An empirically derived population-response model of the short form of the Oral Health Impact Profile

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Abstract – *Objective:* The aim of this paper was to model the consequences of dental conditions from an empirical basis and to test the model's ability to predict response combinations. *Methods:* The model was derived from responses to the short-form Oral Health Impact Profile (OHIP14) obtained from a UK population sample of 5281 dentate adults. This model was then used to predict OHIP14 response combinations obtained from a sample of 3973 dentate and edentulous adults in Australia. *Findings:* The empirically derived population-response model accounted for over 98% of response combinations of Australian dentate adults. *Conclusions:* The empirically derived model followed a similar hierarchical pattern to the base model underlying the long-form version of the measure (thereby supporting the validity of the OHIP14 measure) and was strongly predictive of the pattern of responses obtained from Australian adults.

A conceptual model has been proposed to explain the biological, behavioural and psychosocial consequences of oral disease (Fig. 1) (1). Locker's concepts (1) were, themselves, based on the World Health Organization's first classification of impairment, disability and handicap (2). Locker's model consists of links between dimensions describing the adverse effects that potentially result from a person's oral condition. For example, a pathway might consist of the experience of dental caries (the disease dimension) leading to tooth loss (the dimension of impairment) which in turn might affect a person's ability to chew (the dimension of functional limitation) leading to them being restricted in what they eat (the dimension of disability) ultimately causing them to avoid social eating (the dimension of handicap). This model does not imply that a person with some dental disease will necessarily experience all of these adverse affects



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but that the potential exists for some combinations of effects. The advantage of such a model is that it becomes possible to make predictions about the way people can be affected by their oral condition.

Since the publication of Locker's conceptual framework, a variety of oral health status measures have been based on it (3–7). Sheiham and Spencer (8) reviewing the characteristics of sociodental measures for population need assessment suggested that an index needed to be brief and easy to use, that the scaling should be relevant to decisionmaking criteria and that the index required an underlying model to provide cause-and-effect relationship information for policy makers. Of the indicators available at that time, it was concluded that the Oral Health Impact Profile (OHIP) (4) and the Dental Impacts on Daily Living Index (5) were the closest to these requirements (8). The Dental Impacts on Daily Living Index has been further



Fig. 1. The model on which the Oral Health Impact profile was based [Locker (1)].

developed as the Oral Impacts on Daily Performances (OIDP) Index (6). Similarly the Oral Health Impact Profile has been supplemented by a shorter 14-item version (OHIP14) (7). OIDP and OHIP14 were assessed for validity in a side-by-side comparison study using a convenience sample of adult attenders at a UK dental hospital, 95% of whom were aged between 19 and 74 years (9). This comparison concluded that OHIP14 correlated more closely to the presence of a dental problem, pain and self-reported oral health status than OIDP, and that its superior face validity made it more suitable for questionnaire-based research (9). Inclusion of this scale (OHIP14) in surveys in the UK and Australia has provided an opportunity to develop a model of population responses to the OHIP and to test this using a fresh population sample. It is not intended to replace or modify the conceptual model itself.

Material and methods

The data in this study were collected as part of the 1998 survey of Adult Dental Health (10) in the UK and the 1999 National Dental Telephone Interview survey in Australia. The UK survey was commissioned by the Departments of Health of the UK and undertaken by the Office for National Statistics in collaboration with the dental schools of Birmingham, Dundee, Newcastle-upon-Tyne and Wales (10). Scotland, Wales and Northern Ireland were over-sampled to enable separate analysis of the findings for the four countries making up the UK. At the first stage, 76 postcode sectors in England, 32 in Scotland and 16 in Wales were selected from a list stratified by region, socioeconomic group and car ownership. Forty addresses within each sector were then selected. This gave a total of 4960 sampled addresses. In Northern Ireland, a simple random sample of 580 addresses were selected. Interviewers were sent to each address to seek interviews with all adults aged >16 years living there. Eleven per cent of these addresses did not contain an eligible household, of the remaining eligible addresses 21% refused to take part and 5% could not be contacted; 3666 households responded. A total of 6764 adults were found in the remaining addresses. Of these, 6204 (92%) agreed to be interviewed about dental issues. The 5281 dentate members of the sample completed the OHIP14 questionnaire, which was presented by the interviewer in written form. The Australian Research Centre for Population Oral Health conducted the Australian survey. The Australian sample was a stratified random selection of telephone numbers listed in the electronic 'white pages', drawing a sample from the capital city of each Australian State and Territory, and an equal-sized sample from the residual populations of each mainland State. According to estimates of the Australian Bureau of Statistics, 97.5% of Australian households have a fixed line (11); however, figures regarding opt-out from telephone listing are unavailable. Information regarding the proportion of these which are unlisted is unobtainable. Overall this produced 13 sites, with sample sizes determined to yield at least 600 participants per site. Householders with these sampled numbers were invited to participate in the computer-assisted National Dental Telephone Interview Survey that consisted of an interview and follow-up dental questionnaire. In the case of Australia, OHIP14 was presented verbally. The response rates for both surveys are shown in Table 1.

