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Interim Population Norms for the AQoL-6D and AQoL-8D Multi Attribute Utility Instruments

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ABSTRACT

Objective: To document population norms for two health related multi attribute utility instruments, the Assessment of Quality of Life (AQoL)-6D and the Assessment of Quality of Life (AQoL)-8D and the population norms for the eight physical and psycho-social subscales from which they are constructed.

Methods: Three population surveys which contained the AQoL-4D, AQoL-6D, and AQoL-8D were combined. Each age-gender cohort was compared with the corresponding cohort in a national survey which contained the AQoL-4D. The distribution of responses within each cohort was adjusted to match the distribution in the national survey. The adjusted database was employed to construct population norms.

Results: There is a significant age related decrease in AQoL-6D and AQoL-8D utilities and in each of the physical health dimension scores. In contrast, differences in psycho-social health are cohort specific and there is no overall age-related decrease in scores. The highest psycho-social scores are obtained by young men, and the lowest by young women and women aged 35-44.

Conclusions: Norms vary with the instrument from which they are derived. The inclusion of a significant psycho-social component in the AQoL-6D and, particularly, the AQoL-8D alters the pattern revealed by previous instruments.

TABLE OF CONTENTS

1 Introduction....1
2 Methods....3
3 Results....5
4 Discussion....9
5 Conclusion....10
Supplementary Material....11
References....14

List of Tables

Table 1 Population norms 2
Table 2 Population norms by age and gender (n=1568) 8

Table S.1 Dimension norms by age and gender (n=1568).... 11
Table S.2 Utilities and dimension scores by educational attainment (n=1568).... 13

List of Figures

Figure 1 AQoL-8D and AQoL-6D instruments*.... 4
Figure 2 AQoL-8D dimensions by age, gender; AQoL-6D, 8D by educational status 6

Interim population norms for the AQoL-6D and AQoL-8D multi attribute utility instruments

1 Introduction

Numerous ‘instruments’ have been created which produce indices of the health related quality of life (HRQoL) (Bowling 2005, McDowell 2006, Simmons and Lehmann 2013). To assist with the interpretation of the numbers produced by these instruments it is common practice to provide ‘population norms’ for these instruments: estimates of the average value of the index for different age-gender cohorts.

Population norms have a number of purposes. First, and most generally, they help interpret the numbers obtained from an instrument: whether a particular score represents an excellent, normal or poor health relative to the general population. Secondly, in observation studies they permit an estimate to be made of the difference between a population subgroup and the general population. This may be the basis for estimating the burden of disease associated with an illness and the distribution of the burden by demographic cohort. Third, in the absence of longitudinal data norms may be used to estimate the improvement in health status from an intervention which will return a group to normal health and to estimate the effectiveness of an intervention: the extent to which it succeeds in returning patients to normal health. In Australia, norms have been produced for the SF-36 version 1 and 2 (ABS 1995, Hawthorne, Osborne et al. 2007), the K10 (Slade, Johnston et al. 2009), the WHOQoL-Brèf (Hawthorne, Herrman et al. 2006), the Personal Wellbeing Index (Cummins, Knapp et al. 2005). Australian norms for MAU instruments have been published for the SF-6D (Norman, Church et al. 2013) and for the AQoL-4D (Hawthorne, Osborne et al. 2007, Hawthorne, Korn et al. 2013).

The majority of HRQoL instruments focus upon a narrow range of health states associated with a particular problem (Bowling 2005, McDowell 2006). However a subset seeks to measure the strength of the population’s preference for the health state – the health state utility. These multi attribute utility (MAU) instruments are used, in conjunction with epidemiological and clinical studies to conduct economic evaluations. The utility instruments are generally employed to calculate quality adjusted life years (QALYs) which are the unit of benefit in cost utility analyses (CUA). The main MAU instruments, which are described in Brazier et al. (2007) and Richardson et al. (2014) consist of a descriptive system (or classification) – a set of health related questions and response categories – and a corresponding set of utility weights which converts responses to a numerical score on a scale where 0.00 represents death and 1.00 represents the utility of the best health state described by the descriptive system. Seven instruments dominate the field; the EQ-5D (EuroQol Group 1990, Dolan, Gudex et al. 1995), HUI 3 (Feeny, Furlong et al. 2002), SF-

6D (Brazier, Roberts et al. 2002, Brazier, Roberts et al. 2004). 15D (Sintonen and Pekurinen 1989), HUI 2 (Torrance, Feeny et al. 1996), AQoL-4D (Hawthorne, Richardson et al. 1999) and QWB (Kaplan, Bush et al. 1976).

The AQoL instruments were created to increase the range of options available to researchers and to increase sensitivity to particular dimensions of health. Like the SF-6D, the AQoL-4D includes items describing both physical and psycho-social health but it increases the depth of the description. AQoL-6D extends the instrument to include coping and greater sensitivity to relatively good health states. AQoL-7D and AQoL-8D add dimensions to the AQoL-6D to increase sensitivity to particular health states. AQoL-7D adds a specialised dimension for vision (VisQoL) (Misajon, Hawthorne et al. 2005) and AQoL-8D adds two additional dimensions relating to psycho-social dimensions of health (Richardson, Iezzi et al. 2012). Like other instruments, each of the AQoL instruments has a feature which makes direct comparison problematical. In particular, as described in Section 2, related but differing methods were adopted to derive the final utility formula.

