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Construction and validation of the quality of life measure for dentine hypersensitivity (DHEQ)

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Abstract

Aim: To develop and validate a condition specific measure of oral health-related quality of life for dentine hypersensitivity (Dentine Hypersensitivity Experience Questionnaire, DHEQ).

Materials and Methods: Questionnaire construction used a multi-staged impact approach and an explicit theoretical model. Qualitative and quantitative development and validation included in-depth interviews, focus groups and cross-sectional questionnaire studies in a general population ($n = 160$) and a clinical sample ($n = 108$).

Results: An optimized DHEQ questionnaire containing 48 items has been developed to describe the pain, a scale to capture subjective impacts of dentine hypersensitivity, a global oral health rating and a scale to record effects on life overall. The impact scale had high values for internal reliability (nearly all item-total correlations >0.4 and Cronbach's $\alpha = 0.86$). Intra-class correlation coefficient for test–retest reliability was 0.92. The impact scale was strongly correlated to global oral health ratings and effects on life overall. These results were similar when DHEQ was validated in a clinical sample.

Conclusions: DHEQ shows good psychometric properties in both a general population and clinical sample. Its use can further our understanding of the subjective impacts of dentine sensitivity.

Key words: cross-sectional validation; dentine hypersensitivity; quality of life

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Self-reported assessments are increasingly used in dentistry to capture the psychosocial experiences, for example of pain, discomfort and malfunctioning, supplementing clinical indicators (Jokovic et al. 2002). Such research has been important in recognizing the long-term complex effects of oral conditions and can be used to evaluate clinical interventions and measurement of change (Awad & Feine 1998, Baker et al. 2006, Pearson et al. 2007).

Research on oral health-related quality of life (OHQoL) has commonly used instruments such as the Oral Health Impact Profile (OHIP) (Slade & Spencer 1994, Slade 1997) that are generic for a number of oral health conditions and so enquire about a broad spectrum of limitations and dysfunctions. Yet this breadth can be a disadvantage as generic measures may not detect the nuances of a specific condition or distinguish them from other impacts. Wong et al. (2007) showed that many OHIP items are irrelevant to specific oral health states, which prompted their work on a new instrument – OHIP-aesthetic. Elsewhere, OHIP-49 was found only partially responsive to changes following tooth whitening (McGrath et al. 2005). In relation to dentine hypersensitivity (DH), Bekes et al.(2009) found that the generic OHIP-49 was insensitive to the particular impacts of DH. While patients attending for treatment of hypersensitivity experienced more impacts and had poorer oral health than the general population, the difference in mean scores was $<10\%$ of the overall scale. All of the above suggest that the impacts of specific oral conditions and, in particular, DH are not captured by generic measures.

DH is a ''short, sharp pain arising from exposed dentine in response to stimuli, typically thermal, evaporative, tactile, osmotic or chemical and which

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cannot be ascribed to any other dental defect or pathology'' (Dababneh et al. 1999, p. 606). Theories to explain the underlying mechanism focus on a hydrodynamic mechanism (Holland et al. 1997, Orchardson & Gillam 2006), exacerbated by tissue lost to erosion and abrasion (Dababneh et al. 1999). The condition is increasingly common. However, population studies contrast sharply with studies that use clinical diagnoses. Some clinical research estimates the prevalence as low as 3.8–4.1% in a UK general dental practice (Rees & Addy 2002). Other studies report significantly higher prevalence, often over 50% (Irwin & McCusker 1997, Gillam et al. 1999, Rees et al. 2003). These differences suggest that DH may be underreported and unrecognized by both clinicians and patients.