In both surveys, the impact of oral health was measured using the OHIP14. The dimensions and the subjects of the questions were: 'Functional Limitation': trouble pronouncing words, worsened taste; 'Physical Pain': aching in mouth, discomfort eating food; 'Psychological Discomfort': feeling self-conscious or feeling tense; 'Physical Disability': interrupted meals or poor diet; 'Psychological Disability': difficulty relaxing, embarrassment; 'Social Disability': irritability, difficulty in doing usual jobs; 'Handicap': life less satisfying, inability to function. Respondents reported the frequency of each impact during the preceding year on a

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Table 1. Sample derivation and response rates

Australia 1999 National Dental Telephone Interview Survey	
Number sampled	16 289
Excluded	2439
Refused	5230
Participated in interview	7289 (57% of sample)
Interviewed/sent a questionnaire	6152
Responded	3973 (55% of interviewees, 24% of sample)
United Kingdom 1998 Adult Dental Health Survey	
All eligible households	4984
Responding households	3666 (74% of eligible households)
Individuals in responding households	6764
Agreement to be interviewed	6204 (68% of individuals in eligible households)

five-point scale ranging from 'never' to 'hardly ever', 'occasionally', 'fairly often' to 'very often'.

The base model underlying the OHIP measure (Fig. 1) was tested in this study by determining the frequency that the 15 possible combinations of the four major dimensions measured in OHIP were reported by each participant in the UK. These are Functional Limitation; Pain and Discomfort (combining Physical Pain and Psychological Discomfort); Disability (combining Physical Disability, Psychological Disability and Social Disability) and Handicap. The dimensions of 'Disease' and 'Impairment' are not measured by OHIP. A respondent was defined as being affected in a specific dimension if he or she reported experience of one or both of the OHIP items in that dimension 'occasionally' or more frequently during the previous year. For example, a person who reported 'occasional' trouble pronouncing words (functional limitation) and 'fairly often' interrupting meals (disability) would be classified as experiencing 'Functional Limitation' with 'Disability'. However, if they reported 'occasional' trouble pronouncing and 'hardly ever' interrupting meals, it would correspond with 'Functional Limitation' alone. To test the sensitivity of the results to the threshold used to define impact, the analysis was repeated using a different definition of impacts occurring 'fairly often' or more frequently. Following these analyses, revisions to the conceptual model were developed and tested using the Australian data set, which unlike the UK sample, included a representative section of the edentulous population.

Results

The OHIP14 was originally tested on adults aged >60 years, this raises a concern that some of the response categories may be less relevant to adults <60 years of age. To determine whether this would

affect the response combinations when applied to a population sample, the responses of those aged >60 years were compared with those of the total population of which they were a part (Table 2). The response patterns are consistent in both the group of dentate subjects from the UK and the group of dentate and edentulous adults in Australia in terms of the rank ordering of the impact combinations reported. Despite the inclusion of edentulous subjects in the Australian sample, adults aged >60 years were less likely to report an impact in both countries which suggests that the impacts assessed by the OHIP14 measure have at least equal (probably, more) relevance to people <60 years old.

The 15 response combinations that can be derived from the four dimensions for UK dentate adults are shown in Table 3. Overall, 49.0% of respondents in UK reported no occasional or more frequent impact. The most frequently reported of the 15 response combinations were those indicating the experience of 'Pain/Discomfort' with no other impact (23.8% of respondents) and 'Pain/Discomfort' with a form of 'Disability' (12.1% of respondents). The empirical model was constructed to exclude any combinations of dimensions that were reported by 0.1% (1/1000 people) or fewer (three pathways). In addition, new combinations of dimensions were added if they were reported by >0.1% (three pathways). Figure 2 shows the pathways subtracted as grey arrows and those added as black arrows. The pathways removed were 'Impairment with Handicap', 'Functional Limitation with Handicap' and 'Functional Limitation with Disability'. The pathways that were added were 'Impairment with Disability', 'Functional Limitation with Pain/Discomfort' and 'Pain/ Discomfort with Handicap'.

