

**Construction and Utility Scaling of the
Assessment of Quality of Life (AQoL)
Instrument**

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NOTE

This paper is an updated and expanded version of Hawthorne et al (1997), [The Assessment of Quality of Life \(AQoL\) Instrument: Construction, Initial Validation and Utility Scaling](#). Melbourne, CHPE, Working Paper 76.

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1 Introduction

The Assessment of Quality of Life (AQoL) Project aimed to construct and validate a health-related quality of life instrument which would:

- (a) be a psychometrically appropriate instrument for the evaluation of a range of health interventions, from the medical and pharmacological treatment of acute illness through to health promotion activities; and
- (b) enable the economic evaluation of programs through the computation of utilities before and after health-related interventions.

This paper summarises the construction, preliminary validation evidence and scaling of the *Assessment of Quality of Life Instrument (AQoL)*.

Interest in health-related quality of life (HRQoL) can be attributed to four interrelated changes that have occurred in the second half of the twentieth century [1]. Improvements in health care technology have had the effect of reducing morbidity and early mortality, and prolonging the lives of those who would otherwise have died [2]. There has also been a fundamental shift in the nature of illness in economically developed societies, through drastic reductions in early mortality from exogenous causes (e.g. acute infections) to increases in endogenous causes (e.g. chronic illnesses such as cancers or circulatory disorders) [3]. There is now an increasing awareness that 'curing' illness is not the only outcome from health interventions. This has led to the provision of many services designed to prevent any further deterioration in quality of life [4]. And fourthly, an increasing conflict between the availability of potentially useful interventions and the resources available to pay for them. There is a strong moral argument that health resources should be allocated in ways that best benefit communities [1, 2].

These changes imply the need for the explicit evaluation of health-related interventions, be they primary, secondary or tertiary in nature. The role of HRQoL measurement within this late 20th Century paradigm is to assist with the evaluation of health care interventions by quantifying the increasingly important quality of life dimension of health outcomes. As shown in Figure 1, HRQoL measurement complements (not replaces) epidemiological or clinical evidence of program effectiveness through providing estimates of the value of additional life-years gained or of improved health status.

Figure 1: The Role of HRQoL Measurement

Program outcomes		
	Physical health effects	Value of these effects
	⇓	⇓
Evidence of program effect:	Clinical & Epidemiologic evidence <ul style="list-style-type: none"> • RCT • Cohort • Case-control • Case studies 	Evaluation & Economic evidence <ul style="list-style-type: none"> • Cost-benefit analysis (\$s or physical outcomes) • Cost-utility analysis (Quality-adjusted life years [QALYs])
Measurement units:	Life years gained Change in health state	Value of life years gained Preference for health states

The importance of HRQoL is indicated by the number of instruments that have already been constructed [3-5]. The vast majority of these are disease-specific and cannot be used for the comparison of a broad range of interventions. There are a smaller number of generic instruments which can be used in such comparisons. However, the majority of these provide health status profiles for specific dimensions of HRQoL and do not yield single utility scores which reflect the strength of preference for different health states as required for economic evaluations.

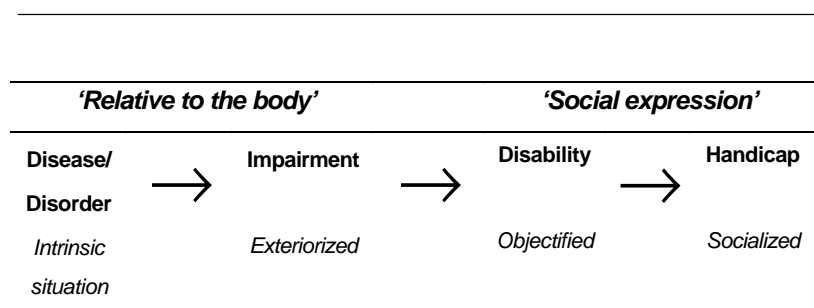
Only a handful of generic instruments have attempted to measure utility, viz; the UK Rosser-Kind Index [6], the US Quality of Wellbeing instrument [7], the Canadian Health Utilities Instruments [8, 9], the Finnish 15D [10] and the European EQ5D (EuroQol) [11]. Whilst these instruments have their strengths, to our knowledge none were constructed using normal psychometric principles to ensure construct validity. Several instruments achieve simplicity at the expense of sensitivity and there is some evidence others do not adequately validate the life/quality of life tradeoff that is implied [12, 13]. Consequently there was the challenge to develop and validate such a generic instrument.

The AQoL project was designed to assist with meeting this challenge, through construction of an instrument that would: a) cover the full universe of HRQoL as far as was practicable; b) meet standard psychometric requirements for reliable and valid measurement; c) be sensitive to a wide range of health states; and d) be capable of use as a psychometric instrument (yielding 'health state' scores) or as an economic instrument (yielding 'preference' scores). The present paper summarises the progress made to date in achieving these objectives.

2 AQoL Construction Procedures

The project commenced with a literature review of the key HRQoL instruments published since the early 1970s; our definition of HRQoL was *living without handicap attributable to health status*. This definition was derived from the World Health Organisation's (WHO) discussion of the relationship between an intrinsic disease or disorder, impairment, disability and handicap as shown in Figure 2. This postulates there is a social handicap if "a disadvantage for a given individual, resulting from an impairment or disability,... limits or prevents the fulfilment of a role that is normal... for that individual" [14, p29].

Figure 2: A Model of HRQoL



Note: The table shows that an intrinsic condition (e.g. loss of an eye) is described as an impairment (the person is blind), which may give rise to a disability (the person cannot drive safely) resulting in a social handicap (the person may be isolated in their community).

Source: Adapted from the World Health Organization (1980).

Copies of the identified instruments were obtained and subjected to critical analysis. The results suggested there were two overarching levels of HRQoL, which incorporated twenty dimensions of life. The two levels were HRQoL 'relative to the body' and the 'social expression' of health and wellbeing (Figure 3). The twenty dimensions were grouped into five broad primary dimensions based on the criteria that they: (a) obviously contributed to the broad concept 'HRQoL', (b) emphasised handicap, and that (c) a dimension was not obviously and fully subsumed within another dimension. A model was subsequently constructed comprising the two aspects of the HRQoL universe. The five primary dimensions contributing to this universe were identified as illness, independent living, physical ability, psychological wellbeing and social relationships. The model of this theoretical structure underpinning the AQoL is shown in Figure 4. A pool of items was generated from the literature, interviews and focus groups with 24 clinicians from St Vincent's Hospital (Melbourne) and the Department of General Practice and Public Health (formerly the Department of Public Health and Community Medicine) at The University of Melbourne.

Figure 3:

HRQoL Dimensions

Relative to the body

- Anxiety/Depression
- Bodily care
- Cognitive ability
- General health
- Memory
- Mobility
- Pain
- Physical ability/Vitality
- Rest/Fatigue
- Sensory functions

Social expression

- Activities of daily living
 - Communication
 - Emotional fulfilment
 - Family role
 - Intimacy/Isolation
 - Medical aids use
 - Medical treatment
 - Sexual relationships
 - Social function
 - Work function
-

Figure 4:

AQoL factor Loading

Illness	0.86	0.15	0.09	0.07	0.18
	0.86	0.14	0.08	0.07	0.08
	0.84	0.24	0.07	0.06	0.08
Independent living	0.08	0.87	0.07	0.17	-0.02
	0.15	0.71	0.11	-0.03	0.17
	0.27	0.76	0.08	0.14	0.13
Social relationships	0.02	0.06	0.84	0.12	-0.11
	0.10	0.08	0.71	0.08	0.19
	0.16	0.47	0.56	-0.06	0.18
Physical senses	0.14	0.09	-0.05	0.67	-0.15
	0.14	0.08	0.14	0.79	0.13
	-0.13	0.03	0.14	0.68	0.35
Psychological well-being	0.08	0.07	0.11	0.07	0.75
	0.11	0.01	0.46	0.16	0.64
	0.20	0.24	-0.16	0.04	0.53

Note: Each row represents an item from the AQoL

Following editing and revision of items, the item pool was administered to a construction sample comprising two cohorts: a list sample of 143 patients from St Vincent’s Hospital and a random sample of 112 Melbourne residents selected from the telephone directory.

