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Development of a questionnaire for assessment of the psychosocial impact of dental aesthetics in young adults

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SUMMARY The aim of this study was to develop a psychometric instrument for assessment of orthodontic-specific aspects of quality of life. The study subjects, 194 young adults aged 18–30 years, were interviewed using a pool of 23 items dealing with the psychosocial impact of dental aesthetics. Self- and interviewer-rating of the dental aesthetic appearance of each subject were carried out using the Aesthetic Component (AC) of the Index of Orthodontic Treatment Need (IOTN). Additionally, the Perception of Occlusion Scale and a modification of the Dental Aesthetic Index (DAI) were applied.

Factorial analyses identified four measures within the item pool, namely Dental Self-Confidence, Social Impact, Psychological Impact, and Aesthetic Concern. The factor structure was confirmed in an independent sample of 83 subjects aged 18–33 years. The reliabilities of the factor analysis-derived scales were between alpha (α) 0.85 and 0.91. They differed between respondents with varying severity of malocclusion, as assessed by subject and interviewer ratings.

The results suggest that the proposed instrument, termed the 'Psychosocial Impact of Dental Aesthetics Questionnaire' (PIDAQ), meets the criteria of factorial stability across samples and criterion-related validity and reliability, and might be a promising tool for further research and clinical application in orthodontics.

Introduction

Improvement of oral health and enhancement of psychosocial well-being are perceived benefits of orthodontic treatment (Bennett *et al.*, 1995). Patients' expectations from orthodontics are primarily improvements in appearance, self-image and social functioning (Pietilä and Pietilä, 1996). This is supported by research on general body image which shows that individuals satisfied with their own physical appearance tend to be more outgoing and successful in social contact (Cash and Fleming, 2002). Orthodontists traditionally have considered oral health and function as the principal goals of treatment (O'Brien *et al.*, 1998; Hunt *et al*., 2001). However, recently there has been growing acceptance of aesthetics and its psychosocial impact as an important treatment benefit (Giddon, 1995; Cunningham and Hunt, 2001; Hunt *et al*., 2001). Some patients report markedly improved body image and appearance-related self-confidence after orthodontic treatment (Albino *et al.*, 1994; Cunningham *et al.*, 1996, 2002; Birkeland *et al.*, 1997; Kiyak, 2002), and good dental aesthetics and previous orthodontic treatment might have a beneficial influence on oral health-related attitudes and behaviour of young adults (Klages *et al*., 2005).

Despite agreement amongst professionals about the importance of the psychosocial effects of treatment, no psychometric instruments are currently available for objective assessment of the impact of dental aesthetics on subjective well-being (O'Brien *et al*., 1998; Cunningham and Hunt, 2001). Published work has often relied on single-item measures such as, for instance, questioning the study subjects about the perceived benefits of orthodontics. However, methodological considerations advocate the use of multi-item and multi-trait measures in order to investigate the complex construct of orthodontic-related psychosocial well-being (O'Brien *et al*., 1998; Bennett and Phillips, 1999; Cunningham and Hunt, 2001). Factorial structure, homogeneity of scales and relationships with variables such as dental aesthetics, must be established before an instrument may be accepted into routine use (Juniper *et al*., 1996; Pruzinsky and Cash, 2002).

Instruments assessing health-related quality of life (HRQoL) address a patient's perspective of the impact of a medical condition on subjective well-being and everyday functioning. In the past, oral HRQoL research was primarily directed at the assessment of the experiences of elderly patients who often suffer periodontal disease, tooth loss or inadequate dentures (Locker and Jokovic, 1996; Inglehart and Bagramian, 2002). Recently oral HRQoL in children and adolescents has received considerable interest (Broder *et al*., 2002; Jokovic *et al*., 2002). The instruments addressing these issues are not directly applicable to orthodontic treatment, which is usually confined to elective correction of asymptomatic deviations from an aesthetic norm (O'Brien *et al.*, 1998; Cunningham and Hunt, 2001). Therefore, development of an instrument is required which is selective and specific to orthodontic aspects of oral HRQoL.