Pain is the major symptom of the condition. Studies of patients' experiences have been restricted to ratings of pain, usually in response to a stimulus within a clinical setting (Al-Wahadni & Linden 2002, Rees & Addy 2002). There has been little consideration of the impact on everyday life. In one study, DH hindered toothbrushing in 8.7% of cases, 28.2% of participants could not drink cold water and 26% could not eat ice cream without discomfort so that 10% avoided the area of discomfort (Gillam et al. 1999). In the light of these data, a qualitative study explored the daily experiences of people with DH (Gibson et al. 2010). The findings showed the depth and complexity of pain experiences associated with sensitivity, impacts on functional status and everyday activities such as eating, drinking, talking, toothbrushing, social interaction and also more subtle impacts on emotions and identity. The current paper draws upon those data to develop a condition-specific questionnaire for DH.

The first reason for constructing a condition-specific measure was, therefore, the need to address the particular impacts of DH. We could further expect that such measure could be more responsive to changes in the condition. Hence, the aim of the study was to develop and validate a specific measure of oral health-related quality of life in relation to DH (The Dentine Hypersensitivity Experience Questionnaire, DHEQ) based on an improved biopsychosocial understanding of the condition.

Materials and Methods

The study was designed in seven stages based on a multi-staged impact approach (Juniper et al. 1996). The further sections report on the material and methods of each stage. Ethical approval was obtained from the University of Sheffield Ethics Committee.

Stage 1: Theoretical model

Initially, a theoretical model was chosen as the framework for the study to guide the interviews and questionnaire development. Three models were considered: Locker's (1988) model of oral health, the World Health Organisation's (2001) International Classification of Functioning, Disability and Health (ICF) and the Wilson & Cleary (1995) model linking clinical variables quality of life. The Wilson & Cleary model was selected based on its compatibility with the functional and coping impacts of DH. This model is also compatible with the Locker model but provides a broader framework for understanding the relationship between clinical status, symptoms, functioning, perceived health and overall quality of life (Fig. 1). The ICF was difficult to operationalize as it classifies conditions and impacts but is less clear on how these may be related.

Stage 2: Qualitative interviews

To identify the everyday impacts of sensitivity, 23 in-depth interviews (15 females, eight males) were conducted (Gibson et al. 2010) until saturation was achieved. Participants were recruited purposively from the general population using the criteria of adults with sensitive teeth from a range of ages, gender and longevity of the condition. The number of female participants prevailed over male participants, which accords with the gender balance affected by DH (Rees 2000, Rees & Addy 2002). Participants from young (18–40) and older groups (40–65) were evenly interviewed. Half of the participants recruited for the study characterized themselves as having DH, whereas half described twinges in their teeth in response to thermal (cold, hot) or physical stimuli (tooth brushing). This second group was recruited to reflect people who experienced symptoms consistent with DH but who may not identify themselves as having the condition.

Upon gaining consent, an interview was arranged at a mutually suitable time and place. Interviews lasted 30–40 min. The interviews were transcribed and then analysed using framework analysis (Ritchie & Spencer 1994). The preliminary interview guide was based on the theoretical model and previous data, including self-reported experiences in focus groups conducted by a consumer healthcare company.

Stage 3: Questionnaire development

The qualitative findings were used to generate the questionnaire items. The data were used to populate the theoretical model within domains of pain (symptoms in the model), functional restrictions, adaptation, avoidance, social impact, emotional impact, identity (all regarded as functional limitation) and effect on life overall (quality of life). A global oral health rating was added to represent general health perceptions for purposes of construct validation. Response formats were chosen that were relevant to the domain. Particularly, the frequencies of some impacts were not recorded due to their intermittent nature and participants' strategies for avoiding pain stimuli. Indeed, these strategies for coping formed part of the impact of the condition.

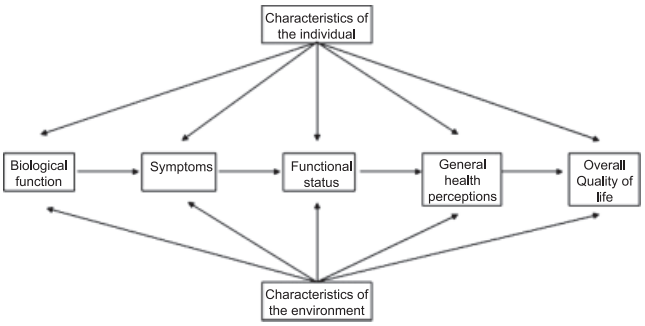

Fig. 1. Wilson & Cleary (1995). Copyright JAMA. Used with permissions.