Standard psychometric procedures were used to examine item properties, and items failing to meet specified criteria were discarded. The remaining items were then pooled and a two-stage factor analysis (principal components and varimax) was used to identify redundant items. Reliability analysis was also carried out to identify item-rest-of-test correlations and Cronbach α . These steps were repeated until the most parsimonious solution was derived consistent with psychometric and measurement theory [15-17], and with the model of HRQoL described above.

This resulted in an instrument with five factors (described as 'dimensions'), each with three items, as shown in Figure 4. In this figure the columns are the factors and the rows the individual items. For clarity, each resulting dimension has been labelled. The average factor item loading was 0.74 and on cross-factors it was 0.13; these data indicate the five factors were orthogonal¹ to each other, and that each comprised a single scale or dimension. The internal consistency of the instrument was appropriate (Cronbach $\alpha = 0.80$).

The AQoL items can be found in Appendix 1. Full details of the construction procedures and validation of the AQoL model can be found in Hawthorne et al [18].

¹ Orthogonality implies statistical independence under varimax rotation since the axes are held at right angles to each during the factor analysis [16].

During testing of the instrument a logical problem with respect to Dimension 1: Illness emerged. This had been constructed to reflect an underlying pathological health state. Instead of measuring this directly, we sought to measure it via indicators of health service consumption on the assumption that these would reflect the level of the pathological health state. Subsequent validation analyses revealed a logical difficulty with this approach; *viz.* a confounding of the dimension as an indicator of HRQoL with the beneficial effect of the service. In extreme cases the increased use of highly effective services could indicate poorer HRQoL yet the increased service use could reduce illness and increase HRQoL. Therefore this dimension was omitted from the utility computation. The four dimensions used in utility computation are Independent Living, Social Relationships, Physical Senses and Psychological Wellbeing.²

3 Utility Weights

The validity of a multi-attribute utility (MAU) instrument depends upon the achievement of preference independence such that utility scores on each dimension are independent of the other dimensions' scores [8]. In addition, if there is a high correlation between attributes, some attribute may then be 'doubled counted' [19]. The first property is usually assumed or achieved by careful item selection [8]. The second requirement appears to have been largely ignored in the literature. The AQoL satisfies this property through the orthogonality of its dimensions, as described in Section 2 above.

The character of an MAU instrument will reflect three key decisions; *viz.* (1) which scaling method is used to quantify health states (standard gamble, time tradeoff, rating scale, etc); (2) what form of model is employed to combine item scores (additive, multiplicative or statistical interpolation from the values of a limited number of health states); and (3) in the case of a multiplicative model, the relationship between the initial model scores and utility scores on a life-death scale.

For reasons discussed by Richardson [20] and Dolan et al [21] scaling was carried out using the time tradeoff technique (TTO). Interviews were conducted with a random sample of 350 Victorians within electoral divisions stratified to represent the Australian population. Respondents were asked to evaluate each item response on an 'item best-worst' response scale; the item worst response was evaluated on a 'dimension best-worst' scale; dimension 'all-worst' health states and the instrument 'all-worst' health state were measured on a 'normal health-death' scale.

The AQoL adopted the hierarchical model structure shown in Figure 8 (see page 16) as this reduced the (inevitable) tradeoff between instrument sensitivity and the need for response orthogonality noted above. This latter property was achieved between dimensions. Within dimensions there was no attempt made to achieve item independence, thereby allowing greater descriptive accuracy. The possibility of double counting was overcome by limiting the possible disutility from each dimension to the disutility of the dimension all worst health state as independently measured.

² This does not imply that the Illness dimension has no value; it provides an estimate of the consumption of health care resources.

The AQoL measures approximately 479 million health states and consequently direct utility measurement of each state is impossible. Of the two feasible MAU models available — additive and multiplicative — the latter is significantly more flexible³ and was adopted for modelling each of the five dimensions and the overall utility score from the four dimensions used in this; *viz.* Independent Living, Social Relationships, Physical Senses and Psychological Wellbeing.

Multiplicative models create a score between 0.00–1.00, which must then be recalibrated on a ‘normal health–death’ scale. In previous studies this has been carried out using the single value of the instrument ‘all worst health’ state on a ‘full health–death’ scale. However, if this value is incorrect then all of the MAU-values will be systematically biased. When this approach was used with the AQoL a result was obtained which (as elsewhere) predicted lower MAU scores than those directly observed. As a consequence the final utility scores were computed from the four independent dimensions ‘all worst health’ states (see Figure 4; excluding Illness). While this resulted in significantly higher utility values these have not, to date, been independently validated.

Disutility (DU) results for all 15 items in the AQoL are given in Table 1, where these are rescaled between 0.00–1.00. These may be inserted in the five multiplicative equations below which estimate the disutility for each dimension, where the utility is measured on a 1.00-0.00 scale, where 1.00 and 0.00 represent the index disutility number for the dimension ‘all worst’ and ‘all best’ respectively. The methods used for the derivation of these is given in Richardson & Hawthorne [22]; these follow the procedures described in Winterfeldt & Edwards [19]. The formulae are:

$$DU1 = 1.1641 \cdot [1 - (1 - 0.3350 \cdot U1) \cdot (1 - 0.5927 \cdot U2) \cdot (1 - 0.4896 \cdot U3)]$$

Equation 1: Illness

$$DU2 = 1.0989 \cdot [1 - (1 - 0.6097 \cdot U4) \cdot (1 - 0.4641 \cdot U5) \cdot (1 - 0.5733 \cdot U6)]$$

Equation 2: Independent Living

$$DU3 = 1.0395 \cdot [1 - (1 - 0.7023 \cdot U7) \cdot (1 - 0.6253 \cdot U8) \cdot (1 - 0.6638 \cdot U9)]$$

Equation 3: Social Relationships

$$DU4 = 1.6556 \cdot [1 - (1 - 0.2476 \cdot U10) \cdot (1 - 0.2054 \cdot U11) \cdot (1 - 0.3382 \cdot U12)]$$

Equation 4: Physical Senses

³ The difference is fundamental to understanding the properties of different utility instruments. Although this is a complex technical matter, the following discussion simplifies it for illustrative purposes. In an additive model the value of each dimension is added and the resulting sum is the utility. Since utilities are on a bounded scale from 0.00 (death) to 1.00 (full health) this implies that each dimension can only ever contribute a fixed total amount to utility. For example, suppose an instrument had 2 dimensions, one of which was weighted at 0.60 (Dimension A) and the other at 0.40 (Dimension B), which satisfies the requirement for full health having a utility of 1.00 (0.60 + 0.40 = 1.00). If a person was in the worst health state in Dimension A and obtained a value of 0.00, but his health for Dimension B was normal (0.40), his utility would be 0.00+0.40 = 0.40. Now, assume the same two dimensions and the same weights, but in a multiplicative instrument. This time the same person's utility could be 0.00·0.40 = 0.00. I.e. in a multiplicative instrument any dimension can (theoretically) take a person to 0.00. Extending this it may be seen that multiplicative models deal in proportions whereas additive models deal in absolute amounts. For a further discussion of the modelling and the implications of additive and multiplicative models the reader is referred to Richardson & Hawthorne [22].

$$DU5 = 1.2920 \cdot [1 - (1 - 0.1703 \cdot U13) \cdot (1 - 0.2554 \cdot U14) \cdot (1 - 0.6347 \cdot U15)]$$

Equation 5: Psychological Wellbeing

The formula for computing the utility value (U^*) for each dimension is given in equation 6, where DU^* is the relevant dimension disutility given in equations 1 to 5:

$$U^* = 1 - DU^*$$

Equation 6: Conversion to utility values

For each dimension there are 64 possible health states, the utility value of which may be estimated either directly from equations 1–6 or from the computer code given in Appendix 2.