The Orthognathic Quality of Life Questionnaire (OQLQ; Cunningham *et al.*, 2000, 2002) is the only instrument

which addresses the subjective impact of orthodontic-specific conditions in young adults. In the development of the present questionnaire (Klages *et al.*, 2004, 2005), the OQLQ scales 'Social Aspects' and 'Facial Aesthetics' and a newly developed 'Dental Self-Confidence Scale' proved to discriminate between subjects with excellent dental aesthetics and those with minor irregularities as judged by the Aesthetic Component (AC) of the Index of Orthodontic Treatment Need (IOTN). In these studies, the strongest statistical effects were exhibited by the Dental Self-Confidence Scale consisting of items referring to dental aesthetics. Based on the experience derived from these studies it appeared promising to improve the content validity (Murphy and Davidsdorfer, 1998) of the Facial Aesthetics and Social Aspects scales by reformulating items in order to address specific concerns of orthodontic patients and to develop new items specific to this group. The OQLQ was developed for use with surgical-orthodontic patients for whom facial and general appearance is likely to be more important, and it therefore contains items referring to facial appearance. However, a study of orthodontic subjects found that facial body image and dental body image were independent from each other, and only the latter was related to patients' treatment expectations (Bos *et al.*, 2003).

Therefore, the aim of the present investigation was to identify significant factors in the proposed item pool, to assess the reliability of factor analysis-derived scales and to reveal potential relationships with subject- and interviewer-rated dental aesthetic appearance. This multi-item psychometric instrument assessing the psychosocial impact of dental appearance was termed the 'Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ)'. The study subjects were young adults, who have a more stable self-concept compared with adolescents, but are still concerned about physical appearance when compared with older individuals.

Subjects and methods

The subjects were 194 young adults aged 18–30 years (mean 23.3, SD 3.2; 37.1 per cent male, 62.9 per cent female) of whom 86 per cent had at least 13 years of primary and secondary school education and 14 per cent, 9 years or less. Fifty per cent of the subjects were university students, 25.1 per cent were in paid employment and 17.7 per cent were vocational trainees. Dentists and dental students were not included. A history of orthodontic treatment, with a mean duration of 3.69 years (SD 2.05), was reported by 69.6 per cent.

The subjects were approached on the university campus and asked to participate in a study on dental aesthetics and oral HRQoL. An oral hygiene set was given as an incentive. The interviewer was a 28-year-old female postgraduate student without a personal history of orthodontic treatment, who had been trained by a senior academic orthodontist in the application of the orthodontic indices described below. The questionnaires were administered individually, and the rejection rate was below 3 per cent. The respondents were asked about previous orthodontic treatment, and then completed the PIDAQ, followed by the Perception of Occlusion Scale, and self-rating of their own dental aesthetics and attractiveness as detailed below. The interviewer made her own ratings on these measures and, in addition, examined the subjects' anterior teeth using a modification of the Dental Aesthetic Index (DAIM; Jenny and Cons, 1996) as described in detail below.

PIDAQ item development

An expert team was constructed that included two orthodontists, one clinical psychologist, and two interviewers from the previous stage of the development of the questionnaire (Klages *et al.*, 2004, 2005). The interviewers contributed their experience using the Aesthetics and Social Aspects Scales of the OQLQ (Cunningham *et al.,* 2000) and registered comments and suggestions for reformulation. Item revision is suggested by test theory as a necessary step when adapting a questionnaire for use in special subgroups (Aiken, 1994). Guidelines for item reformulation were (1) to improve content validity of the items (Murphy and Davidshofer, 1998) by including references to dental aesthetics following a proposal by Slade and Spencer (1994) in the development of their Oral Health Impact Profile, and (2) to improve acceptance of items, which previously had a low endorsement, by revising symptom descriptions (e.g. by inserting 'somewhat distressed' instead of 'depressed'). Additional items were generated from the experience of clinicians and interviewers and from the study of the relevant literature. Finally a total of 29 items was judged by the experts as to whether they were relevant and whether there were variants of the same content and, as a consequence of this, six items were discarded. The final version (Appendix 1) contained six items from the Self-Confidence Scale (Klages *et al*., 2004, 2005), eight revised items from the Social Aspects Scale of the OQLQ (numbers 15–22), three revised items from the Aesthetics Scale of the OQLQ (numbers 7, 10 and 11), and six newly formulated items relating mainly to the psychological impact of dental aesthetics. This version was presented to 12 orthodontic patients in the initial stages of their treatment. They were asked to evaluate the items using a five-point Likert scale with numerical values 0 = 'not at all', 1 = 'a little', 2 = 'somewhat', 3 = 'strongly' and 4 = 'very strongly'. Overall the patients judged the items as understandable and relevant to their condition (results not shown).