Stage 4: Focus groups

Face validation of DHEQ was undertaken by three focus groups. As in the qualitative stage, 20 participants were recruited on the basis age, gender, educational background and disease longevity. The gender split was 1:2 (male to female). One focus group (six participants) involved people with long-standing DH and participants therefore tended to be older. The second group (seven) included participants of different ages and both the long-term affected and those with ''twinges and discomfort''. The third group (seven) consisted of young people with ''twinges and discomfort'' who were new to the symptoms of DH. After completing DHEQ, the participants were asked about each item so that problems in wording and meaning could be identified and resolved.

Stage 5: Cross-sectional validation

To examine validity and reliability, the DHEQ was tested cross-sectionally in a quota sample of 163 adults recruited from the general population via online advertisements at the University of Sheffield (75%) and across the United Kingdom (25%). The questionnaire was distributed via post. Three participants (1.8%) provided questionnaires missing more than 10% of the items and were excluded from further analysis. As intended, 64% of participants had self-reported DH and 34% described themselves as experiencing ''twinges'' but did not describe this as sensitive teeth. Demographic quotas included an equal split of genders and age. Participants broadly matched the socioeconomic status of the UK general population.

For test–retest reliability assessment, a proportion of the participants (25% of the sample) were sent a second copy of the questionnaire after 2 weeks, as in reliability tests of other OHQoL measures (Jokovic et al. 2002). Assessment was based on data from 34 participants (21% of the sample) whose global rating of oral health was the same as at the first administration.

Analytical procedures

To assess the reliability and validity of the DHEQ in this general population sample, data were analysed iteratively in four stages. First, the data were described using the numbers of missing responses, proportions and appropriate measures of central tendency and spread for each of the items and scale scores. Item-impact values for the scale items were calculated as the product of the mean score and percentage of people broadly agreeing they had that impact (''strongly agree'', ''agree'', ''agree a little'' responses on the item) (detailed description of items and the statistics on item impact are available on request).

Second, preliminary psychometric analysis of the scales was performed. Internal consistency and test–retest reliability were assessed using item and subscale-total correlations, Cronbach's α and intra-class correlation coefficients. Construct validity was assessed by correlating the impact scale and its subscales with the global oral health rating and the summary measure of impact on life overall.

Third, confirmatory factor analysis (CFA) was used to provide a further test of the within-construct validity of the scale. CFA is the first in the two-stage process of structural equation modelling (SEM) (the measurement model) (Kline 2005). CFA provides information on how scale items (e.g. ''Having the sensations in my teeth takes a lot of the pleasure out of eating and drinking'') measure underlying (latent) constructs (e.g. functional restrictions and is therefore a test of the validity of selected items (i.e. do items selected to measure a construct actually do so) and the number of constructs that ''fit'' the data [e.g. 1 (''DH impacts'') or 8 (e.g. ''pain'', ''restrictions'', etc.)].

Fourth, the results of the CFA and item-impact analysis were used to revise the questionnaire. The revised version had one item removed from each of the restrictions and identity subscales. The approach and avoidance coping subscales were merged into a single adaptation subscale.

Fifth, the psychometric analyses were repeated on the revised structure. Data were analysed using SPSS 16.0 and AMOS 6.0. A p-value of 0.05 was selected as the level of significance in hypothesis tests.

Stage 6: Follow-up interviews

A follow-up validation was stimulated by the relatively high proportion of neutral responses (''neither agree, nor disagree'') received during the validation study that provoked a question about the clarity of questions. Follow-up face-to-face interviews were held with 11 participants who used neutral responses in the cross-sectional validation. The participants were asked to complete the questionnaire out loud and comment on its clarity as they progressed.