Population norms were published for AQoL-4D in 2005 using results from the South Australian Omnibus Survey (Hawthorne and Osborne 2005) and revised in 2013 using data from the 2007 National Survey of Mental Health and Wellbeing (NSMHWB) (ABS 2013, Hawthorne, Korn et al. 2013). These norms, which are used in the analyses below, are reproduced in Table 1 and contrasted with the Australian norms for the SF-6D (Norman, Church et al. 2013). The AQoL-4D norms are very similar as the same instrument and the same scoring formula were employed. The differences are attributable to small sampling effects and variation in the preferences of the respondents to the surveys used for the two studies. By contrast SF-6D norms differ by amounts which cannot be explained in these terms and are attributable to the content and scoring of the instruments.

Table 1 Population norms

Instrument	Age					
	16-19 [4]	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**
AQoL-4D[1]	0.87	0.87	0.85	0.85	0.80	0.79
AQoL-4D[2]	0.87	0.86	0.84	0.81	0.80	0.80
SF-6D[3]	-	0.79	0.79	0.77	0.75	0.74

[1] Hawthorne and Osborne (2005)
[2] Hawthorne, Korn, et al. (2013)
[3] Norman, Church et al. (2013)
[4] The age range for the 1998 AQoL-4D norm was 15-19

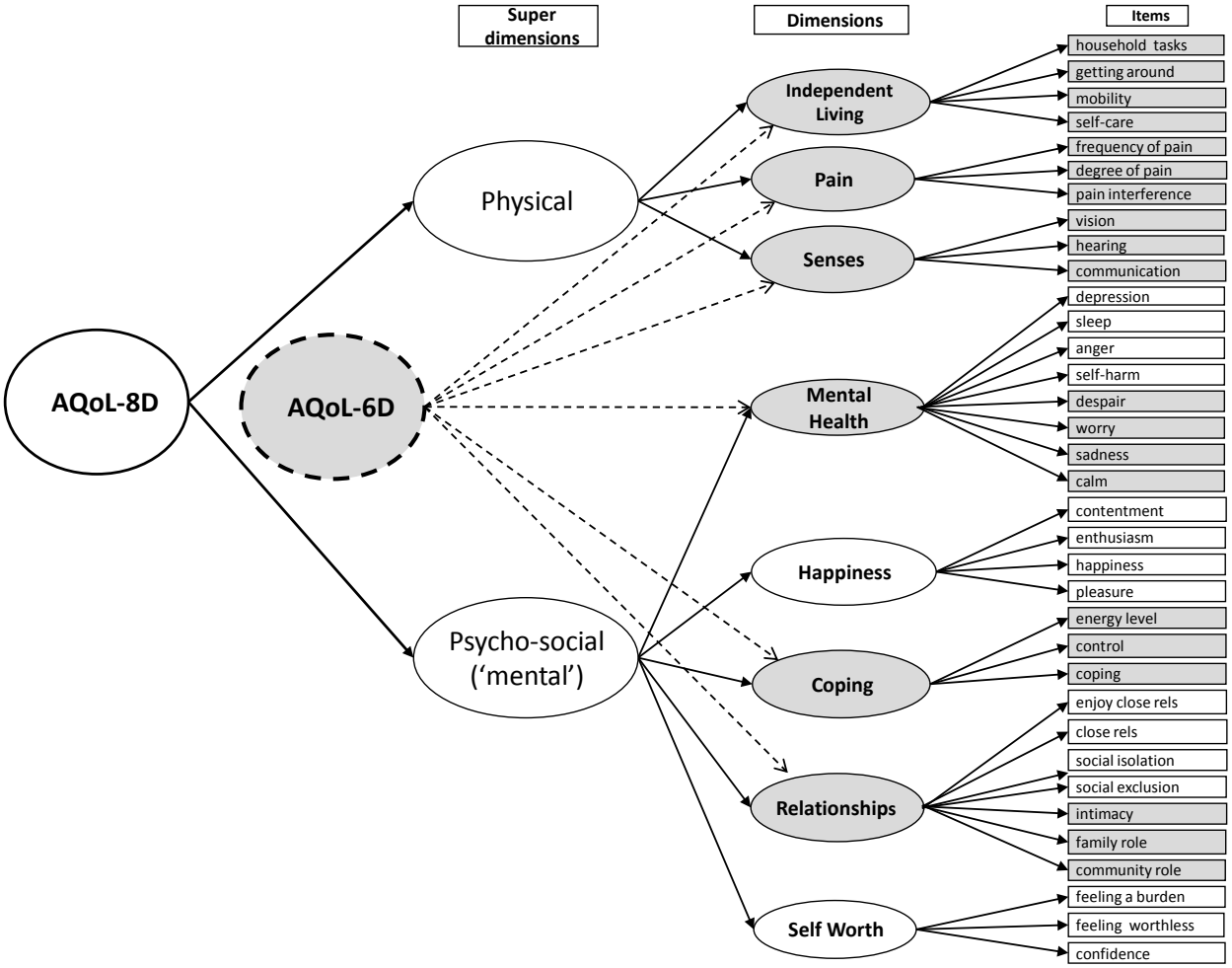
Ideally, norms are estimated from the results of a large national or area bases survey with sufficient resources to achieve response rates which give confidence in the representativeness of the results. AQoL-4D norms were based upon such surveys. No such survey has included the AQoL-6D or AQoL-8D. Nevertheless for the reasons given above it is desirable to have population norms for these instruments. The present paper outlines a method for obtaining these based upon the adjustment of imperfect data. The method, described in Section 2 below, 'piggy backs' upon the norms obtained from the two AQoL-4D studies (Hawthorne and Osborne 2005, Hawthorne, Korn et al. 2013). These are used to adjust independently collected AQoL-6D and AQoL-8D data. The results, presented in Section 3 provide an unbiased estimate of mean utilities by population cohort but biased estimates of the standard errors. For this reason results are described as 'interim norms'.