Perception of Occlusion Scale

This self-rating instrument has been used in previous studies (Espeland and Stenvik, 1991; Birkeland *et al.*, 1997).

Six items referring to dental arrangements with aesthetic significance were presented. These statements were: 'There are gaps between the upper front teeth'; 'The upper front teeth are crowded'; 'The lower front teeth are crowded'; 'The upper front teeth are irregular'; 'The lower front teeth are irregular'; 'The upper front teeth are positioned too far anterior to the lower front teeth (the overjet is too large)'. The response format was an agreement on a five-point scale as above.

IOTN AC

Dental aesthetics was assessed using the IOTN AC (Brook and Shaw, 1989). The subjects were presented with 10 black and white photographs of anterior teeth displaying varying degrees of malocclusion, and were asked to indicate which photograph most closely resembled their own dentition. There was no time limit for studying the photographs, and the majority of respondents needed around two minutes to give an evaluation of their dental appearance. In addition, the dental appearance of each study subject was assessed by the interviewer using the IOTN AC.

DAIM

This scale is an abbreviated form of an instrument originally developed by Cons *et al.* (1986). It has been suggested that it measures different aspects of dental aesthetics compared with IOTN AC (Jenny and Cons, 1996). The scale contained six items referring to dental irregularities. The interviewer examined the presence of missing visible teeth, crowding and spacing in the anterior segments, midline diastema, increased overjet and open bite. No weighting was used.

Statistical analysis

For all analyses, with the exception of a confirmatory factor analysis, the statistical software used was the Statistical Package for the Social Sciences for Windows Release 11.5 (SPSS Inc., Chicago, Illinois, USA). Item endorsement was assessed by calculating the percentage of positive responses to each statement. To be included in the questionnaire, items referring to detrimental effects had to be endorsed by at least 10 per cent of the respondents and items referring to well-being by at least 90 per cent of the subjects (Murphy and Davidshofer, 1998). A principal component analysis with orthogonal rotation using the varimax procedure was performed to identify the factorial structure of the item pool (Gorsuch, 1997). Salient loading should attain a value of 0.35 or more (Floyd and Widaman, 1995). A confirmatory factor analysis was undertaken to test the fit of the proposed factor model to the questionnaire data in an independent sample (Panter *et al.*, 1997). This was carried out using the AMOS™ 5.0 statistical package (SPSS Inc.) by calculating a solution with the unweighted least squares method (Arbuckle, 2003). Reliability analyses were conducted to assess the consistency of the factor analysis-derived scales by calculating Cronbach's alpha (α). To be evaluated as a reliable scale, an α of at least 0.70 was required. Correlations of each item with the sum of the remaining items in the same scale were calculated (corrected item-total correlations). To be included in the questionnaire an item was required to attain $R > 0.40$. For each item, the reliability of the respective scale was calculated with that item excluded. If the reliability of the scale increased when an item was deleted, the latter was considered not sufficiently reliable for inclusion into the questionnaire (Aiken, 1994). One-way analyses of variance were performed comparing the PIDAQ scores in respondents with different degrees of subject- and interviewer-rated dental aesthetics. Cut-off values were determined using the quartile split procedure.

Results

Assessment of item endorsement showed that all statements regarding detrimental effects were selected by at least 10 per cent of respondents and all statements about well-being by over 90 per cent. Thus on the basis of such a uniform response no item was excluded.