Stage 7: Validation on a clinical population

A second cross-sectional validation of DHEQ was performed on a population with clinically diagnosed DH recruited at pre-intervention stage in a sponsored randomized controlled trial, before the participants received any interventions or other study procedures. Data were collected from 108 participants and analysed using similar statistical measures to Stage 5.

Results

An initial pool of 50 items was generated from the qualitative data within the domains of pain (corresponding to a symptom in the original model), impact (corresponding to functional limitation) and effect on live overall (corresponding to quality of life) (Table 1). The impact scale had six subscales based on the initial domains of the Wilson & Cleary model. For the purposes of construct validation, a standard global rating of oral health was added.

Two summary measures were created for the impact scale and its subscales. The ''total score'' was calculated as the sum of the item scores (1–7 Likert scale) per participant (possible range of 0–257 and 0–243 in the original and revised DHEQ, respectively). ''Subscale scores'' for each of the subscales were created in the same way. The ''extent'' of impacts was calculated as the number of impacts per participant to which each participant broadly agreed (''strongly agree'', ''agree'', ''agree a little'' responses; possible range of 0–36 and 0–34 for original and refined versions).

The three focus groups suggested minor modifications to item wording but generally understood the scales and reported no consistent problems in the use of DHEQ.

Validation in the general population sample

Descriptive results

The number of missing values was low. Six participants (3.7%) did not provide

Table 1. Format of the DSEQ

	No and type of items	Purpose	Summary measure
Introductory descriptors	6 closed questions	Describe pain	Each item treated separately
Pain scales	3 visual analogue scales	Measure pain	Each item treated separately and scaled 0–10.
Intensity			
Bothersomeness			
Tolerability			
Impact subscales‡			
Restrictions	5/4*	Measure restrictions in daily activity	7-point Likert scales coded: 1 = ''strongly disagree'' to 7 = ''strongly disagree''
Approach coping	6†/12	Measure activities to cope and prevent sensitivity episodes.	
Avoidance coping	6†	Measure impacts due to avoiding potential pain stimuli	
Social impact	5	Measure handicap	
Emotional impact	8	Measure emotional impact	
Identity	6/5*	Measure impact on personal identity	
Global oral health rating	1	Measure health perception	5-point Likert scale coded 1 = ''excellent'', 2 = ''very good'', 3 = ''good'', 4 = ''fair, 5 = ''poor'', 6 = ''very poor''
Overall effect	4	Measure effect on overall quality of life	5-point Likert scale coded 0 = ''not at all'' to 4 = ''very much''

*One item was removed from each of these two subscales in the revised questionnaire. These subscales form the impact scale of the DSEQ.
†These two scales were merged in the revised version of the questionnaire.
‡Together these subscales form the impact scale of the DSEQ.

an answer to one item and three (1.8%) did not respond to another item of the original DHEQ. Nine other items received only one (0.6%) non-response. The visual analogue scales placed the pain of sensitivity at the middle range (Table 2).

The means for all summary measures of impact were close to the centre of the possible range and there was substantial spread in the data indicating no floor or ceiling effects (Table 3). The data are summarized in subscale scores (Table 3) for the original and revised versions of DHEQ in the left and right hand columns, respectively. Total score and extent data were approximately normally distributed.

Individual item weights are presented in Table 4 along with the frequencies, means (SD) and item impacts for the original scale items (Q10–45). Item impact, calculated as mean score multiplied by the proportion with that impact demonstrated a wide range (11.88–529.52).

Reliability and validity

Nearly all item-total correlations were over 0.4 and all were statistically significant (Table 4).

The questionnaire demonstrated high levels of internal consistency for all impact scores and subscales (Table 5). All correlations between the subscales and total scores were significant and consistent. The highest correlations were seen between ''total score'' and ''emotional impact'' ($r = 0.89$) and ''total score'' and ''avoidance'' ($r = 0.85$) in the original version and between ''total scores'' and the merged ''adaptation'' subscale ($r = 0.90$) in the revised DHEQ.