The disutility values from the four dimensions used in the AQoL utility score combine to produce an overall utility score using equation 7.

$$U = 1.04 \cdot [(1 - 0.841 \cdot DU2) \cdot (1 - 0.855 \cdot DU3) \cdot (1 - 0.931 \cdot DU4) \cdot (1 - 0.997 \cdot DU5)] - 0.04$$

Equation 7: AQoL utility score

Table 1: Item Disutility Values

Dimension	Item	Health level			
		1	2	3	4
Illness	1.	0.000	0.328	0.534	1.000
	2.	0.000	0.269	0.467	1.000
	3.	0.000	0.166	0.440	1.000
Independent	4.	0.000	0.154	0.403	1.000
Living	5.	0.000	0.244	0.343	1.000
	6.	0.000	0.326	0.415	1.000
Social Relationships	7.	0.000	0.169	0.396	1.000
	8.	0.000	0.095	0.191	1.000
	9.	0.000	0.147	0.297	1.000
Physical Senses	10.	0.000	0.145	0.288	1.000
	11.	0.000	0.253	0.478	1.000
	12.	0.000	0.219	0.343	1.000
Psychological Wellbeing	13.	0.000	0.107	0.109	1.000
	14.	0.000	0.141	0.199	1.000
	15.	0.000	0.104	0.312	1.000

It will be observed that equation 7 permits values 'worse than death'. Negative utilities were first reported by Rosser & Kind [23]. Torrance, in his seminal review of utilities, noted that negative utilities result in unconstrained scores, thereby allowing apparent utility scores as low as minus infinity [24]. It was suggested that these should be constrained to the range 0.00 through -1.00 thus giving a maximum disutility of 2.00; advice which was accepted in the scaling of the EQ5D [25]. The only argument, however, for this was on the appeal to symmetry. In scaling the AQoL we have argued that while negative utility scores can have meaning over a limited range, this meaning is rapidly lost as the magnitude of the negative score increases. For reasons given in Richardson & Hawthorne we adopted a maximum disutility of 1.20 in any individual measurement. This resulted in a lower boundary at -0.04 for the AQoL [22].

4 AQoL Validation

This section is presented in two parts: psychometric validation and evidence for validity of the utility scores.

4.1 Psychometric Validation of the Descriptive System

Generally, three forms of validation—content, construct and criterion—are accepted as providing evidence of the nomological net necessary for accepting that a measure possesses validity [17, 26, 27].

Content validity refers to the relationship between the hypothesised universe and the measurement: the measurement must provide adequate coverage of the universe. Following the procedures outlined by Lennon [28], the content of each AQoL item, along with those of three other utility instruments (the EQ5D [29], HUI3 [8, 9, 30, 31], and 15D [10, 32, 33]) and a generic non-utility health status instrument (the SF-36 [34-36]), were mapped against the HRQoL universe defined through the literature review. The results are given in Figure 5, where each asterisk represents an item. The figure shows that the AQoL provides good coverage across the important HRQoL dimensions; coverage which is at least as good if not better than comparable instruments.

Figure 5: HRQoL Coverage: Key Instruments

HRQoL dimensions	SF-36	AQoL	EuroQoL	HUI-III	15D
<i>Relative to the body</i>					
Anxiety/Depression	***	*	*		**
Bodily care	*	*	*	*	
Cognitive ability				*	*
General health	*****				
Memory				*	
Mobility	***	*	*	*	*
Pain	**	*	*	**	*
Physical ability/Vitality	*****			*	*
Rest and fatigue	**	*			*
Sensory functions		**		****	*****
<i>Social expression</i>					
Activities of daily living		*	*		*
Communication		*		**	*
Emotional fulfilment	**			**	
Family role		*			
Intimacy/Isolation		*			
Medical aids use		*			
Medical treatment		**			
Sexual relationships					*
Social function	**	*			
Work function	**				

The importance of good coverage of HRQoL dimensions is graphically illustrated in Figures 6 & 7. Both figures draw on data from a study of back pain, involving concept mapping to derive the HRQoL-dimensions important to patients undergoing rehabilitation [37]. Figure 6 shows that while the SF-36 provides reasonable coverage, it omits measurement on a range of medical and social issues. Figure 7, shows the same concept map with the AQoL items superimposed; it reveals a broader and more representative coverage.

Figure 6: Coverage: SF-36 Items & Back Pain

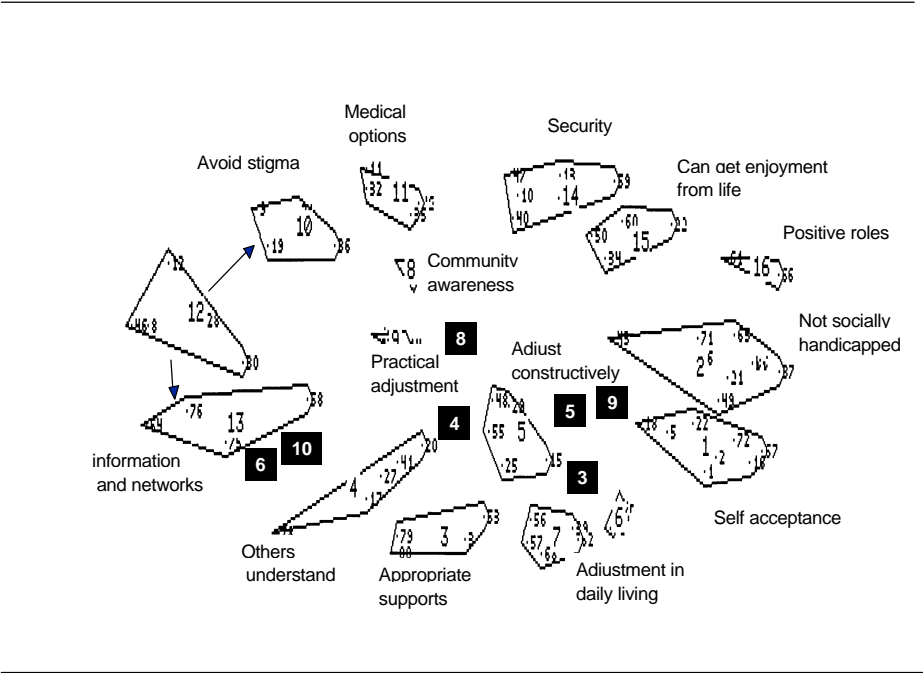
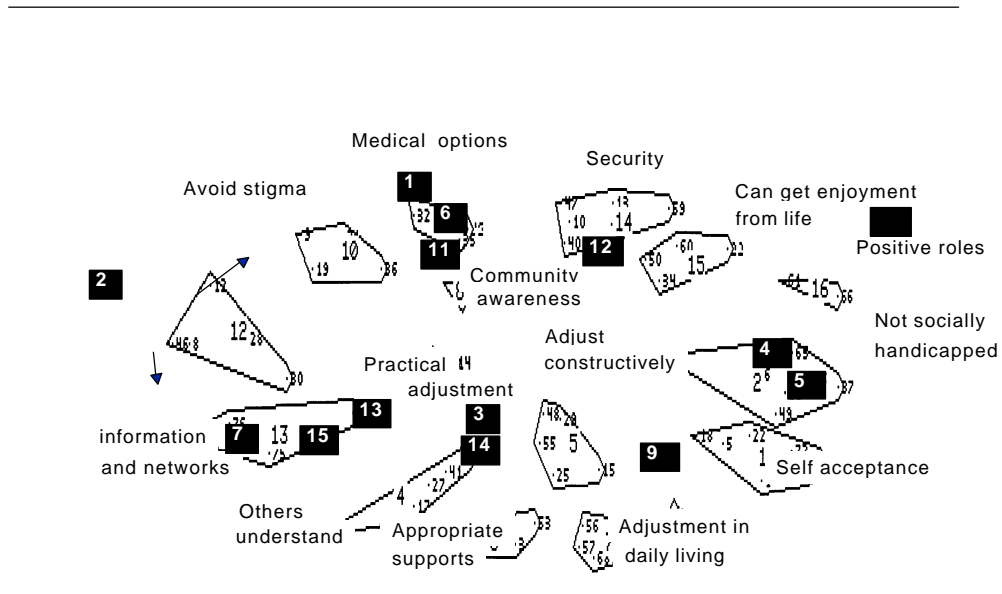


