of dental arches' in the Croatian OES. Furthermore, the facial profile is something not frequently regarded as important by the majority of patients as they do not observe their own profiles. This element differentiates between the OES and SASS constructs. However, the OES takes longer to fill out compared with the SASS, which is conditioned by a larger number of items and a wider range of possible answers. A reduced range of possible answers on the Likert scale is obviously clearer to patients[14].

Several methods confirmed excellent stability of the instrument, which can be attributed to clear and simple statements, as well as limited categories of possible answers[18–20]. As measurement error is very low, that is, below one scalar point, it can be used to control both systematic and random errors in patients' self-reporting in a measured construct[19]. The smallest

Table 6 Hierarchical multiple regression analysis for evaluation of the predictors of satisfaction with smile aesthetics assessed using the Smile Aesthetics Satisfaction Scale (SASS)

Model	Predictor variable	Unstandardised coefficients B	SE	Standardised coefficients beta	Significance	Correlations		
						Zero-order	Partial	Part
1	(Constant)	11.891	0.145					
	Crowding	−0.939	0.237	−0.151	<0.001	−0.151	−0.151	−0.151
2	(Constant)	12.233	0.156					
	Crowding	−0.969	0.233	−0.156	<0.001	−0.151	−0.159	−0.156
	Fracture	−1.360	0.262	−0.194	<0.001	−0.190	−0.197	−0.194
3	(Constant)	12.370	0.157					
	Crowding	−0.893	0.230	−0.144	<0.001	−0.151	−0.148	−0.143
	Fracture	−1.278	0.260	−0.183	<0.001	−0.190	−0.187	−0.182
	Self-reported gingivitis	−1.485	0.337	−0.164	<0.001	−0.187	−0.168	−0.163
4	(Constant)	12.034	0.171					
	Crowding	−1.064	0.230	−0.171	<0.001	−0.151	−0.177	−0.169
	Fracture	−1.206	0.256	−0.172	<0.001	−0.190	−0.180	−0.172
	Self-reported gingivitis	−1.320	0.334	−0.146	<0.001	−0.187	−0.152	−0.144
	Intact teeth	1.123	0.238	0.175	<0.001	0.175	0.180	0.172
5	(Constant)	15.243	0.699					
	Crowding	−1.155	0.227	−0.186	<0.001	−0.151	−0.194	−0.182
	Fracture	−1.023	0.255	−0.146	<0.001	−0.190	−0.154	−0.144
	Self-reported gingivitis	−1.143	0.331	−0.126	0.001	−0.187	−0.133	−0.124
	Intact teeth	0.921	0.239	0.143	<0.001	0.175	0.148	0.138
	Chroma	−0.164	0.035	−0.177	<0.001	−0.229	−0.180	−0.169
6	(Constant)	14.164	0.806					
	Crowding (0 = no; 1 = yes)	−1.170	0.226	−0.188	<0.001	−0.151	−0.197	−0.185
	Fracture (0 = absent; 1 = visible)	−1.046	0.254	−0.150	<0.001	−0.190	−0.158	−0.147
	Self-reported gingivitis (0 = never/rarely; 1 = often/always)	−1.211	0.330	−0.134	<0.001	−0.187	−0.141	−0.131
	Intact teeth (0 = restorations; 1 = intact)	0.888	0.238	0.138	<0.001	0.175	0.143	0.133
	Chroma	−0.161	0.035	−0.174	<0.001	−0.229	−0.178	−0.166
	Visibility of 11 when smiling (ratio)	1.357	0.511	0.095	0.008	0.089	0.103	0.095

1. $R = 0.151$; R-square = 0.023; adjusted R-square = 0.021; $P < 0.001$.
2. $R = 0.246$; R-square = 0.061; adjusted R-square = 0.058; $P < 0.001$; ΔR-square = 0.038; $P < 0.001$.
3. $R = 0.295$; R-square = 0.087; adjusted R-square = 0.083; $P < 0.001$; ΔR-square = 0.027; $P < 0.001$.
4. $R = 0.342$; R-square = 0.117; adjusted R-square = 0.111; $P < 0.001$; ΔR-square = 0.029; $P < 0.001$.
5. $R = 0.381$; R-square = 0.145; adjusted R-square = 0.139; $P < 0.001$; ΔR-square = 0.029; $P < 0.001$.
6. $R = 0.393$; R-square = 0.154; adjusted R-square = 0.147; $P < 0.001$; ΔR-square = 0.009; $P = 0.008$.