Cronbach's α for the total impact score in the original DHEQ was 0.91 (Table 6). αs for the subscales ranged from 0.50 for functional restrictions to 0.87 for emotional impact, indicating fair to good internal consistency. αs improved for all subscales in the revised scale. In particular, the scores for ''restrictions'' and ''identity'' rose to 0.76 and 0.70, respectively. The merging of the ''avoidance'' and ''approach'' subscales into an ''adaptation'' subscale also had better internal reliability as measured by Cronbach's α.

Table 2. Mean scores for the pain scale among 160 participants in the general population sample

Pain scale (VAS)	Mean (SD)	Range
Intensity	5.5 (1.73)	1–9
Bothersomeness	5.3 (2.17)	1–10
Tolerability	4.4 (2.00)	1–9

Table 3. Total score, extent and subscales scores among 160 participants in the general population sample

	Original DSEQ			Revised DSEQ		
	no. items	mean (SD)	range	no. items	mean (SD)	range
Total score	36	138.6 (36.36)	40–228	34	130.96 (35.06)	34–219
Extent	36	16.52 (7.52)	1–35	34	14.43 (5.97)	1–33
Subscales						
Restrictions*	5	21.82 (5.44)	9–35	4	17.01 (4.98)	4–28
Approach coping	6	22.81 (7.60)	6–38	12	47.57 (14.01)	12–73
Avoidance coping**	6	24.76 (7.48)	6–41			
Social impact**	5	15.29 (6.53)	5–35	5	15.29 (6.53)	5–35
Emotional impact	8	32.67 (9.55)	8–53	8	32.67 (9.55)	8–53
Identity*	6	21.24 (6.78)	6–41	5	18.42 (5.68)	5–34
Global oral health rating	1	3.36 (1.14)	1–6	4	3.36 (1.14)	1–6
Effect on life overall	4	4.38 (3.06)	1–16	4	4.38(3.06)	1–16

*One item was removed from each of these two subscales in the revised questionnaire.
**These two scales were merged in the revised version of the questionnaire.

Table 4. Mean scores, item impacts and item-total correlations among 160 participants in the general population sample

	Item	Mean	SD	% of people who had impact	Item impact	r Item-total correlation
10	Restrictions – pleasure out of eating	4.39	1.72	63	276.57	0.704
11	Restrictions – cannot finish meal	2.76	1.66	21	57.96	0.690
12	Restrictions – longer to finish meal	4.00	1.76	51	204.0	0.719
13	Restrictions – uncertainty when*	4.82	1.80	68	327.76	0.256
14	Restrictions – problems with eating ice-cream	5.86	1.35	89	521.54	0.347
15	Adaptation – modification of eating	4.90	1.66	77	377.3	0.590
16	Adaptation – careful when breathing	4.29	2.04	58	248.82	0.558
17	Adaptation – warming food/drinks	4.24	1.76	54	228.96	0.550
18	Adaptation – cooling food/drink	3.24	1.92	33	106.92	0.623
19	Adaptation – cutting fruit	3.24	1.93	32	103.68	0.550
20	Adaptation – putting a scarf over mouth	2.91	1.77	24	69.84	0.478
21	Adaptation – avoiding cold drinks/foods	4.47	1.86	61	272.57	0.624
22	Adaptation – avoiding hot drinks/foods	3.07	1.80	35	107.45	0.650
23	Adaptation – avoiding contact with certain teeth	5.18	1.68	80	414.4	0.483
24	Adaptation – change toothbrushing	4.23	1.95	52	219.96	0.448
25	Adaptation – biting in small pieces	4.17	1.90	54	225.18	0.588
26	Adaptation – avoiding other food	3.64	1.81	36	131.04	0.665
27	Social – longer than others to finish	3.35	1.87	33	110.55	0.715
28	Social – choose food with others	3.32	1.79	32	106.24	0.730
29	Social – hide the way of eating	2.78	1.70	21	58.38	0.623
30	Social – unable to take part in conversations	1.98	1.19	6	11.88	0.483
31	Social – painful at the dentist	3.86	2.08	42	162.12	0.661
32	Emotions – frustrated not finding a cure	4.05	1.83	47	190.35	0.725
33	Emotions – anxious of eating contributes	4.25	1.77	55	233.75	0.590
34	Emotions – irritating sensations	5.36	1.30	88	471.68	0.663
35	Emotions – annoyed with myself for contributing	3.86	1.88	44	169.84	0.451
36	Emotions – guilty for contributing	3.44	1.88	34	116.96	0.668
37	Emotions – annoying sensations	5.42	1.38	85	460.7	0.510
38	Emotions – embarrassing sensations	2.64	1.42	12	31.68	0.441
39	Emotions – anxious because of sensations	3.65	1.79	40	146	0.715
40	Identity – difficult to accept	2.82	1.81	19	53.58	0.510
41	Identity – part of my life*	5.72	1.17	91	529.52	0.209
42	Identity – different from others	2.61	1.59	16	41.76	0.651
43	Identity – makes me feel old	3.38	1.95	34	114.92	0.565
44	Identity – makes me feel damaged	3.08	1.75	28	86.24	0.566
45	Identity – makes me feel unhealthy	3.64	1.81	44	160.16	0.527