Figure 7: Coverage: AQoL Items & Backpain



Construct validity refers to how well an instrument's score can be used to infer scores about the underlying psychometric universe or concept that is to be measured. Generally, construct validity is established by either examining how well empirical data 'fits' the hypothesised model or how well obtained scores 'predict' specified outcomes.

In order to understand the AQoL model and the relationships between the various scales, the AQoL was subjected to structural equation modelling (SEM) [17, 38]. Assuming dimension orthogonality (see Figure 4, page 5), a *total disaggregation second order SEM model* was employed, in which each item was used to operationalise its respective hypothesised latent dimension. The model provides for the most detailed level of analysis as the properties of each item are described. Under these stringent requirements the measures of 'fit'—i.e. estimates of how well a specified model fits the data—typically provide values (around 0.80) below those advocated for less restrictive models, such as total or partial aggregation models (>0.90) [39]. This model assumed the AQoL dimensions were independent (thus it assumed no correlations between the first level dimension disturbances), and that for each item any common variance was explained by one latent factor only. Analysis of the model, based on correlation and regression weights analysis, confirmed these assumptions [17, 38]. Under these circumstances the loadings within the model also represent the correlations between the model components.

The results are given in Figures 8 and 9. In the following description, the values for the utility version of the AQoL (i.e. Figure 9; four dimensions) are given in brackets. Figure 8 (Figure 9 shows that, on average, the correlations between the latent five (four) dimensions and the manifest items averaged 0.64 (0.63), explaining an average of 41% (39%) of the item variance.

The loadings of the five (four) first order latent dimensions on the generic HRQoL index were 0.64 for the Illness scale (explaining 41% of the variance within the Illness scale), 0.67 (0.80) for the Independent Living scale (45% (64%) of scale variance), 0.77 (0.89) for the Social Relationships scale (59% (79%) of scale variance), 0.51 (0.51) for the Physical Senses scale (26% (26%) of scale variance), and 0.87 (0.88) with the Psychological State scale (76% (77%) of scale variance). The overall comparative fit index (CFI) was 0.90 (0.91), indicating a much better fit than might be expected under the restrictive conditions of model construction outlined above [17, 39].

Figure 8: AQoL 5 – Dimension Structural Equation Analysis

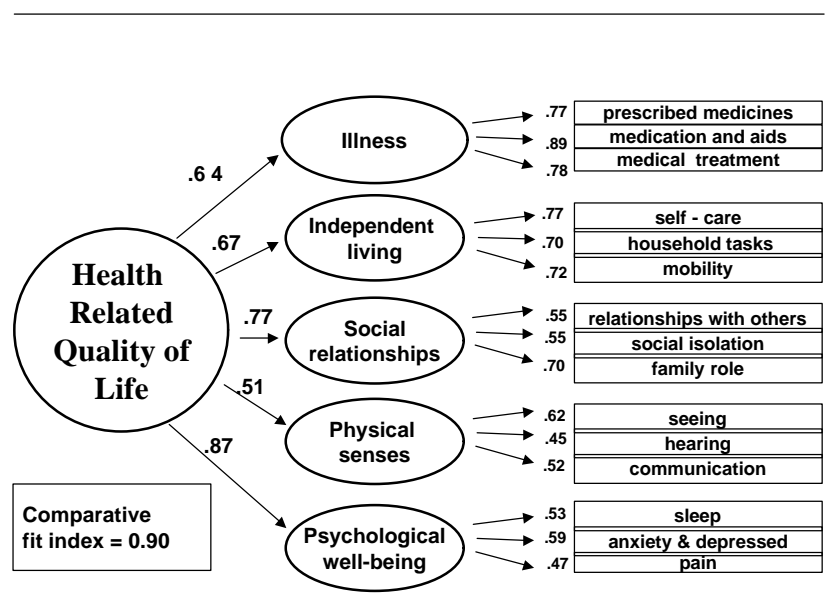
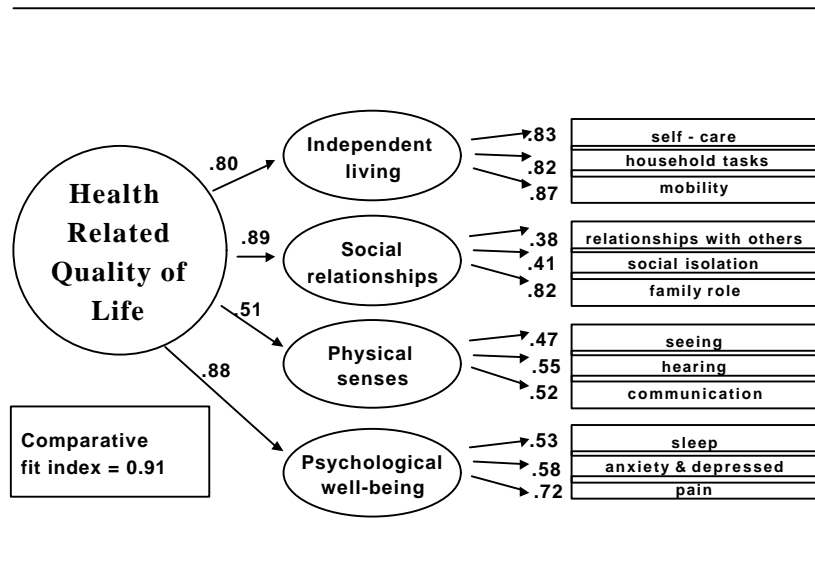


Figure 9: AQoL 4 – Dimension Structural Equation Analysis



Summarising these results, the analysis indicates that 90% (91%) of variation between observations may be explained by the structure of the AQoL. There is virtually no addition to explanatory power through relationships not postulated by the model.

Some preliminary evidence is available regarding criterion (concurrent) validity, where the criterion was the correlation with other independent measures. The data presented below were based on the AQoL-utility (i.e. AQoL 4-dimension) version. Three measures are presented here, each measuring an important aspect of HRQoL: self-rated health, affect and physical health status. Since each of these measured a different aspect of HRQoL, moderate correlations — $r = 0.40-0.70$ — between each instrument and the AQoL were expected.