detectable change is a measure of the variation in a scale pointing to the changes above the measurement error, which are considered as true changes attributed to the measured construct[19]. The minimum change in score as a result of clinical intervention using the SASS should be one aspect that represents real change. It was expected that the observed change in reported satisfaction without any dental intervention would predominantly equal zero, or close to that value. It might have also been assumed that the measurement error value would be low (minimum one scalar point). Although it is appropriate for the difference between the two measurements without any intervention to be within limits of agreement for 95% of the pairs of observations, the present instrument had lower values. When considering sample size, this may be appropriate as only one out-of-limits person out of 30 participants yields 95%. In the present instrument, 25 of 30 subjects had absolutely the same values in two administrations, five differed by only one scalar point and none by more than one scalar point.

One scalar point is the value that obviously presents a cut-off point for both measurement error and a clinically relevant change, as a result of the intervention detectable by this instrument. Only two of five elements were able to detect a change as a result of anterior tooth whitening (tooth appearance and colour), with the range of detected change being 1 to a maximum of 4. More than 60% of the subjects reported a change in satisfaction as a result of tooth whitening, mostly (37% of the subjects) with an increase of two or three scalar points. Although the SASS was able to detect a change in satisfaction as a result of the whitening procedure, it still cannot be stated that the relationship between the change in satisfaction and colour was linear. An increase in the degree of colour change does not necessarily lead to an increase in patient satisfaction. This is probably because patients are quite subjective when assessing their appearance, in that the tooth colour and its subsequent change fail to affect patient satisfaction notably[21]. Another reason is that people in general are easily influenced, meaning that they may perceive a clinically minor change as notable. The limited number of categories for particular answers still provides a sufficient range for the detection of changes, such

that they may equal 1 for minimal improvement to 10 for the maximal improvement in all aspects.

This research demonstrated that clinically measurable elements of smile aesthetics were not strongly related to patients' satisfaction when smiling but were instead markedly influenced by an individual's personality, which has been previously confirmed[22–24]. This may compromise the success of treatment through a misunderstanding between the patient and the treating dentist regarding the expectations, treatment plan, treatment steps and the outcome. According to our research, the absence of tooth crowding and reduced chroma of the anterior teeth are somewhat more significant clinical predictors of the satisfaction with smile aesthetics, followed by the absence of gingivitis, fractures and restorative works, with the least significant predictor being tooth display when smiling. Other elements assessed (lightness, lack of harmony in tooth colour and shape, gum display when smiling, age, gender and level of education) were not detected as significant predictors of satisfaction. Hierarchical multiple regression analysis accounts only for about 15% of variability to describe the SASS summary score, which is quite low. A weak effect of tooth display on satisfaction with smile is probably because the SASS does not include the dimension of patient satisfaction with tooth display. The questionnaire itself demonstrated good psychometric properties and may therefore be recommended for evaluating patients' perception of smile aesthetics.

As most of the elements of smile aesthetics evaluated using this questionnaire may be modified through prosthetic procedures, it is be advisable to evaluate its efficacy through patient-centred outcomes in prosthetic rehabilitation.

CONCLUSION

The SASS is a good, short questionnaire measuring patient satisfaction with smile aesthetics. It helps the operating dentist to assess the patient's desires and increases the likelihood of treatment success.

CLINICAL SIGNIFICANCE

Patient-centred outcome measures of aesthetic interventions in dentistry, such as this new instrument, help the therapist to assess the patient's desires and increase the likelihood of therapy success. Given its precision and briefness, the authors recommend the SASS for detecting aesthetic elements, which are not only the most relevant but also the most concerning for the patient.

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Conflict of interest

The authors declare that there is no conflict of interest.