2 Methods

All of the AQoL instruments, their scoring algorithms and transformations between them can be obtained from the AQoL website (http://www.aqol.com.au). Construction of the descriptive systems and utility algorithms for the AQoL-6D are described in Richardson et al. (2004, 2012) and for the AQoL-8D in Richardson et al. (2011). Both instruments were derived using a similar two-stage methodology. In the first stage, an item bank was constructed which included items from the AQoL-4D and supplementary items from re-review of the literature and from focus groups of individuals with insight into the additional elements to be included in each instrument. The descriptive system for each instrument was constructed using a combination of restrictive and unrestrictive factor analyses as recommended by McDonald (2005). In Stage 2, utility scores were modelled using results of a second survey of a stratified sample of the population using the time trade-off (TTO) technique to elicit utility scores. A two part modelling methodology was employed. First, the multiplicative model recommended by Decision Analytic Theory (Von Winterfeldt and Edwards 1986) combined item scores. Secondly an econometric 'correction' was carried out to eliminate possible double counting of disutility arising from the non-orthogonality of dimensions. A similar correction was applied to each of the dimension scores in the AQoL-8D.

The resulting models are shown in Figure 1. AQoL-6D is subsumed by AQoL-8D and is shown as the shaded items and dimensions. AQoL-8D consists of five psycho-social and three physical dimensions. With one exception each of these represents a psychometrically valid subscale, ie tests indicate they measure a common construct. The exception is the dimension for senses where the three constituent items – vision, hearing and communication – do not reflect a common construct. It was retained in the instrument because of the importance of these items for the quality of life. Six of the eight dimensions of AQoL-8D occur in AQoL-6D including the three physical and three of the psycho-social dimensions. The three physical dimensions are related to a single construct (the 'physical super-dimension') and the five psycho-social dimensions to a single construct (the 'mental super-dimension').

Figure 1 AQoL-8D and AQoL-6D instruments*



*AQoL-6D is shown as the shaded items and dimensions. It does not map into psychometrically valid 'super-dimensions' shown for AQoL-8D

Data

No representative national survey has included the AQoL-6D or AQoL-8D. Consequently data from three recent projects were combined into a 'research sample'. (Richardson, Iezzi et al. 2009, Richardson, Chen et al. 2011, Richardson, Maxwell et al. 2012). Each survey included demographic questions, the AQoL-4D, AQoL-6D and AQoL-8D instruments and were administered by mail or by online questionnaire to members of the public, aged over 18 years in postcodes which were representative of the Australian SES profile. An initial adjustment was made to each of the 12 (6 x 2) population cohorts in the analyses in order to obtain the same mean score for the AQoL-4D as reported in Hawthorne and Osborne (2005). The editing procedures to eliminate frivolous or ill-considered responses are described in project reports (Richardson, Iezzi et al. 2009, Richardson, Chen et al. 2011). They were based upon the inclusion of repeated questions and the removal of respondents providing inconsistent answers. To offset the effects of unrepresentative sampling, the research sample was adjusted to replicate the results from the surveys used to construct the AQoL-4D norms.

The cohort specific AQoL-4D frequency distributions in the project database displayed the typical left hand skew of utility scores. To the left of the cohort mean the distribution was approximately normal; to the right it was non-normal because of the truncation of values at U = 1.00. On the assumption that this asymmetry also occurred in an unbiased sample different procedures were adopted above and below the cohort mean obtained from the HO norms study. Below each cohort mean it was assumed that the distribution was normal. This allowed the use of the Z statistics from a normal distribution in combination with the standard deviation reported by HO to predict the AQoL-4D utility cut-off scores which would divide a representative population into deciles. The actual numbers in the 'research sample' between the cut-off scores were compared with the predicted numbers in a representative decile and individuals were randomly selected and removed from the sample until the actual and predicted numbers were equal. Above each cohort mean the (smaller) distance from the mean to full health (1.00 - mean) was divided into 5 intervals and the midpoint, U_i and the frequency, fi, of actual observations was obtained. For simplicity, it was assumed that the contribution of each individual, within one of the five intervals, to the cohort mean could be approximated by the midpoint utility U_i Consequently, the contribution to total utility of all individuals above the mean would be: $C = \sum_{i-1}^{5} f_i U_i$. An equation was then solved to determine the factor, N, by which this amount, C, would have to be increased so that, in combination with the population below the cohort mean, the average cohort AQoL-4D utility would be equal to the average cohort utility in the HO study. Within each interval, observations were duplicated at random until the sample size had increased by the factor, N.

Details of the cohort specific adjustments and the weights implied by the process are given elsewhere (Richardson, Khan et al. 2012). The resulting database of 1,568 cases generated identical mean AQoL-4D values in each demographic cohort as those as obtained from the SA Omnibus Survey (Table 1, column 1). As reported earlier, subsequent norms published by Hawthorne et al. (2013) upgraded these results using data from the 2007 NSMHWB (Table 1 column 2). Revised mean values were within 1 percent of the earlier mean values in 10 of the 18 population cohorts, with an overall discrepancy of 2 percent. To allow for the change, further additions and deletions were made to the sample. As the numbers involved were small this adjustment was carried out manually until the mean AQoL-4D score in each cell was identical to the result from the NSMHWB survey.