A principal component analysis of the item pool referring to psychosocial impact of dental appearance was conducted, and four factors were extracted according to the Kaiser–Guttman criterion with an eigenvalue greater than 1.0. Eigenvalues indicate the amount of variance of all items accounted by each factor. The factors are listed in Table 1 together with the percentages of explained variance according to the initial solution. The four components together explained 63.28 per cent of the total variance, which is above the minimum recommended for a stable factor solution (Streiner, 1994). An orthogonal rotation was performed using a varimax procedure to achieve a simple structure with each item loading on as few dimensions as possible. Factor loadings of the items following orthogonal rotation are shown in Table 1. All salient loadings were above 0.35 on the respective factor. No unique factors were identified, with only one or two high loadings. Thus no item had to be excluded in order to attain an improved solution. The first factor explained 18.78 per cent of variance after rotation and the six items of the Dental Self-Confidence Scale showed values from 0.66 ('find tooth position nice') to 0.85 ('proud of my teeth'). The second factor explained 18.68 per cent of the variance following orthogonal rotation and the eight items showed loadings from 0.50 ('irritated on remarks about teeth') to 0.78 ('offensive remarks'). Seven of the items in this group were modified from the Social Aspects Scale of the OQLQ, and one novel item ('worried about opposite sex') was added. Generally this second factor may be termed 'social impact of dental appearance'.

The third factor, accounting for 14.53 per cent of variance, may be termed 'psychological impact of dental aesthetics'. The highest loading was found for the statement 'wish teeth

Table 1 Factor loadings of the items of the Psychosocial Impact of Dental Aesthetics Questionnaire scales after principal component analysis and orthogonal rotation, amount and percentage of variance explained by each factor (initial and rotated solution), α when item deleted from the respective scale, and reliabilities of the scales (Cronbach's α).

Items in brief	Dental self-confidence	Social impact	Psychological impact	Aesthetic concern	α when item deleted
Proud of teeth	**0.85**	−0.09	−0.13	−0.05	0.89
Like to show teeth	**0.82**	−0.12	−0.11	−0.22	0.88
Pleased to see teeth in mirror	**0.86**	−0.06	−0.11	−0.11	0.88
Teeth are attractive	**0.80**	−0.10	−0.13	−0.06	0.89
Satisfied with appearance	**0.71**	−0.19	−0.29	−0.23	0.89
Find tooth position nice	**0.66**	−0.06	−0.35	−0.29	0.90
Hold back when I smile	−0.16	**0.61**	0.37	0.29	0.80
What others think	−0.15	**0.62**	0.33	0.07	0.81
Offensive remarks	−0.14	**0.78**	0.20	−0.01	0.81
Inhibited in social contacts	−0.05	**0.65**	0.31	0.19	0.80
Hide my teeth	−0.03	**0.63**	−0.02	0.30	0.82
People stare	−0.09	**0.76**	0.09	0.02	0.81
Irritated on remarks	−0.26	**0.50**	0.17	0.12	0.85
Worry about opposite sex	−0.04	**0.62**	0.17	0.16	0.82
Envy	−0.24	0.20	**0.74**	0.18	0.84
Somewhat distressed	−0.11	0.29	**0.68**	0.04	0.86
Somewhat unhappy	−0.25	0.44	**0.61**	0.24	0.83
Others have nicer teeth	−0.22	0.32	**0.38**	0.29	0.86
Feel bad	−0.19	0.39	**0.57**	0.28	0.83
Wish teeth looked better	−0.28	0.22	**0.74**	0.32	0.81
Don't like teeth in mirror	−0.24	0.12	0.38	**0.72**	0.85
Don't like teeth in photo	−0.25	0.29	0.16	**0.82**	0.78
Don't like teeth on video	−0.21	0.30	0.22	**0.77**	0.82
Amount of variance explained (initial solution)	9.27	2.98	1.30	1.04	
Percentage of variance explained (initial solution)	40.42	12.68	5.63	4.54	
Percentage of variance explained (rotated solution)	18.78	18.68	14.53	11.28	
Cronbach's α	0.91	0.86	0.87	0.87	

Salient factor loadings are highlighted in bold.