Table 4 summarizes the extent to which the base model and the empirically derived model fitted the population responses of dentate adults in the UK in

	Dentate adults in United Kingdom 1998 – Age (%)		Dentate and edentulous adults in Australia 1999 – Age (%)	
Response combinations	60+	All	60+	All
No impact reported	56.1	49.0	40.4	37.5
Some impact reported	43.9	51.0	59.6	62.5
Pain/Discomfort (alone)	20.5	23.8	24.3	27.8
and Disability	8.6	12.1	11.8	14.3
and Disability and Handicap	2.1	3.6	2.9	2.9
and Handicap	0.5	0.5	0.5	0.3
Functional Limitation (alone)	1.9	1.0	1.0	1.1
Pain/Discomfort and Functional Limitation	2.7	2.1	6.1	4.4
and Disability	2.9	3.6	6.5	5.7
and Disability and Handicap	2.7	2.9	4.9	4.4
Disability (alone)	1.3	1.1	0.6	0.8
Other response combinations	0.7	0.3	1.0	0.8

Table 2. Comparison of the combination of responses from adults aged 60 or over with that of the population sample from which they were drawn

In the United Kingdom in 1998 the sample consisted of dentate adults, in Australia in 1999 the sample consisted of dentate and edentulous adults.

Table 3.	Distribution	of combinations	of responses to the	e OHIP14	questionnaire from	n 1998 A	dult Dental	Health survey
of the U	K for two res	ponse thresholds	s for dentate adult	s	•			-

Compliance with model/response combinations	Threshold I (occasional/fairly or very often)	Threshold II (fairly or very often)
No impact reported	49.0	84.1
Response combinations from >0.1% of respondents	50.7	15.7
Pain/Discomfort (alone)	23.8	8.8
and Disability	12.1	3.1
and Disability and Handicap	3.6	0.7
and Handicap	0.5	0.1
Functional Limitation (alone)	1.0	0.6
Pain/Discomfort and Functional Limitation	2.1	0.8
and Disability	3.6	0.5
and Disability and Handicap	2.9	0.5
Disability (alone)	1.1	0.6
Response combinations for <0.1% of respondents	0.3%	0.2%
Functional Limitation		
and Handicap	<0.1	0
and Disability	0.1	0.1
and Disability and Handicap	0	0
and Pain/Discomfort and Handicap	0.1	0
Disability and Handicap	<0.1	<0.1
Handicap (alone)	0.1	0.1

Combinations of items in the original baseline model (see Fig. 1) are underlined.

1998 and then how they subsequently predicted the responses from dentate and edentulous adults in Australia in 1999. In the UK in 1998, 10.3% of respondents reported combinations of dimensions experienced occasionally or more often within a year that did not fit the base model of the OHIP scale. The empirical model improved the fit to the extent that 0.3% remained unspecified. Applying the empirical model to the Australian population sample reduced the lack of fit from 14.4% in

dentate Australian adults to 0.5% and among edentulous Australian adults from 30.1% to 1.9%.

Using a threshold where only responses of 'fairly often' or 'very often' were included as positive indications of some experience of impact showed a generally similar pattern. For example, 84.1% of UK adults reported no impact, 13.4% reported combinations of dimensions specified in the model and 2.5% gave responses that were not congruent with the base model.

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Fig. 2. (a) The base model; the empirical model was derived first by subtraction of pathways representing 0.1% or fewer of response combinations in (a) (in shading) and then by the addition of pathways in (b) in shading that fitted more than 0.1% of response combinations (in shading). 'Disease' and 'Impairment' are not assessed by OHIP but are depicted as necessary precursors to any subjective impact in the base model. They are retained in the empirical model, but are not supported by empirical evidence; (a) pathways subtracted (shaded); (b) pathways added (shaded).

Table 4. Response combinations specified in base model and empirical model for dentate adults in the UK in 1998, dentate adults in Australia 1999 and edentulous adults in Australia in 1999

Sample/compliance with model	Base model % of respondents	Empirical model % of respondents
Threshold I (occasional or more frequent experie	nce/year)	
UK dentate adults (N $=$ 5281)	5	
No impact reported	49.0	49.0
Response combinations specified in model	40.7	50.7
Response combinations unspecified in model	10.3	0.3
Australian dentate adults (N $=$ 3302)		
No impact reported	38.0	38.0
Response combinations specified in model	47.7	61.5
Response combinations unspecified in model	14.4	0.5
Australian edentulous adults ($N = 388$)		
No impact reported	32.7	32.7
Response combinations specified in model	37.1	65.4
Response combinations unspecified in model	30.1	1.9
Threshold II (Fairly often or more frequent exper	ience/year)	
UK dentate adults (N = 5281)/Threshold II		
No impact reported	84.1	84.1
Response combinations specified in model	13.4	15.7
Response combinations unspecified in model	2.5	0.2
Australian dentate adults (N = 3302)/Threshold	ł II	
No impact reported	81.2	81.2
Response combinations specified in model	15.6	18.6
Response combinations unspecified in model	3.2	0.2
Australian edentulous adults ($N = 388$)/Thresh	old II	
No impact reported	75.8	75.8
Response combinations specified in model	17.6	24.0
Response combinations unspecified in model	6.7	0.2

Threshold I uses all responses of occasional or more frequent experience of impact. Threshold II uses responses of fairly often or more frequent experience of impact.