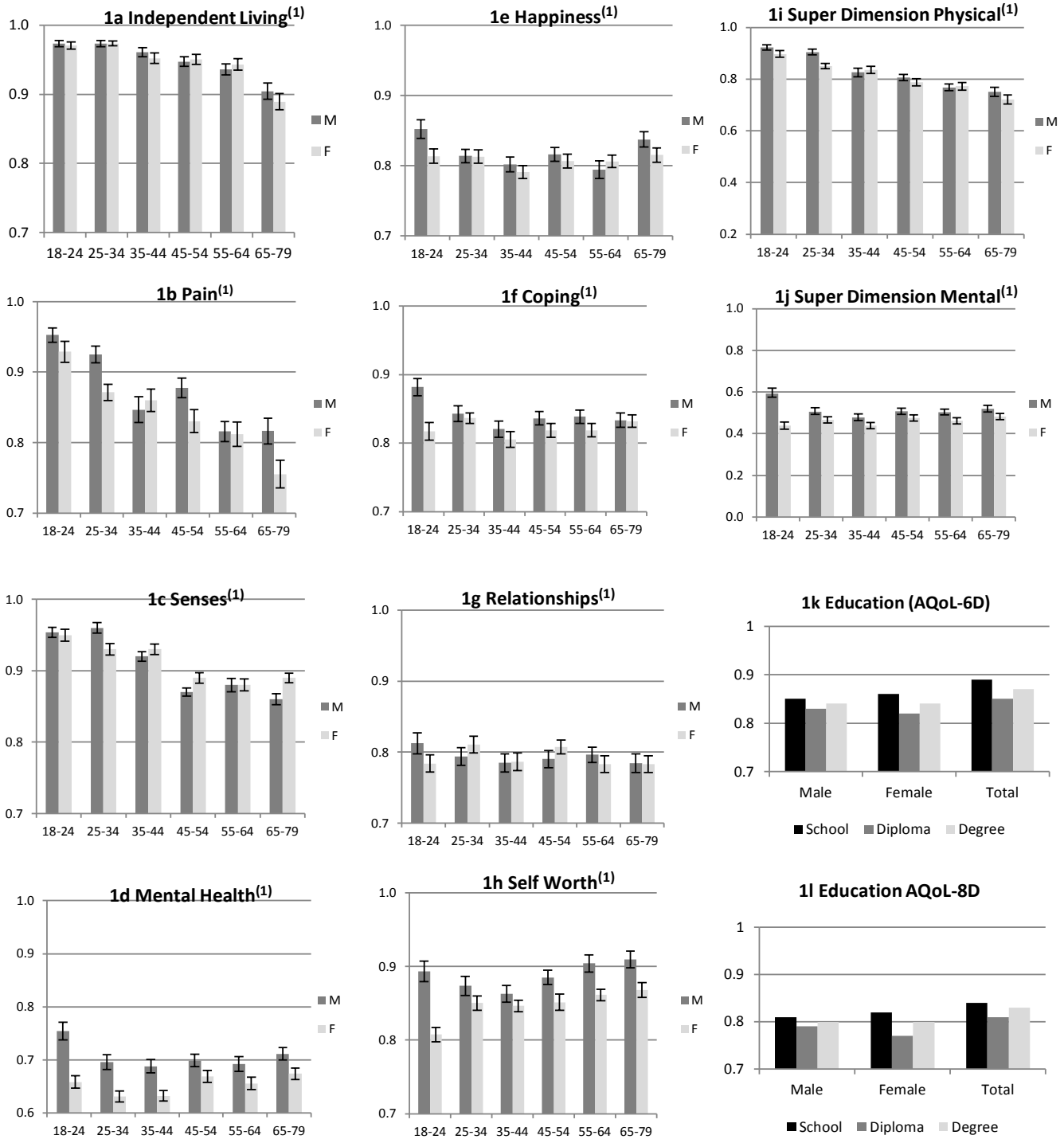
In subsequent analysis independent t tests for two groups were used to identify significant differences in cohort scores. Data were analysed using excel and STATA.

3 Results

Dimensions: Population norms for the dimensions of the AQoL-6D and AQoL-8D are shown in Figure 2 and reported in full as supplementary material. Dimension scores are obtained from unweighted item responses. The number of items per dimension and the number of response categories per item vary. Consequently, each dimension scale is unique and scores from different dimensions cannot be compared. For the four dimensions with identical items – independent living, pain, senses and coping – scores from the two instruments are very similar. Scores for independent living and coping are essentially identical. The two common dimensions with additional items in the AQoL-8D changed more substantially. With Mental Health, scores for men differed by up to 0.04. The maximum difference for women was 0.03. Scores on the AQoL-6D relationship scale were between 0.1 and 0.18 higher than on the AQoL-8D scale, reflecting the

larger number of AQoL-8D items from which disutility could be identified. Despite these differences, the two sets of dimension scores are very similar and comments below relate specifically to the AQoL-8D dimensions.

Figure 2 AQoL-8D dimensions by age, gender; AQoL-6D, 8D by educational status



*Numerical values are given in supplementary material

(1) Bars represent 95% confidence intervals

The three physical dimension scores decline significantly with age. Independent living and pain scores decline monotonically for both men and women, with the only exception being a rise in the score for pain for men after the age range 45-54. There are no significant differences in independent living between men and women, but men recorded less pain except in the age range 35-44. Scores on the senses scale are significantly greater for women in the age cohorts 45-54 and 65-79. They are insignificantly different in other age cohorts. Consistent with the pattern of these three dimensions, the physical super-dimension declines monotonically with age for both men and women. There is little difference by gender with a significantly greater score for males only in the age range 25-34.