looked better' (0.74) and the lowest for 'others have nicer teeth' (0.38). Five novel items had been included in this factor with the intention of assessing the potential psychological impact of malocclusion, one item ('somewhat distressed') was modified from an item originally included in the Social Aspects Scale of the OQLQ. The fourth factor explained 11.28 per cent of the variance and was characterized by high loadings of three items (0.72–0.82) referring to feelings of uneasiness when confronted with one's own dental appearance. These items were derived from the Aesthetics Scale of the OQLQ and this factor is best termed 'aesthetic concern'. Subsequent analyses of reliability demonstrated that the factor analysis-derived scales were highly consistent (Table 1) ranging from α = 0.85 (Social Impact) to α = 0.91 (Dental Self-Confidence). All items in each scale exhibited strong correlations with the corresponding corrected total scale scores (between R = 0.46 and R = 0.79). Deletion of items did not improve reliability of the scales (Table 1: row 'α when item deleted'). Thus no statement in the questionnaire had to be excluded because of potential item inconsistency.

A cross-validation of the factor structure was conducted using preliminary data from two separate ongoing studies, one addressing potential relationships between the PIDAQ and cost-effectiveness of orthodontic treatment, and the other investigating the re-test reliability of the PIDAQ. This separate cross-validation sample comprised 83 subjects, aged 18–33 years (mean 25.0, SD 3.6). Following factor analysis, the model was tested with the questionnaire responses of the new sample and the resultant fit indices approached a value of 1.00, thus indicating an excellent fit of the model with the data (Arbuckle, 2003). The adjusted fit index attained a value of 0.98, the relative fit index was 0.97, and the normed fit index 0.98. The results suggest an invariance of the factor model across samples.

Comparison of male and female subjects in their PIDAQ scores showed no significant differences between the groups with *t*-values between 0.13 and 1.74. Correlation analyses

found no relationship of the PIDAQ subtests to the subject's age. Pearson's correlation coefficients showed a range from $R = 0.01$ to $R = 0.09$.

With respect to self-rated dental aesthetics using the IOTN AC, it was found that 33.5 per cent of the respondents evaluated their dental appearance as grade 1, 23.7 per cent as grade 2, 24 per cent as grade 3 and 8.8 per cent as grade 4 or higher. The results of the comparison of the PIDAQ values between the four groups are presented in Table 2. The Dental Self-Confidence Scale and the Psychological Impact Scale demonstrated the strongest differences with *F*-values of 15.47 and 14.33 (both $P < 0.001$). Aesthetic Concern also differed between groups ($F = 9.84$ at $P < 0.001$) and Social Impact attained a value of $F = 4.43$ and $P = 0.01$.

The Perception of Occlusion Scale was the second instrument assessing self-perceived dental aesthetics. A value of zero or one was indicated by 21.6 per cent, 33 per cent of the respondents gave a value of two to four, 23 per cent a value of five to eight, and 21.1 per cent a value of nine or more. The results of one-way analyses of variance comparing subject with different degrees of self-perceived aesthetics according to the Perception of Occlusion Scale are shown in Table 3. Significant associations were found in the Aesthetic Concern, Dental Self-Confidence and Psychological Impact scales (ranging from $F = 13.91$ to $F = 14.72$; both $P < 0.001$). Social Impact differed between groups at a slightly lower level ($F = 4.31$; $P = 0.008$).

Interviewer ratings of dental aesthetics using the IOTN AC resulted in 29.4 per cent of the subjects achieving grade 1, 37.6 per cent grade 2, 21.1 per cent grade 3 and 11.9 per cent grade 4 or higher. The results of one-way analyses of variance comparing respondents with different interviewer-rated IOTN AC grades are shown in Table 4. The Dental Self-Confidence, Psychological Impact and Aesthetic Concern scales differed between the groups at $P < 0.001$ (*F*-values ranging from 8.27 to 10.39). For the Social Impact Scale the four groups were different at $P < 0.05$ (*F-values* = 3.56).

As shown by the DAIM, which was used as an alternative method of assessing dental appearance by the interviewer, 37.6 per cent of the respondents had no irregularities in tooth position. In 19.1 per cent one irregularity was found, 29.9 per cent achieved a value of two, and, in 13.4 per cent, three or more deviations from the norm were identified. Table 5 presents the results of the comparison of the PIDAQ subscale scores of the four groups. The strongest statistical effects were observed in the Aesthetic Concern and Dental Self-Confidence scales ($F = 7.75$ and

Table 2 Results of one-way analyses of variance comparing Psychosocial Impact of Dental Aesthetics Questionnaire scale scores in respondents with a different Aesthetic Component of the Index of Orthodontic Treatment Need (IOTN AC) as rated by the subjects. Means (M), standard deviations (SD), *F*-statistics and level of significance.