The first measure, shown in Figure 10, shows the results of plotting AQoL median scores against the SF-36's health rating status question. These data were from 961 respondents who were randomly sampled members of the general community, outpatients and inpatients who self-completed the SF-36 and AQoL. As expected, there were significant differences in AQoL scores between the different SF-36 self-rated levels (ANOVA, $F=177.97$, $df = 4$, 956 , $p < 0.01$); viz. the worse the health state rating the lower the median AQoL utility score. Figure 11 shows the relationship between the AQoL and a measure of mood, the Affects Balance Scale (ABS) [40].

As shown the correlation between the two instrument scores is in the expected direction and falls within the expected range ($r = 0.66$). Figure 12 shows the relationship between the SF-36 Physical summary scale (PCS) and the AqoL. Once again the relationship is what was expected with the correlation being $r = 0.64$.

Figure 10: Self-rated Health vs. AqoL (medians)

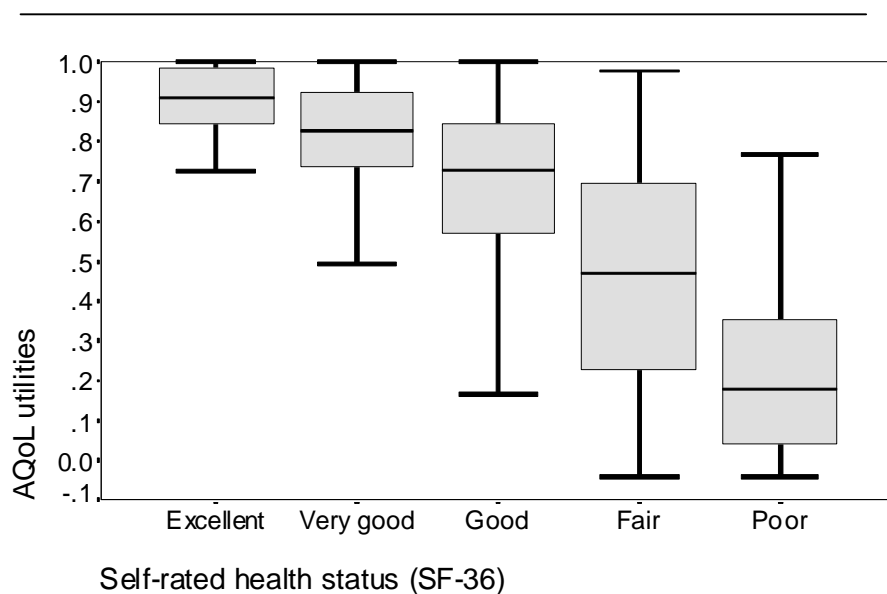


Figure 11: Affects Balance Scale vs AQoL

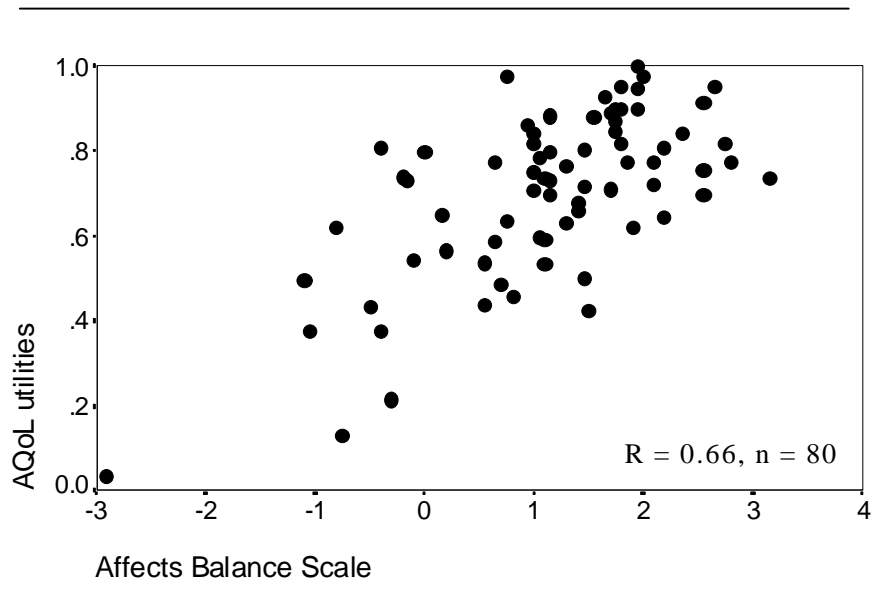
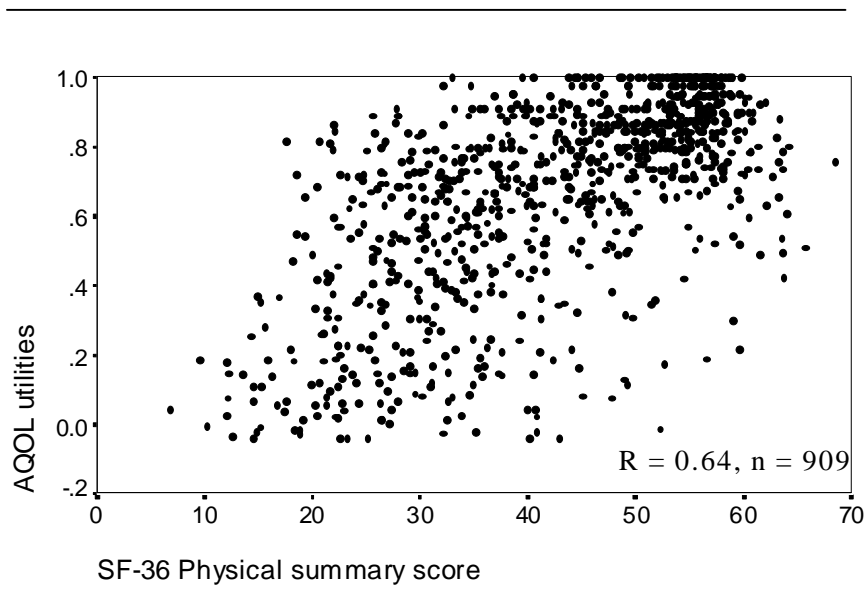


Figure 12: SF – 36 PCS vs AQoL



Taken together, these three sets of results provide good evidence of concurrent validity.

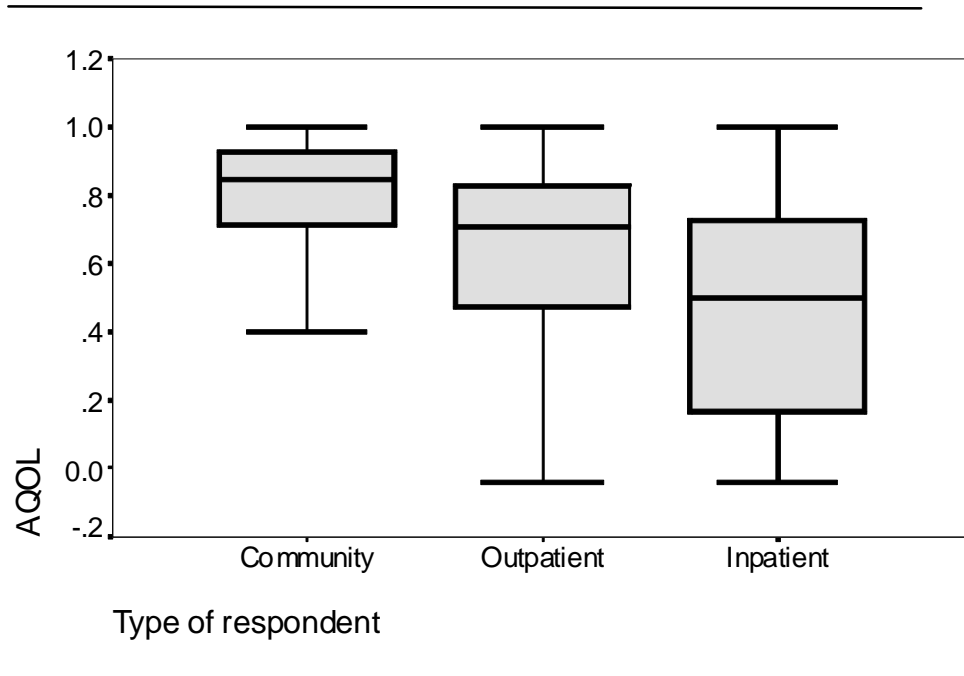
4.2 Evidence For Utility Validity

Three indicators of the validity of utility scores are (1) logical discrimination by health status, (2) a correlation between instrument and self-evaluated preferences, and (3) an association with other utility instruments. Examples of each are given below using results from the AQL validation study which compared the AQL with three other leading utility instruments: viz, the EQ5D [29], HUI3 [8, 9, 30, 31] and 15D [10, 32, 33]). For details see Hawthorne et al [41].