The pattern for the psycho-social dimensions is more complex. Reflecting the greater score on every psycho-social dimension, young males have the highest mental super-dimension score by a numerically large and statistically significant margin. In contrast, women aged 18-24 have the lowest score in this age range, equalled only by the cohort aged 35-44. For young women this is attributable to the score for self-worth which is lower than at any other age.. For women between the ages of 35-44 the low score is attributable to coping, happiness and mental health all of which attain their lowest scores in this age range.

The mental super-dimension score for men declines by a marginally significant amount in the retirement age range 55-64. This is associated with a statistically significant decline in happiness. In other years, scores on all scales for both men and women are relatively stable and, in contrast with the physical dimensions, there is no age related decline. In the oldest age cohort, mental health, happiness and self-worth scores are higher for both men and women than for the 25-34 age cohort, and there is little difference in the scores for coping and relationships. In sum, deviation from stable psycho-social health is cohort specific, not directly age related. It is high for young men, low for young women, and for women in the 35-44 age cohort.

AQoL-6D, 8D: Table 2 reports the population norms constructed from the dimensions. Unlike the dimension 'values' which have no intrinsic meaning, the numbers in Table 2 represent utilities: they are a cardinal representation of the strength of preferences as initially measured by the time trade-off technique. Utilities predicted by the AQoL-8D are between 0.03 and 0.05 lower than utilities from the AQoL-6D for every cohort. This is consistent with the difference between the instruments' descriptive systems. The 'all best' AQoL-8D health state represents significantly better health. As compared with the AQoL-6D 'all best' health state, individuals in the AQoL-8D all best health state must achieve best health on an additional 15 items.

With both instruments utilities for men are between 0.02 and 0.03 higher than for women except for men in the youngest age cohort where scores are 0.05 and 0.06 higher on the AQoL-6D and AQoL-8D respectively. This is consistent with the higher dimension scores for young men. Using the AQoL-6D, utilities for both men and women decline monotonically with age. With the AQoL-8D a monotonic decline is broken by the scores in the 35-44 age cohort for both men and women. The marginally significant decrements from the previous cohort scores are likely to reflect underlying health and not a statistical artefact. The age cohort 35-44 is associated with poorer psycho-social health for both men and women. AQoL-6D's failure to register the effect is attributable to its omission of two of the main psycho-social dimensions contributing to the lower utility, namely, coping and happiness.

Table 2 Population norms by age and gender (n=1568)

Age group	Gender	N	AQoL-8D (Utilities)						AQoL-6D (Utilities)					
			Mean	SD	se	Median	95% CI		Mean	SD	se	Median	95% CI	
18-24	M	96	**0.87**	0.15	0.013	0.92	0.84	0.91	**0.91**	0.13	0.013	0.97	0.89	0.94
	F	87	**0.81**	0.11	0.009	0.81	0.78	0.83	**0.86**	0.11	0.012	0.89	0.84	0.89
	Total	183	**0.84**	0.13	0.009	0.87	0.82	0.86	**0.89**	0.12	0.009	0.93	0.87	0.91
25-34	M	123	**0.84**	0.15	0.013	0.90	0.81	0.87	**0.88**	0.13	0.012	0.94	0.86	0.90
	F	162	**0.81**	0.15	0.013	0.84	0.79	0.83	**0.84**	0.11	0.009	0.85	0.82	0.86
	Total	285	**0.82**	0.15	0.009	0.86	0.81	0.84	**0.86**	0.12	0.007	0.89	0.84	0.87
35-44	M	112	**0.81**	0.16	0.013	0.87	0.78	0.84	**0.86**	0.14	0.014	0.91	0.83	0.88
	F	114	**0.79**	0.15	0.013	0.83	0.76	0.82	**0.83**	0.13	0.012	0.85	0.80	0.85
	Total	226	**0.80**	0.15	0.009	0.85	0.78	0.82	**0.84**	0.14	0.009	0.88	0.82	0.86
45-54	M	152	**0.82**	0.16	0.013	0.84	0.79	0.84	**0.86**	0.14	0.011	0.92	0.84	0.89
	F	154	**0.80**	0.15	0.013	0.83	0.77	0.82	**0.83**	0.13	0.011	0.86	0.81	0.85
	Total	306	**0.81**	0.15	0.009	0.83	0.79	0.82	**0.85**	0.14	0.008	0.89	0.83	0.86
55-64	M	178	**0.81**	0.16	0.013	0.87	0.79	0.83	**0.85**	0.15	0.011	0.89	0.83	0.87
	F	136	**0.79**	0.16	0.016	0.84	0.76	0.81	**0.83**	0.14	0.012	0.88	0.81	0.85
	Total	314	**0.80**	0.16	0.009	0.85	0.78	0.82	**0.84**	0.14	0.008	0.88	0.83	0.86
65-79	M	110	**0.82**	0.14	0.013	0.85	0.79	0.84	**0.86**	0.11	0.011	0.87	0.84	0.88
	F	144	**0.78**	0.15	0.013	0.80	0.76	0.81	**0.83**	0.13	0.011	0.84	0.80	0.85
	Total	254	**0.80**	0.15	0.009	0.83	0.78	0.81	**0.84**	0.13	0.008	0.86	0.82	0.85
Total 18-79	M	771	**0.83**	0.15	0.005	0.87	0.82	0.84	**0.87**	0.14	0.005	0.91	0.86	0.88
	F	797	**0.79**	0.15	0.005	0.83	0.79	0.81	**0.84**	0.13	0.004	0.86	0.83	0.84
	Total	1568	**0.81**	0.15	0.003	0.85	0.8	0.82	**0.85**	0.13	0.008	0.89	0.84	0.86