	IOTN AC self-rating degrees				
	=1 *n* = 65 M (SD)	=2 *n* = 46 M (SD)	=3 *n* = 66 M (SD)	≥4 *n* = 17 M (SD)	*F*
Dental Self-Confidence	15.00 (6.01)	11.41 (5.72)	10.01 (5.21)	6.05 (4.57)	15.47***
Social Impact	1.49 (2.68)	2.26 (3.07)	3.01 (4.06)	4.71 (5.28)	4.43**
Psychological Impact	2.98 (3.39)	4.60 (3.83)	6.56 (4.88)	9.58 (5.68)	14.33***
Aesthetic Concern	1.09 (1.85)	2.10 (2.28)	2.97 (3.08)	4.11 (2.80)	9.84***

**$P < 0.01$; ***$P < 0.001$.

Table 3 Results of one-way analyses of variance comparing Psychosocial Impact of Dental Aesthetics Questionnaire scale scores in respondents with differing self-perceived aesthetics in the Perception of Occlusion Scale: means (M), standard deviations (SD), *F*-statistics and level of significance.

	Perception of Occlusion Scale values				
	0–1 *n* = 42 M (SD)	2–4 *n* = 64 M (SD)	5–8 *n* = 47 M (SD)	≥ 9 *n* = 41 M (SD)	*F*
Dental Self-Confidence	14.83 (6.07)	12.12 (5.32)	12.32 (5.49)	6.97 (5.67)	14.38***
Social Impact	1.59 (2.81)	2.42 (3.74)	1.87 (2.88)	4.14 (4.53)	4.31**
Psychological Impact	3.02 (3.94)	3.96 (3.90)	5.63 (3.93)	8.68 (5.34)	14.72***
Aesthetic Concern	1.16 (2.25)	1.50 (2.00)	2.49 (2.41)	4.19 (3.07)	13.91***

**$P < 0.01$; ***$P < 0.001$.

Table 4 Results of one-way analyses of variance comparing Psychosocial Impact of Dental Aesthetics Questionnaire scale scores in respondents with a different Aesthetic Component of the Index of Orthodontic Treatment Need as rated by the interviewer: means (M), standard deviations (SD), *F*-statistics and level of significance.

	IOTN-AC interviewer-rating values				
	=1 *n* = 57 M (SD)	=2 *n* = 73 M (SD)	=3 *n* = 41 M (SD)	≥4 *n* = 23 M (SD)	*F*
Dental Self-Confidence	13.96 (6.14)	12.33 (5.73)	9.24 (6.09)	8.21 (4.87)	8.27***
Social Impact	1.75 (3.12)	2.04 (2.77)	3.29 (4.04)	4.17 (5.58)	3.56*
Psychological Impact	3.89 (3.97)	4.19 (3.60)	7.09 (5.16)	7.95 (6.29)	8.31***
Aesthetic Concern	1.35 (2.08)	1.79 (2.17)	3.07 (2.97)	4.34 (3.17)	10.39***

*$P < 0.05$; ***$P < 0.001$.

Table 5 Results of one-way analyses of variance comparing Psychosocial Impact of Dental Aesthetics Questionnaire scale scores in respondents with different Dental Aesthetic Index (modified) as rated by the interviewer: means (M), standard deviations (SD), *F*-statistics and level of significance.

	Dental Aesthetic Index (modified)				
	0 *n* = 73 M (SD)	1 *n* = 37 M (SD)	2 *n* = 58 M (SD)	≥3 *n* = 26 M (SD)	*F*
Dental Self-Confidence	13.65 (5.86)	12.54 (5.84)	10.34 (6.16)	7.80 (5.11)	7.82***
Social Impact	1.90 (3.07)	2.51 (3.72)	2.89 (4.01)	3.07 (4.16)	1.08
Psychological Impact	4.05 (3.93)	4.32 (4.30)	6.22 (5.07)	7.11 (5.36)	4.46***
Aesthetic Concern	1.58 (2.23)	1.45 (2.01)	2.77 (2.96)	3.96 (2.80)	7.75***

***$P < 0.001$.

$F = 7.82$, respectively; both $P < 0.001$), followed by Psychological Impact ($F = 4.46$; $P < 0.001$). The inter-group differences for the Social Impact Scale were not significant ($F = 1.08$).