Regarding discrimination by health status, Figure 13 shows differences in AQL scores by type of respondent (community, outpatient and inpatient); the differences between each respondent type were highly significant and as expected (ANOVA, $F = 88.64$, $df = 2,857$, $p < 0.01$).

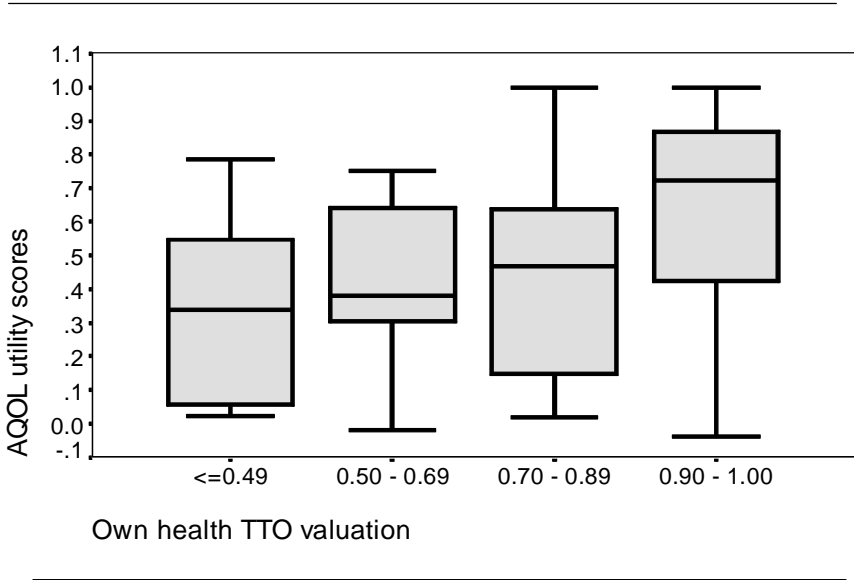
Figure 13:

AQoL Utilities By Type of Respondent



Self-evaluated preferences are arguably the gold standard for a utility instrument. However, interpreting the relationship between these and scores obtained on a utility instrument is difficult. Individuals assessing their own HRQoL status may be biased (i.e. unaware or lacking insight), while instrument weights reflect those of the fully informed (healthy) community. Subject to this caveat, Figure 14 shows the relationship between 121 individuals who completed the AQoL and also a self-evaluated TTO in which they indicated the percentages of their own lives they would sacrifice to move from their existing health state to the AQoL all-best health state. Due to the small number of respondents reporting very low utility values (<0.50; n = 16), self-reported TTOs were grouped as shown in Figure 14. Analysis of the data indicated significant differences in AQoL scores between the different self-rated TTO groups (Kruskall-Wallis $\chi^2 = 18.87$, $p < 0.01^*$).

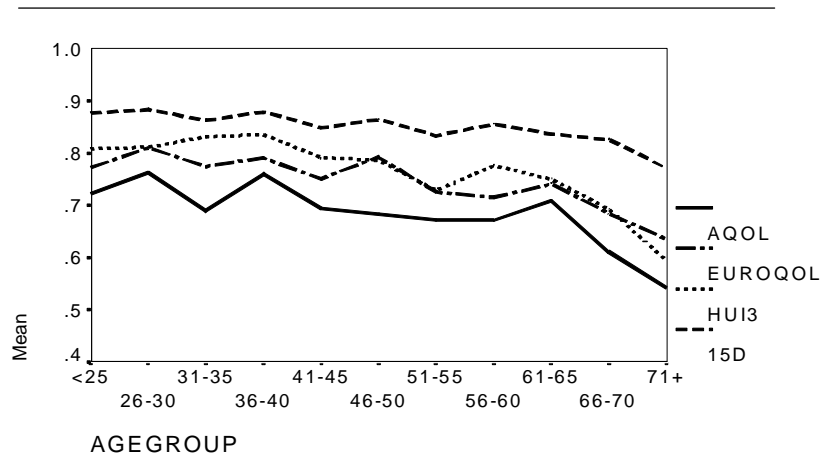
Figure 14: Own Health TTO vs. AQL



We also made comparisons between utility instruments. While each of the MAU instruments included in our validation study purport to measure the same underlying concept, viz. the utility of each health state, it is unsurprising that in practice the obtained scores differ. This is because different items are used, meaning that different aspects of HRQoL are measured by different instruments (as shown in Figure 5, page 10). In addition, different weights and combination rules also ensure differences between instruments; the AQL uses a multiplicative model, as does the HUI3. The EQ5D uses a modified regression model and the 15D uses an additive model. The different cultural milieu in which the instruments were developed and weighted will also play a part; the 15D reflects Finnish weights, the EQ5D British, the HUI3 Canadian and the AQL Australian weights. And the four instruments differ on the scale ranges employed: the theoretical lower boundaries, based on the scoring algorithms for each instrument, are -0.04 (AQL), -0.59 (EQ5D), -0.36 (HUI3) and +0.11 (15D). Figure 15 provides a visual comparison of the different scores obtained by the different instruments, broken down by age groups.

Figure 15

:Utility Instrument Scores by Age



The validation of the utility scores produced by utility instruments is more demanding than validation of non-utility instrument scores because of the claims underlying utility theory. Correlation with other instruments is necessary, but, in addition, the absolute scores should be the same. Even more importantly for the evaluation of health programs, the change in the scores between two utility instruments should be the same. Since both of the utility scores in a pairwise comparison contain an error term, the comparison cannot be carried out using simple linear regression. Barnett (1969) offered a partial solution to this problem of comparability, and his procedures were applied to the data from the four utility instruments. [42] The results are presented in Figure 16. This shows the slope coefficient in the linear relationship between the four utility scores from the AQL validation study instruments. If the predicted changes in the utility scores on two instruments are the same, then this slope coefficient would have a value of 1.00.

Figure 16: Linear Relationship Between Instruments

$$x_1 = a_1 + b \cdot X_2$$

$$x_2 = a_2 + (1/b) X_1$$

b coefficient

X_1	X_2			
	AQoL	HUI	EuroQoL	15D
AQoL		1.05	1.13	2.1
HUI	0.95		0.99	2.0
EuroQoL	0.88	1.01		1.9
15D	0.49	0.5	0.5	

Barnett, VD 1969, 'Simultaneous Pairwise Linear Structural Relationships', *Biometrics*, 25, 129-142.