Results by educational status are reported in Figure 2 for AQoL-6D and AQoL-8D. Full norms including dimension norms are reported in supplementary material. With both instruments the overall result is consistent with previous findings; viz, that utility is higher amongst the more educated and that the education related differences are greater for men than women. The gender difference is apparent in both physical and psycho-social health. The super-dimension scores for university qualified women are 2.5 and 2.1 percent higher than for women with school qualifications, in contrast with the 6.3 and 7.5 percent advantage for university qualified men. The pattern of dimension scores for men and women is markedly different. University educated men obtain significantly higher scores on every scale with the exception of independent living and self-worth. In contrast, university educated women have significantly higher scores only for coping, relationships and self-worth. Amongst women, the lowest psycho-social health occurs amongst those with diploma qualifications and not amongst the least educated. The mental super-dimension score of 0.44 for diploma qualified women is the lowest of any cohort and 8.3 and 17.0 percent below the scores achieved by university qualified women and men respectively. The outcome is attributable to three dimensions; coping, relationships and happiness where they obtain the lowest score of any cohort.

4 Discussion

The existence of multiple instruments raises the question of which to use and, for that matter, why multiple AQoL instruments have been created. The questions are not restricted to the AQoL instruments but apply to MAU instruments in general. With respect to the second question, different instruments have been created to meet perceived shortcomings with previous instruments. The EQ-5D was created as no instrument at the time appeared suitable for use in all European countries. The SF-6D was created since, like the larger SF-36 from which it was derived, it contained psycho-social items absent from the EQ-5D. The rationale for each of the AQoL instruments was discussed in the introduction.

At present, there is no simple answer to the first question relating to the choice of instrument. Use of a single instrument ensures discrimination against services which affect dimensions of health which are not well measured by the instrument. In principle, services should be evaluated by the instrument which is most sensitive to the dimensions of health affected by the service. In practice, rigorous comparative analyses have not been published with respect to the service specific sensitivity of instruments and, as a consequence, researchers have little alternative to a discretionary assessment of the likely sensitivity of alternative instruments based upon their descriptive systems.

A further constraint facing researchers is that available instruments do not all have national population norms. This is because, to date, the construction of norms has depended upon the inclusion of an instrument in a representative national survey. While no such survey has included either the AQoL-6D or AQoL-8D the present paper has demonstrated how a more limited database may be adjusted to replicate the key results from a national survey. The final database employed to generate norms in this study produced average AQoL-4D utilities which were identical in every age gender cohort to the norms obtained by Hawthorne et al. (2013) from the National Survey of Mental Health and Wellbeing. The chief assumption needed for the creation of the new norms was that respondents in the initial surveys answered AQoL-4D, AQoL-6D and AQoL-8D questions with equal accuracy. As rigorous consistency tests were carried out and inconsistent results removed from the initial database the assumption is reasonable.

As with norms obtained elsewhere the average utility predicted from both the AQoL-6D and AQoL-8D declines with age. However, as compared with results from AQoL-4D and SF-6D shown in Table 1, there are several differences. First, the reduction in utility with age is smaller with both the AQoL-6D and AQoL-8D. For both of these instruments the decrements are 0.06, and 0.03 for males and females respectively. For the AQoL-4D the decrement is 0.08 for both males and females over a very similar age range (Table 1). The difference is attributable to two factors. First, the standard deviation of AQoL-4D is greater than for the AQoL-6D or AQoL-8D. This is a reflection of the methods employed for modelling utility and, in particular, the use of a second stage adjustment with the two more recent instruments. This tended to compress utilities. Secondly, AQoL-6D and, particularly, AQoL-8D, have a significantly larger psycho-social component than AQoL-4D. As noted, while scores on the physical component of the instrument decline monotonically with age this does not occur with the psycho-social components. Thus, in instruments where the psycho-social component is larger the net age related decline will be smaller.

The age related differences in utilities are comparatively small and relatively similar as measured by all of the instruments reported here. In view of the common conclusion cited in the introduction – that instruments differ significantly – greater differences might be expected. In the Australian seven instrument comparative study, for example, the standard deviation of utility measured by

the AQoL-4D was 22, 27 and 102 percent greater than when it was measured by the AQoL-8D, AQoL-6D and SF-6D respectively (Richardson, Khan et al. 2012). In contrast with these differences, the age related differences for the four instrument norms are relatively small, varying from 0.05 to 0.08 (Table 1, 2). The contrasting magnitudes indicate that age per se has a relatively small effect upon the health related QoL of the general population and it is variation within, rather than between, age cohorts which is responsible for the greatest differences between instruments. For this reason also, population norms reveal relatively little about the overall properties of an instrument. However the purpose of norms is not, primarily, to explain variation in survey data but to provide a basis for comparison when a protocol does not include a control group.

5 Conclusion

The instruments available for measuring patient utility vary in their construction and sensitivity which forces researchers to select the most appropriate instrument for their purpose. The AQoL instruments were constructed to increase the choices available and, more specifically, to offer options with increased sensitivity to particular health states. As compared with earlier instruments AQoL-6D provides greater sensitivity close to full health and, like the SF-6D, includes a significant social component in its descriptive system. AQoL-8D has the most detailed description of psycho-social health of any instrument to date. The present paper has provided population norms for these two instruments. They differ from other norms reflecting their unique construction and content. They are, nevertheless, broadly consistent with the results found elsewhere and provide a basis for comparison for researchers using one of these instruments.