Discussion

The aim of this study was to develop and test a multi-item psychometric instrument for assessment of psychosocial impact of dental aesthetic appearance. The item pool was based on previous research investigating dental aesthetics and oral HRQoL (Klages *et al.*, 2004, 2005), and was modified by reformulation of previously used items and development of new items. It included items from the previously tested Dental Self-Confidence Scale and revised items from the Aesthetics and Social Aspects scales of the OQLQ (Cunningham *et al.*, 2000). Special attention was paid to content validity (Murphy and Davidshofer, 1998) by including reference to dental aesthetics in each item, as proposed by Slade and Spencer (1994). An exploratory principal component analysis with orthogonal rotation identified four factors: Dental Self-Confidence; Social Impact; Psychological Impact and Aesthetic Concern. An additional cross-validation study, employing a confirmatory factor analysis, found a good fit of this model with the item responses of an independent sample of subjects. Reliability analyses of the four factorial analysis-derived scales were highly consistent as confirmed by Cronbach's α values ranging from 0.85–0.91.

The first factor, Dental Self-Confidence, suggested a significant impact of dental aesthetics on the emotional state of an individual. It has been proposed that oral HRQoL instruments should not only include measures of detrimental effects of the oral condition but also items dealing with the subjective perception of well-being (McGrath and Bedi, 2001). Huppert and Whittington (2003) suggested that positive and negative well-being relate differently to psychological and social conditions. It therefore appears necessary to measure positive impacts of dental aesthetics on the emotional state of a person.

The second factor, which was termed 'Social Impact', includes items referring to potential problems in social situations due to subjective perception of an unfavourable own dental appearance. This finding confirms previous observations that subjects with malocclusions might be attributed unfavourable personality traits by others (Kerosuo *et al.*, 1995) and this may disturb the self-concept and self-efficacy of the affected individuals (Albino *et al.*, 1990). The third factor, the so-called 'Psychological Impact' of dental aesthetics, is composed of items dealing with a feeling

of inferiority and unhappiness when the affected individual compares him/herself with persons with superior dental aesthetics. It is known that comparison processes play an important role in psychological well-being and that upward comparisons might provoke dysphoric moods (Jensen and Karoly, 1992; Wilson *et al.*, 1995). The fourth factor comprises statements referring to disapproval of one's own dental appearance when confronted with mirror, photographic and/or video images. This finding seems to be related to the fact that enhancement of dental aesthetics is a major motivating factor for orthodontic treatment (Bennett *et al.*, 1995).

On the whole, factorial analysis of the PIDAQ items confirmed the findings of Cunningham *et al.* (2000) that social impact and aesthetic concern are different and independent psychosocial factors. It has been proposed, for example, that detrimental effects of medical conditions are independent from effects on well-being (Huppert and Whittington, 2003) and that social and psychological effects of oral health are also independent (Slade and Spencer, 1994). If enhancement of subjective well-being by improved dental aesthetics is a benefit of orthodontic treatment as currently thought (Giddon, 1995), it would be reasonable to expect PIDAQ scores to differ in subjects with varying degrees of dental aesthetics as evaluated both by the subject and interviewer ratings. This hypothesis was tested in order to examine the validity of PIDAQ which is a *sine qua non* of psychological testing (Murphy and Davidshofer, 1998). Self-assessment of dental appearance was accomplished by two methods addressing different aspects of dental aesthetics. The IOTN AC self-rating involves grading of the severity of one's own malocclusion which is related to varying degrees of treatment need (Brook and Shaw, 1989). The Perception of Occlusion Scale (Birkeland *et al.*, 1995) represents self-evaluation of irregularities in the labial segments. The subjects with varying degrees of dental aesthetics differed significantly ($P < 0.001$) in the scale scores for Dental Self-Confidence, Psychological Impact and Aesthetic Concern, when both the IOTN AC and the Perception of Occlusion Scale were applied. The group differences in the Social Impact Scale were smaller but still significant ($P < 0.01$).