Our results are consistent with this prediction for three of the four AQoL comparisons. For example, suppose the AQoL's score was to increase by 0.10, by reading down the AQoL column, it can be seen that the HUI3 score would increase by a factor of 0.95, the EQ5D score would increase by 0.88 and the 15D score by 0.49. These results are very encouraging: with the exception of the 15D, they imply that the predicted change in utility would be very similar when any of the three instruments — AQoL, EQ5D or HUI3 — were used.

This finding suggests that although the AQoL provides slightly lower utility scores when compared with the other instruments, this is because the questions in the AQoL cover a wider range of health states and include a greater number of sources of disutility: specifically, disutility arising from social and personal relationships and family role; neither of which are measured by the other instruments (see Figure 5, page 10).

5 Conclusion

As shown in this paper, the preliminary evidence suggests that a wide range of health states may be described by the AQoL's dimensions and that these dimensions broadly correspond with those found in the literature. The orthogonality of the dimensions supports the assertion that the AQoL is a valid descriptive system which may form the basis for a reliable, valid and sensitive HRQoL instrument. The findings also indicate that the psychometric instrument is suitable for scaling and validation as a QoL/QALY instrument.

The utility values given by equations 1–6 may be used to produce a health profile. Results from equation 7 may be used to estimate the total utility of different health states for use in a cost utility analysis. For the reasons noted earlier we recommend that these final utilities be used cautiously. As with the other utility instruments, they have not to date been independently validated against peoples' revealed preferences. Nevertheless, data which are available suggest that the AQoL utilities provide measures which are sensitive to people in different health states, which vary significantly and appropriately by self-evaluated TTO, and which are highly correlated with utilities obtained from other instruments.

In conclusion, the AQoL appears to be a reliable and valid utility instrument with excellent psychometric properties. The evidence presented in this paper suggests it may have applicability in a wide range of studies.

As it is more widely used and its properties are investigated further, more evidence concerning its validity in different contexts will emerge.

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Appendix 1: The AQoL Instrument

The attached version of the AQoL was designed for self-completion during an interview or through mail administration. A telephone administered version of the AQoL is available upon request.

The attached copy of the AQoL is for review purposes only, and prior to AQoL use, permission must be obtained from the authors.

The Assessment of Quality of Life (AQOL) Instrument⁴

Instructions:

Please circle the alternative that best describes you *during the last week*.

ILLNESS

- 1 Concerning my use of prescribed medicines:
 - A. I do not or rarely use any medicines at all.
 - B. I use one or two medicinal drugs regularly.
 - C. I need to use three or four medicinal drugs regularly.
 - D. I use five or more medicinal drugs regularly.

- 2 To what extent do I rely on medicines or a medical aid? (NOT glasses or a hearing aid.)
(For example: walking frame, wheelchair, prosthesis etc.)
 - A. I do not use any medicines and/or medical aids.
 - B. I occasionally use medicines and/or medical aids.
 - C. I regularly use medicines and/or medical aids.
 - D. I have to constantly take medicines or use a medical aid.

- 3 Do I need regular medical treatment from a doctor or other health professional?
 - A. I do not need regular medical treatment.
 - B. Although I have some regular medical treatment, I am not dependent on this.
 - C. I am dependent on having regular medical treatment.
 - D. My life is dependent upon regular medical treatment.

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This material, incorporating the AQoL instrument cannot be reproduced or applied without the prior approval of the authors.

INDEPENDENT LIVING

- 4 Do I need any help looking after myself?
- A. I need no help at all.
 - B. Occasionally I need some help with personal care tasks.
 - C. I need help with the more difficult personal care tasks.
 - D. I need daily help with most or all personal care tasks.
- 5 When doing household tasks: *(For example, preparing food, gardening, using the video recorder, radio, telephone or washing the car)*
- A. I need no help at all.
 - B. Occasionally I need some help with household tasks.
 - C. I need help with the more difficult household tasks.
 - D. I need daily help with most or all household tasks.
- 6 Thinking about how easily I can get around my home and community:
- A. I get around my home and community by myself without any difficulty.
 - B. I find it difficult to get around my home and community by myself.
 - C. I cannot get around the community by myself, but I can get around my home with some difficulty.
 - D. I cannot get around either the community or my home by myself.

SOCIAL RELATIONSHIPS

- 7 Because of my health, my relationships *(for example: with my friends, partner or parents)* generally:
- A. Are very close and warm.
 - B. Are sometimes close and warm.
 - C. Are seldom close and warm.
 - D. I have no close and warm relationships.
- 8 Thinking about my relationship with other people:
- A. I have plenty of friends, and am never lonely.
 - B. Although I have friends, I am occasionally lonely.
 - C. I have some friends, but am often lonely for company.
 - D. I am socially isolated and feel lonely.

-
- 9 Thinking about my health and my relationship with my family:
- A. My role in the family is unaffected by my health.
 - B. There are some parts of my family role I cannot carry out.
 - C. There are many parts of my family role I cannot carry out.
 - D. I cannot carry out any part of my family role.

PHYSICAL SENSES

- 10 Thinking about my vision, including when using my glasses or contact lenses if needed:
- A. I see normally.
 - B. I have some difficulty focusing on things, or I do not see them sharply.
For example: small print, a newspaper, or seeing objects in the distance.
 - C. I have a lot of difficulty seeing things. My vision is blurred.
For example: I can see just enough to get by with.
 - D. I only see general shapes, or am blind. *For example: I need a guide to move around.*
- 11 Thinking about my hearing, including using my hearing aid if needed:
- A. I hear normally.
 - B. I have some difficulty hearing or I do not hear clearly.
For example: I ask people to speak up, or turn up the TV or radio volume.
 - C. I have difficulty hearing things clearly. *For example: Often I do not understand what is said. I usually do not take part in conversations because I cannot hear what is said.*
 - D. I hear very little indeed. *For example: I cannot fully understand loud voices speaking directly to me.*
- 12 When I communicate with others: *(For example: by talking, listening, writing or signing)*
- A. I have no trouble speaking to them or understanding what they are saying.
 - B. I have some difficulty being understood by people who do not know me. I have no trouble understanding what others are saying to me.
 - C. I am only understood by people who know me well. I have great trouble understanding what others are saying to me.
 - D. I cannot adequately communicate with others.

PSYCHOLOGICAL WELL-BEING

- 13 If I think about how I sleep:
- A. I am able to sleep without difficulty most of the time.
 - B. My sleep is interrupted some of the time, but I am usually able to go back to sleep without difficulty.
 - C. My sleep is interrupted most nights, but I am usually able to go back to sleep without difficulty.
 - D. I sleep in short bursts only. I am awake most of the night.
- 14 Thinking about how I generally feel:
- A. I do not feel anxious, worried or depressed.
 - B. I am slightly anxious, worried or depressed.
 - C. I feel moderately anxious, worried or depressed.
 - D. I am extremely anxious, worried or depressed.
- 15 How much pain or discomfort do I experience?
- A. None at all.
 - B. I have moderate pain.
 - C. I suffer from severe pain.
 - D. I suffer unbearable pain.