All $p < 0.05$, Pearson correlation.

*Two items deleted from the impact scale after CFA (revised DHEQ).

The test–retest reliability was calculated for 34 participants whose global rating was the same at baseline and 2 weeks later. The intra-class correlation coefficient was 0.93 and 0.92 for the original and revised versions of the impact scale indicating very high agreement (Table 5). Test–retest reliability for both versions was lowest for the functional restrictions subscale (0.76) but still very acceptable.

Table 5. Impact scale reliability in the general population sample

	Original DSEQ			Revised DSEQ	
	no. items	cronbach α ($n = 160$)	ICC ($n = 34$)	cronbach α ($n = 160$)	ICC ($n = 34$)
Total score	36	0.91	0.93	0.86	0.92
Subscales					
Restrictions	5	0.50	0.76	0.76	0.76
Approach coping*	6	0.74	0.82	0.86	0.88
Avoidance*	6	0.78	0.81		
Social impact	5	0.76	0.83	0.76	0.83
Emotional impact	8	0.87	1.0	0.87	1.0
Identity	6	0.59	1.0	0.70	0.75

*The ''approach coping'' and ''avoidance'' subscales were merged to an ''adaptation'' subscale in the revised DSEQ.

Total and subscale scores of the original and revised impact scales all correlated significantly with global oral health ratings indicating good construct validity (Table 6). Both versions of DHEQ total scores were strongly and significantly correlated with the scores for the subscale of effect on everyday life.

Six items received a high proportion of neutral responses (''neither agree not disagree''). Follow-up interviews suggested that participants chose neutral responses when items were not relevant to their experiences. Therefore, we identified no confusion in the questions or their meaning to people. Thus, the ''neutral response'' option was maintained.

The initial step of the CFA to test the DHEQ using a first order model with pain, restrictions, approach coping, avoidance coping, social impact, emotional impact, identity, impact on life overall as the eight latent constructs.

Table 6. Correlations between impact total and subscales scores with global oral health status

Global oral health rating	Original DSEQ		Revised DSEQ	
	r_s	*P*	r_s	*P*
Total score	0.23	0.00	0.23	0.00
Subscales				
Restrictions	0.15	0.06	0.16	0.04
Approach coping*	0.16	0.04	0.18	0.03
Avoidance coping*	0.17	0.03		
Social impact	0.24	0.00	0.24	0.00
Emotional impact	0.18	0.02	0.18	0.02
Identity	0.24	0.00	0.25	0.00

*The ''approach coping'' and ''avoidance'' subscales were merged into an ''adaptation'' subscale in the revised DSEQ.

Items were not allowed to load on more than one construct, nor were their error terms allowed to correlate.