Supplementary Material

Table S.1 Dimension norms by age and gender (n=1568)

Dimension/ Age Group		AQoL-8D (scores)								AQoL-6D (scores)							
		Male				Female				Male				Female			
Dim	Age	Mean	SD	95% CI		Mean	SD	95% CI		Mean	SD	95% CI		Mean	SD	95% CI	
Independent Living	18-24	0.97	0.04	0.96	0.98	0.97	0.05	0.96	0.98	0.98	0.04	0.97	0.99	0.97	0.05	0.96	0.98
	25-34	0.97	0.05	0.96	0.98	0.97	0.04	0.96	0.98	0.98	0.07	0.97	0.99	0.98	0.04	0.97	0.99
	35-44	0.96	0.07	0.95	0.97	0.95	0.08	0.94	0.96	0.96	0.09	0.95	0.98	0.96	0.10	0.94	0.97
	45-54	0.95	0.08	0.93	0.96	0.95	0.09	0.94	0.97	0.95	0.10	0.94	0.97	0.95	0.12	0.93	0.97
	55-64	0.94	0.11	0.92	0.96	0.94	0.10	0.92	0.96	0.93	0.15	0.90	0.96	0.94	0.13	0.92	0.97
	65-79	0.90	0.12	0.88	0.93	0.89	0.14	0.86	0.92	0.90	0.15	0.87	0.93	0.87	0.20	0.84	0.91
	Total	**0.95**	**0.08**	**0.94**	**0.95**	**0.95**	**0.09**	**0.94**	**0.96**	**0.95**	**0.11**	**0.94**	**0.96**	**0.95**	**0.12**	**0.94**	**0.96**
Pain	18-24	0.95	0.10	0.93	0.97	0.93	0.14	0.90	0.96	0.95	0.11	0.93	0.94	0.92	0.17	0.89	0.95
	25-34	0.92	0.13	0.90	0.94	0.87	0.15	0.85	0.89	0.92	0.16	0.89	0.88	0.86	0.02	0.82	0.90
	35-44	0.85	0.19	0.82	0.88	0.86	0.17	0.83	0.89	0.83	0.23	0.79	0.88	0.85	0.21	0.81	0.88
	45-54	0.88	0.17	0.85	0.91	0.83	0.20	0.80	0.86	0.87	0.20	0.83	0.83	0.80	0.25	0.76	0.84
	55-64	0.82	0.19	0.78	0.85	0.81	0.20	0.77	0.85	0.79	0.24	0.75	0.83	0.79	0.25	0.74	0.84
	65-79	0.82	0.19	0.78	0.86	0.75	0.24	0.71	0.80	0.79	0.24	0.75	0.77	0.72	0.29	0.67	0.78
	Total	**0.87**	**0.18**	**0.86**	**0.88**	**0.84**	**0.17**	**0.82**	**0.85**	**0.86**	**0.21**	**0.85**	**0.88**	**0.82**	**0.24**	**0.81**	**0.84**
Senses	18-24	0.95	0.07	0.94	0.96	0.95	0.07	0.93	0.96	0.97	0.06	0.96	0.98	0.96	0.05	0.95	0.97
	25-34	0.96	0.08	0.94	0.97	0.93	0.07	0.92	0.94	0.97	0.07	0.96	0.98	0.95	0.06	0.94	0.97
	35-44	0.92	0.10	0.90	0.93	0.93	0.08	0.92	0.95	0.94	0.09	0.93	0.96	0.96	0.07	0.95	0.97
	45-54	0.87	0.10	0.85	0.89	0.89	0.10	0.87	0.90	0.90	0.10	0.89	0.92	0.91	0.10	0.90	0.93
	55-64	0.88	0.10	0.86	0.89	0.88	0.08	0.87	0.90	0.91	0.10	0.89	0.92	0.91	0.09	0.90	0.93
	65-79	0.86	0.11	0.84	0.87	0.89	0.08	0.88	0.91	0.91	0.08	0.89	0.92	0.93	0.07	0.91	0.94
	Total	**0.91**	**0.10**	**0.90**	**0.92**	**0.91**	**0.09**	**0.90**	**0.92**	**0.93**	**0.09**	**0.93**	**0.94**	**0.94**	**0.08**	**0.93**	**0.94**
Mental Health	18-24	0.75	0.16	0.72	0.78	0.66	0.13	0.63	0.69	0.79	0.21	0.75	0.83	0.66	0.21	0.62	0.70
	25-34	0.70	0.14	0.67	0.72	0.63	0.15	0.60	0.65	0.70	0.22	0.67	0.73	0.60	0.23	0.56	0.64
	35-44	0.69	0.15	0.66	0.71	0.63	0.12	0.61	0.65	0.71	0.20	0.67	0.74	0.60	0.22	0.56	0.63
	45-54	0.70	0.14	0.68	0.72	0.67	0.13	0.65	0.69	0.73	0.20	0.70	0.76	0.66	0.20	0.63	0.70
	55-64	0.69	0.13	0.67	0.72	0.66	0.13	0.63	0.68	0.71	0.22	0.67	0.75	0.65	0.23	0.61	0.70
	65-79	0.71	0.13	0.68	0.73	0.67	0.13	0.65	0.70	0.75	0.17	0.72	0.78	0.67	0.21	0.64	0.71
	Total	**0.70**	**0.14**	**0.69**	**0.71**	**0.65**	**0.14**	**0.64**	**0.66**	**0.73**	**0.21**	**0.71**	**0.74**	**0.64**	**0.22**	**0.62**	**0.65**
Happiness	18-24	0.84	0.13	0.81	0.86	0.83	0.12	0.81	0.84								
	25-34	0.81	0.12	0.79	0.83	0.82	0.11	0.80	0.84								
	35-44	0.80	0.13	0.78	0.82	0.79	0.12	0.77	0.81								
	45-54	0.82	0.13	0.80	0.84	0.81	0.12	0.79	0.83								
	55-64	0.79	0.12	0.77	0.82	0.81	0.11	0.78	0.83								
	65-79	0.83	0.10	0.81	0.85	0.82	0.12	0.79	0.84								
	Total	**0.82**	**0.12**	**0.81**	**0.83**	**0.81**	**0.12**	**0.80**	**0.82**								
Coping	18-24	0.88	0.12	0.85	0.90	0.82	0.12	0.80	0.84	0.87	0.18	0.84	0.90	0.80	0.18	0.76	0.83
	25-34	0.84	0.13	0.82	0.86	0.84	0.12	0.82	0.86	0.82	0.21	0.79	0.86	0.82	0.16	0.79	0.85
	35-44	0.82	0.13	0.80	0.84	0.81	0.12	0.79	0.83	0.81	0.19	0.78	0.84	0.79	0.19	0.76	0.82
	45-54	0.84	0.12	0.82	0.86	0.82	0.13	0.80	0.84	0.83	0.18	0.80	0.86	0.80	0.19	0.77	0.83
	55-64	0.84	0.13	0.82	0.86	0.82	0.11	0.80	0.84	0.84	0.18	0.80	0.87	0.81	0.17	0.78	0.84
	65-79	0.83	0.11	0.81	0.85	0.83	0.11	0.81	0.85	0.84	0.15	0.81	0.87	0.83	0.16	0.80	0.86
	Total	**0.84**	**0.13**	**0.83**	**0.85**	**0.82**	**0.12**	**0.81**	**0.83**	**0.83**	**0.19**	**0.82**	**0.85**	**0.81**	**0.18**	**0.80**	**0.82**