A potential limitation of this study may be seen in the gender distribution of the sample which included more female than male subjects. However, the mean values of the PIDAQ scales did not differ between the genders, suggesting that the psychosocial impact of dental aesthetics is similar across the genders. It may be concluded therefore that the sample composition did not affect the results.

As mentioned previously, 8.8 per cent of the respondents rated themselves as IOTN-AC grade 4 or higher which is comparable with the ratings reported by Birkeland *et al.* (1997), in their study of orthodontic treatment need in young adults. In the present investigation the subjects rating grade 4 and higher were pooled because of small cell counts. It is, therefore, possible that the results obtained from the present sample might limit generalizations about the power of the PIDAQ in discriminating between severe IOTN-AC grades. This warrants further investigation; however, this might be difficult as a sufficiently large sample of subjects with a high degree of dental aesthetic impairment in this age cohort is not easily obtained in countries with widely accessible orthodontic care.

The differences in PIDAQ scores comparing subjects with different degrees of interviewer-rated dental appearance were lower than the results based on self-assessment. This is probably related to the fact that professional evaluations of occlusion do not always coincide with patients' perceptions (Kerosuo *et al.*, 2000; Hunt *et al.*, 2002). Notwithstanding, 7 from 8 calculated analyses of variance resulted in statistically significant differences between the groups. In particular, the strongest effects were found for the Dental Self-Confidence and Aesthetic Concern Scales ($P < 0.001$). Compared with applications of the OQLQ (Cunningham *et al.* 2000) in previous research (Klages *et al.*, 2004, 2005), the revised scales in the present study discriminate more strongly between subjects with varying degrees of dental aesthetics. It has been proposed (Cunningham and Hunt, 2001) that HRQoL measures may be classified as generic or condition-specific and, in such a framework, the PIDAQ then approximates to the condition-specific pole.

Conclusions

The PIDAQ appears to meet the criteria of a good instrument as manifested in factorial stability across the samples, in consistency of scales, and in criterion-related validity. However, this questionnaire was developed for, and tested on, young adults, and its potential applicability to children and adolescents for whom a HRQoL assessment is generally complicated by developmental changes in body concept, should be tested in further studies. The questionnaire might be a promising practical tool for further research on orthodontic-specific HRQoL. As far as clinical application is concerned, the PIDAQ may be used for assessing treatment need in patients requesting orthodontic treatment. It is conceivable that orthodontic-related changes of a patient's well-being can be assessed during treatment using this or a similar psychometric instrument. It may be helpful in distinguishing between various patient and provider perspectives and values, and serve as means of documenting the benefits of orthodontic treatment in health policy discussions.

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Appendix

Psychosocial Impact of Dental Aesthetics Questionnaire (PIDAQ) entries

Dental Self-Confidence

I am proud of my teeth.
I like to show my teeth when I smile.
I am pleased when I see my teeth in the mirror.
My teeth are attractive to others.
I am satisfied with the appearance of my teeth.
I find my tooth position to be very nice.

Social Impact

I hold myself back when I smile so my teeth don't show so much.
If I don't know people well I am sometimes concerned what they might think about my teeth.
I'm afraid other people could make offensive remarks about my teeth.
I am somewhat inhibited in social contacts because of my teeth.
I sometimes catch myself holding my hand in front of my mouth to hide my teeth.
Sometimes I think people are staring at my teeth.
Remarks about my teeth irritate me even when they are meant jokingly.
I sometimes worry about what members of the opposite sex think about my teeth.

Psychological Impact

I envy the nice teeth of other people.
I am somewhat distressed when I see other people's teeth.
Sometimes I am somewhat unhappy about the appearance of my teeth.
I think most people I know have nicer teeth than I do.
I feel bad when I think about what my teeth look like.
I wish my teeth looked better.

Aesthetic Concern

I don't like to see my teeth in the mirror.
I don't like to see my teeth in photographs.
I don't like to see my teeth when I look at a video of myself.