The model was examined using AMOS 7.0 with maximum likelihood estimation and bootstrapping (Arbuckle 2005) as recommended for samples of <200 (Efron & Tibshirani 1993). We evaluated model fit using indices from the three fit classes; absolute fit, parsimony adjusted and comparative (Brown 2006) (given that the chi-square statistic (χ^2) can be inflated by sample size, we report the χ^2/df ratio as the measure of overall goodness of fit, together with the standardized root mean squared residual (SRMR). The parsimony-adjusted index was the root-mean-squared error of approximation (RMSEA) with 90% confidence intervals (90%CI). The comparative fit indices were the Tucker–Lewis index (TLI) and the comparative fit index (CFI)). A χ^2/df ratio <3.0, RMSEA values <0.08 or below, CFI and TLI of 0.90 or above and an SRMR <0.08 were taken to indicate an acceptable model fit (Brown 2006).

The eight-factor measurement model was an acceptable fit to the data on three of the *a priori* model fitting indices; χ^2/df = 1.947, RMSEA = 0.077 (90% CIs 0.072–0.083), SRMR = 0.075, CFI = 0.782, TLI = 0.763. Inspection of the standardized regression weights indicated that all items were significant measures of their respective constructs ($p<0.001$), with the exception of ''I am uncertain when I am going to have these sensations in my teeth'' ($p=0.06$) and ''having these sensations in my teeth is now just a part of my life'' ($p=0.87$). The two items were therefore deleted from the revised DHEQ.

As the correlation between the approach and avoidant coping factors was high (0.94) they were collapsed into a single factor (relabelled ''adaptation'') and the CFA re-run. The modification significantly improved the fit of the model ($\Delta\chi^2=138.56$, Δdf = 74, $p<0.01$) (revised model fit criteria; $\chi^2=1.955$, RMSEA = 0.077 (90% CIs 0.072–0.083), SRMR = 0.069, CFI = 0.795, TLI = 0.778). The standardized β weights for the three pain items were high (β-range = 0.67–0.88). Similarly, for restrictions, the range was 0.74–0.80, with the lowest loading being for ''problems eating ice cream'' ($\beta=0.38$). For the relabelled adaptation factor, the loadings were lower ranging between 0.43 (''changed the way I brush my teeth'') to 0.68 (''avoid very cold drinks or food''). In relation to social impacts, β-weights ranged between 0.67 and 0.81, with the exception of the item ''going to the dentist is hard for me'' (0.46). The range in β-weights for the emotional impact factor was between 0.44 (''I felt guilty because I might have contributed to the sensations I am having with my teeth'') to 0.80 (''I've been anxious that something I eat or drink might cause sensations in my teeth''). Finally, the item loadings for both the identity ($\beta=0.63$–0.78) and impact on life overall ($\beta=0.64$–0.86) factors were consistently high. All items were highly significant indicators of their respective constructs (all $p<0.01$) (full CFA data, available on request).

Clinical sample validation

In the validation among the clinical sample, there were few missing data and scores showed neither floor nor ceiling effects. Reliability analyses were restricted to internal consistency. Cronbach's αs were high for the total score (0.82) and subcales (0.79–0.89). Total and subscale scores were significantly correlated with global rating ($r=0.26$). The mean scores and 95% confidence intervals for the impact scale and its subscales in the clinical sample were: ''total score'', 147.6 ± 5.98; ''restrictions'' subscale, 18.91 ± 0.98; ''adaptation'', 55.83 ± 2.52; ''social impact'', 18.08 ± 1.23; ''emotional impact'', 35.89 ± 1.51 and ''identity'', 18.89 ± 1.11. In all cases except for identity, these confidence intervals did not include the scores for the general population in Table 3, indicating greater impact in the clinical sample.

Discussion

The purpose of this study was to develop and validate the DHEQ as an evaluative condition specific-measure of quality of life in people with DH. The study was one of the first to develop a disease-specific OHQoL measure and aimed to measure particular everyday impacts related to DH. The validation of DHEQ supports the feasibility of condition-specific instruments for measuring biopsychosocial impacts of other oral conditions. The results also offer the possibility of a much deeper understanding of a condition that has been described as an enigma (Johnson et al. 1982).