REFERENCES

1. Klages U, Rost F, Wehrbein H *et al.* Perception of occlusion, psychological impact of dental aesthetics, history of orthodontic treatment and their relation to oral health in Naval recruits. *Angle Orthod* 2007 77: 675–680.
2. Wilson NHF, Millar BJ. *Principles and Practice of Aesthetic Dentistry: Essentials of Aesthetic Dentistry*, 1st ed. Amsterdam: Elsevier; 2014.
3. Klages U, Bruckner A, Zentner A. Dental aesthetics, self-awareness, and oral-health related quality of life in young adults. *Eur J Orthod* 2004 26: 507–514.
4. Newton JT, Prabhu N, Robinson PG. The impact of dental appearance on the appraisal of personal characteristics. *Int J Prosthodont* 2003 16: 429–434.
5. MacCallum RC, Widaman KF, Zhang S *et al.* Sample size in factor analysis. *Psychol Methods* 1999 4: 84–99.
6. Silness J, Loe H. Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand* 1964 22: 121–135.
7. Al-Jabrah O, Al-Shammoul R, El-Naji W *et al.* Gender differences in the amount of gingival display during smiling using two intraoral dental biometric measurements. *J Prosthodont* 2010 19: 286–293.
8. Brambilla GP, Cavalle E. Fractured incisors: a judicious restorative approach - part 3. *Int Dent J* 2007 57: 195–204.
9. Commission Internationale de l'Eclairege (CIE). *Lights as a true visual quantity: principle of measurements*. CIE Pub. No. 41. Vienna: Bureau Central de la CIE; 1978.
10. Mokkink LB, Terwee CB, Knol DL *et al.* The COSMIN checklist for evaluating the methodological quality of studies on measurement properties: a clarification of its content. *BMC Med Res Methodol* 2010 10: 22.
11. Mokkink LB, Terwee CB, Patrick DL *et al.* The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. *Qual Life Res* 2010 19: 539–549.
12. Lajnert V, Gržić R, Radica N *et al.* Translation and validation of the Croatian version of the oral impacts on daily performances (OIDP) scale. *Vojnosanit Pregl* 2016 9: 811–816.
13. Spalj S, Lajnert V, Ivankovic L. The psychosocial impact of dental aesthetics questionnaire: translation and cross-cultural validation in Croatia. *Qual Life Res* 2014 23: 1267–1271.
14. Persic S, Milardovic S, Mehulic K *et al.* Psychometric properties of the Croatian version of the Orofacial Esthetic Scale and suggestions for modification. *Int J Prosthodont* 2011 24: 523–533.
15. Bland JM, Altman DG. Cronbach's alpha. *BMJ* 1997 314: 572.
16. McDowell I, Newell C. *Measuring health: a guide to rating scales and questionnaires*, 3rd ed. Oxford: Oxford University Press; 1996.
17. John MT, Reissmann DR, Čelebić A *et al.* Integration of oral health-related quality of life instruments. *J Dent* 2016 53: 38–43.
18. Bland JM, Altman DG. Measurement error. *BMJ* 1996 313: 744.
19. de Vet HC, Terwee CB, Knol DL *et al.* When to use agreement versus reliability measures. *J Clin Epidemiol* 2006 59: 1033–1039.
20. Nunnally JC, Bernstein IR. *Psychometric theory*, 3rd ed. New York: McGraw-Hill; 1994.

21. Pavicic DK, Spalj S, Uhac I *et al.* A cross-sectional study of the influence of tooth-colour elements on satisfaction with a smile's aesthetics. *Int J Prosthodont* 2016 30: 156–159.
22. de Paula DF, Santos NC, da Silva ET *et al.* Psychosocial impact of dental aesthetics on quality of life in adolescents. *Angle Orthod* 2009 79: 1188–1193.
23. Kareema FA, Mahmood TMA. Psychological impact of dental aesthetics for Kurdish adolescents seeking orthodontic treatment. *Int J Health Rehabil Sci* 2010 5: 46–56.
24. Lukez A, Pavlic A, Trinajstic Zrinski M *et al.* The unique contribution of elements of smile aesthetic to psychosocial well-being. *J Oral Rehabil* 2015 42: 275–281.

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