Appendix 2: Analysis Program

```
*****
***   REM This file analyses the AqoL                               ***
***   and produces utilities for each dimension                     ***
***   and the instrument overall.                                   ***
***                                                                 ***
***   REM The AqoL uses D2, D3, D4 & D5                           ***
***   when calculating the utilities,                               ***
***   although dimension utilities are calculated for D1.          ***
***                                                                 ***
***   REM The dimensions are scaled on a                           ***
***   "Dimension Worst Health State - Dimension Best Health State" ***
***   scale where DWHS = 0.00 and DBHS = 1.00.                    ***
***   These are not strict utility values as they have not        ***
***   been evaluated on a life-death scale.                         ***
***                                                                 ***
***   REM The AqoL utility scores are scaled such that the:       ***
***   "AqoL worst health state" = -0.04                            ***
***   (i.e. this is worse than Death, where                       ***
***   Death = 0.00).                                               ***
***   "AqoL best health state" = 1.00 (i.e. this is good health) ***
***                                                                 ***
***   REM Copyright. Version 3. Release date: September 1999.     ***
***                                                                 ***
***   REM Version 3 is an interim release which replaces Versions 1 & 2. ***
***   This new version will increase utility scores by about 3%   ***
***   at the bottom end of the utility scale when compared with Version 1. ***
***                                                                 ***
***   REM THIS IS AN INTERIM RELEASE SUBJECT TO REVISION WITHOUT NOTICE. ***
***                                                                 ***
***   REM RESEARCHERS SHOULD CHECK WITH THE AQOL TEAM FOR MODIFICATIONS. ***
***                                                                 ***
***   REM Note: "AqoL1" etc. are the variables in your questionnaire; ***
***   you will need to replace these with your variable names.   ***
***   This only applies to the first 15 COMPUTE statements.       ***
***   Once these have been changed, your variables are no longer used ***
***   anywhere in the program.                                     ***
*****

Get file = ":\YOURFILE.sav".
```

Compute Q1 = AQoL1.
Compute Q2 = AQoL2.
Compute Q3 = AQoL3.
Compute Q4 = AQoL4.
Compute Q5 = AQoL5.
Compute Q6 = AQoL6.
Compute Q7 = AQoL7.
Compute Q8 = AQoL8.
Compute Q9 = AQoL9.
Compute Q10 = AQoL10.
Compute Q11 = AQoL11.
Compute Q12 = AQoL12.
Compute Q13 = AQoL13.
Compute Q14 = AQoL14.
Compute Q15 = AQoL15.

Compute ILLmiss = Nmiss (Q1 to Q3).
Do if ILLmiss = 1.
Do repeat
 A = Q1 to Q3.
If (Missing (A)) A = RND(Mean (Q1 to Q3)).
End repeat.
End if.

Compute ADLmiss = Nmiss (Q4 to Q6).
Do if ADLmiss < 2.
Do repeat
 A = Q4 to Q6.
If (Missing (A)) A = RND(Mean (Q4 to Q6)).
End repeat.
End if.

Compute SOCmiss = Nmiss (Q7 to Q9).
Do if SOCmiss < 2.
Do repeat
 A = Q7 to Q9.
If (Missing (A)) A = RND(Mean (Q7 to Q9)).
End repeat.
End if.

Compute PHYmiss = Nmiss (Q10 to Q12).
Do if PHYmiss < 2.
Do repeat
 A = Q10 to Q12.
If (Missing (A)) A = RND(Mean (Q10 to Q12)).
End repeat.

End if.

Compute PSYmiss = Nmiss (Q13 to Q15).

Do if PSYmiss < 2.

Do repeat

A = Q13 to Q15.

If (Missing (A)) A = RND(Mean (Q13 to Q15)).

End repeat.

End if.

Compute U1 = Q1.

Compute U2 = Q2.

Compute U3 = Q3.

Compute U4 = Q4.

Compute U5 = Q5.

Compute U6 = Q6.

Compute U7 = Q7.

Compute U8 = Q8.

Compute U9 = Q9.

Compute U10 = Q10.

Compute U11 = Q11.

Compute U12 = Q12.

Compute U13 = Q13.

Compute U14 = Q14.

Compute U15 = Q15.

If (U1 eq 1)U1 = 0.000.

If (U1 eq 2)U1 = 0.328.

If (U1 eq 3)U1 = 0.534.

If (U1 eq 4)U1 = 1.000.

If (U2 eq 1)U2 = 0.000.

If (U2 eq 2)U2 = 0.269.

If (U2 eq 3)U2 = 0.467.

If (U2 eq 4)U2 = 1.000.

If (U3 eq 1)U3 = 0.000.

If (U3 eq 2)U3 = 0.166.

If (U3 eq 3)U3 = 0.440.

If (U3 eq 4)U3 = 1.000.

If (U4 eq 1)U4 = 0.000.

If (U4 eq 2)U4 = 0.154.

If (U4 eq 3)U4 = 0.403.

If (U4 eq 4)U4 = 1.000.

If (U5 eq 1)U5 = 0.000.

If (U5 eq 2)U5 = 0.244.

If (U5 eq 3)U5 = 0.343.

If (U5 eq 4)U5 = 1.000.

If (U6 eq 1)U6 = 0.000.
If (U6 eq 2)U6 = 0.326.
If (U6 eq 3)U6 = 0.415.
If (U6 eq 4)U6 = 1.000.
If (U7 eq 1)U7 = 0.000.
If (U7 eq 2)U7 = 0.169.
If (U7 eq 3)U7 = 0.396.
If (U7 eq 4)U7 = 1.000.
If (U8 eq 1)U8 = 0.000.
If (U8 eq 2)U8 = 0.095.
If (U8 eq 3)U8 = 0.191.
If (U8 eq 4)U8 = 1.000.
If (U9 eq 1)U9 = 0.000.
If (U9 eq 2)U9 = 0.147.
If (U9 eq 3)U9 = 0.297.
If (U9 eq 4)U9 = 1.000.
If (U10 eq 1)U10 = 0.000.
If (U10 eq 2)U10 = 0.145.
If (U10 eq 3)U10 = 0.288.
If (U10 eq 4)U10 = 1.000.
If (U11 eq 1)U11 = 0.000.
If (U11 eq 2)U11 = 0.253.
If (U11 eq 3)U11 = 0.478.
If (U11 eq 4)U11 = 1.000.
If (U12 eq 1)U12 = 0.000.
If (U12 eq 2)U12 = 0.219.
If (U12 eq 3)U12 = 0.343.
If (U12 eq 4)U12 = 1.000.
If (U13 eq 1)U13 = 0.000.
If (U13 eq 2)U13 = 0.107.
If (U13 eq 3)U13 = 0.109.
If (U13 eq 4)U13 = 1.000.
If (U14 eq 1)U14 = 0.000.
If (U14 eq 2)U14 = 0.141.
If (U14 eq 3)U14 = 0.199.
If (U14 eq 4)U14 = 1.000.
If (U15 eq 1)U15 = 0.000.
If (U15 eq 2)U15 = 0.104.
If (U15 eq 3)U15 = 0.312.
If (U15 eq 4)U15 = 1.000.

Compute DU1 = (1.1641*(1-(1-0.3350*U1)*(1-0.5927*U2)*(1-0.4896*U3))).
Compute DU2 = (1.0989*(1-(1-0.6097*U4)*(1-0.4641*U5)*(1-0.5733*U6))).
Compute DU3 = (1.0395*(1-(1-0.7023*U7)*(1-0.6253*U8)*(1-0.6638*U9))).
Compute DU4 = (1.6556*(1-(1-0.2476*U10)*(1-0.2054*U11)*(1-0.3382*U12))).
Compute DU5 = (1.2920*(1-(1-0.1703*U13)*(1-0.2554*U14)*(1-0.6347*U15))).

Compute UD1 = 1-DU1.

Compute UD2 = 1-DU2.

Compute UD3 = 1-DU3.

Compute UD4 = 1-DU4.

Compute UD5 = 1-DU5.

Compute AQOL = ((1.04*((1-(0.613*0))*
(1-(0.841*DU2))*
(1-(0.855*DU3))*
(1-(0.931*DU4))*
(1-(0.997*DU5)))) - 0.04).

Execute

Frequency

/Variables = UD1 UD2 UD3 UD4 UD5 AQoL

/Histogram

/Statistics = Mean Stddev.

Execute.