DHEQ was developed through meticulously following a series of stages and adopting a robust theoretical framework (Wilson & Cleary 1995, Juniper et al. 1996). The interview guide was informed by the model and by previous data. Rich qualitative data were used to populate the model and instrument with items. Focus group data supported the face validity of the original DHEQ. The questionnaire was administered to a general population sample and refined via well known analytical techniques. Follow up interviews focusing on neutral responses further supported the face validity. Content validity is indicated by a wide range of responses. DHEQ has excellent internal reliability as measured by item-total correlations and Cronbach's α (0.86 and 0.82 – for revised DHEQ in population and clinical samples, respectively) that meet standard thresholds for measurements of this kind (Nunnally 1978, Streiner & Norman 2000, p. 65). Test–retest reliability was also excellent. As a result of CFA, internal consistency in subscales was improved by deletion of two items and merging two subscales. Construct validity was indicated by significant correlations between total and subscales scores with both global ratings of oral health and the subscale for impacts on everyday life ($r=0.23$ and $r=0.25$). The revised DSEQ demonstrated high validity and reliability scores in samples from both general and clinical populations.

The findings support the value of condition/disease-specific impacts and their measurement. Generic measures can be too vague in assessing the links between oral conditions and OHQoL. Locker and Allen (2007) raised impor-

tant critical points, associated with instrumental qualities of these measures. Weak links between conditions and impacts on quality of life, were a common problem with generic measures**.** As demonstrated previously, OHIP did not distinguish the impact of DH from those of other conditions (Bekes et al. 2009). DHEQ provides a strong alternative to generic OHQoL instruments because of its direct reference to the problems associated with sensitive teeth. Moreover, measures such as OHIP are designed to detect handicaps and are therefore less relevant for the experiences of DH. This is not to say that DH does not cause impacts, as it is associated with tangible everyday discomfort. DHEQ, in its turn, retains authenticity of the experiences in measuring the whole range of impacts and adaptation strategies: changes in eating practices, food withdrawals, mouth and teeth awareness, modified toothbrushing, associated emotional coping, identity changes, etc. The discriminative capacity of this new measure, therefore, is much higher than previous instruments could show.

The study also indicates possible implications for the development of new quality of life measures. Initially with reference to general health, the poor utility of generic instruments was contrasted with disease-specific (oral health) measures (Allen et al., 1999). Ten years on, this project marks a shift towards measures that are not simply disease-specific in capturing combinations of impacts, but which are based theoretically and in practical and linguistic terms on the impacts of specific oral conditions. The approach adopted in the current study emphasizes a need for a greater care in exploring the nuances of impacts and discriminating between different oral conditions. In this way, the methodologically difficult concept of quality of life can be operationalized through particular impacts of oral conditions, especially if a robust theoretical framework is used and supported by qualitative data.

The applications of condition specific measures in RCTs are relatively new (e.g. Ozcelik et al. 2007) but these may detect changes in functional and personal experiences of the condition. Our research suggests the prospects for DHEQ to capture improvements in pain and other impacts are very high. A forthcoming longitudinal study will test the evaluative properties of DHEQ (Full version of DHEQ is available on the Internet).

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Clinical Relevance

Scientific rationale for the study: Historically, the clinical assessment of DH has focused solely on intensity aspects of a pain response following stimulation of exposed dentine. More recent concepts of health shift the focus to the effect of the condition on the lives of those affected. Using well-characterized methods, this study sought to consider broader psychosocial impacts of DH on everyday life through the application of an oral heath-related quality of life questionnaire (DHEQ).

Principal findings: The results demonstrate DHEQ can measure meaningful and relevant impacts on the behaviours and everyday life of people with DH.

Practical implications: DHEQ offers clinicians and researchers a tool to quantify the effects of DH on everyday life, with the potential to measure the effectiveness of interventions and associated treatments for the condition.