Discussion

Models to explain the consequences of disease are typically developed from a theoretical basis. Ideally, once the theoretical basis has been established, a model should be tested in a population and suitably refined. In such models, the component parts may be independent of each other and any arrows that are used can mean 'may or may not lead to' (12). The model on which OHIP is based reflects the concept that impact moves from a biological basis through an impact on the internal individual to aspects impacting on the social dimension of the individual (1). This structure was mirrored to a great extent by the hierarchical distribution of the responses in the UK population to the OHIP14 questionnaire. The OHIP scale is concerned with the behavioural and psychosocial aspects of impact and does not include measures of 'Disease' and 'Impairment', which are depicted in the model on which it is based. Their relationship to the other dimensions is retained in the empirical model, but is not supported by empirical evidence.

The paths that were deleted from inclusion in the empirical model were those reported by 0.1% of the population or fewer. Two of the rarely reported responses were 'Handicap' (alone) and 'Disability' in combination with 'Handicap'. This would support a view that 'Handicap' and 'Disability' ultimately derive from the experience of other dimensions of impact. The four other combinations that were rarely reported as having been experienced over the preceding year all included 'Functional Limitation'.

Overall, the findings gave very strong support to the general construction of the model that informed the development of the short- and long-form OHIP scales. Nevertheless, the findings did indicate that there was scope for improving the fit particularly among the edentate. The revised empirical model was particularly effective among people with no natural teeth largely as a result of many of them reporting a combination of 'Pain/Discomfort' in association with 'Functional Limitation' that was not explicitly specified in the model on which OHIP was based.

The most notable of the response combinations that was not included in the base model was that of a link between 'Pain/Discomfort' and 'Functional Limitation'. This combination accounted for 8.8% of the combinations that did not fit the pathways implied by the base model on which OHIP was constructed. Although the coexistence of two reported conditions does not necessarily show them to be causally related, the original model, which lacked any explicit link between 'Functional Limitation' and 'Pain/Discomfort' does imply that all such coexistence would be non-causal. However, new links highlighted in this study mirror what one might a priori hypothesize. For example, it is quite plausible that limited functionality can cause pain or discomfort (and vice versa), as in the case of poorly fitting dentures. Furthermore, the possibility of pain leading directly to handicap is sometimes related to conditions such as trigeminal

neuralgia. This extreme consequence is rare, and only likely to be reported by a small number of people in a large population.

Describing the response combinations that result from applying OHIP to a population may be valuable in determining whether differences exist in the experience of orally related impact within a population or between populations. Such differences stem from factors at the biological, behavioural or social level of impact. The OHIP14 model suggested by the dimension combinations obtained in the UK survey leads to some quite specific implications about how people experience impact from their oral condition. 'Pain/Discomfort' was almost universally experienced by anyone who reported any sort of impact on the OHIP14 measure, so it is not surprising that it was the group of items which combined most commonly with other subscales or combinations of subscales. 'Functional Limitation' was usually reported in combination with 'Pain/Discomfort' and was only very rarely reported in combination with any other subscales. Oral 'Handicap' did not occur in isolation, but oral 'Disability' was reported in the absence of other impacts. The model does not however necessarily imply that combinations of dimensions are related to the same specific oral impairment. The empirically derived model developed from this study should be considered as one that describes the underlying linkages between the dimensions covered by the OHIP14 measure when applied to populations rather than as a more general conceptual model. Furthermore, as it is based on population responses it may be more useful as a model for examining responses obtained in dental surveys rather than as an individual or clinical model. It should be recognized that the paths that were deleted from the original model were those reported by 1 in 1000 of the population or fewer. Whilst these might be combinations of responses that are encountered infrequently in a population they may represent the rarer or more difficult circumstances that a clinician may encounter, as may be the case for people experiencing oral cancer. However, OHIP14 is perhaps better considered as a tool for applications such as cross-sectional surveys rather than the ones involving any form of individual clinical assessment (e.g. clinical treatment outcome assessment) for which the longer equivalent of the OHIP (or other more comprehensive sociodental measures) would be preferable. It remains to be seen whether the model proposed here would account

for responses obtained by the long-form version of OHIP which contains 49 items (4). The shorter form version, if anything, may be prone to underrecording impacts in comparison with the more comprehensive version.

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