Dimension/ Age Group		AQoL-8D (scores)							
		Male				Female			
Dim	Age	Mean	SD	95% CI		Mean	SD	95% CI	
		AQoL-8D							
		Male				Female			
Dim	Age	Mean	SD	95% CI		Mean	SD	95% CI	
Relationships	18-24	0.81	0.15	0.78	0.83	0.78	0.11	0.76	0.80
	25-34	0.79	0.14	0.77	0.81	0.81	0.15	0.78	0.83
	35-44	0.78	0.14	0.76	0.81	0.79	0.13	0.76	0.81
	45-54	0.79	0.15	0.77	0.81	0.81	0.12	0.79	0.83
	55-64	0.80	0.14	0.77	0.82	0.78	0.14	0.76	0.81
	65-79	0.78	0.14	0.76	0.81	0.78	0.14	0.76	0.81
	Total	**0.79**	**0.14**	**0.78**	**0.80**	**0.79**	**0.13**	**0.78**	**0.80**
		AQoL-8D							
		Male				Female			
Dim	Age	Mean	SD	95% CI		Mean	SD	95% CI	
Self Worth	18-24	0.89	0.13	0.86	0.92	0.81	0.12	0.79	0.83
	25-34	0.87	0.12	0.85	0.89	0.85	0.12	0.83	0.87
	35-44	0.86	0.12	0.84	0.88	0.85	0.12	0.83	0.87
	45-54	0.88	0.12	0.87	0.90	0.85	0.12	0.83	0.87
	55-64	0.90	0.11	0.89	0.92	0.86	0.13	0.84	0.89
	65-79	0.90	0.09	0.89	0.92	0.87	0.12	0.85	0.89
	Total	**0.89**	**0.12**	**0.88**	**0.90**	**0.85**	**0.12**	**0.84**	**0.86**
Mental Super Dimension	18-24	0.59	0.25	0.54	0.64	0.44	0.16	0.41	0.47
	25-34	0.51	0.19	0.48	0.54	0.47	0.18	0.44	0.50
	35-44	0.48	0.17	0.45	0.51	0.44	0.16	0.41	0.47
	45-54	0.51	0.20	0.47	0.54	0.48	0.19	0.45	0.51
	55-64	0.50	0.18	0.47	0.54	0.46	0.17	0.43	0.49
	65-79	0.51	0.19	0.48	0.55	0.48	0.19	0.45	0.52
	Total	**0.51**	**0.20**	**0.50**	**0.52**	**0.46**	**0.18**	**0.45**	**0.47**
Physical Super Dimension	18-24	0.92	0.10	0.90	0.94	0.90	0.12	0.87	0.92
	25-34	0.90	0.12	0.88	0.92	0.85	0.13	0.83	0.87
	35-44	0.83	0.18	0.80	0.85	0.84	0.15	0.81	0.86
	45-54	0.81	0.15	0.78	0.83	0.79	0.17	0.76	0.82
	55-64	0.77	0.17	0.74	0.80	0.77	0.17	0.74	0.81
	65-79	0.75	0.18	0.71	0.78	0.72	0.21	0.68	0.76
	Total	**0.83**	**0.17**	**0.82**	**0.84**	**0.81**	**0.17**	**0.79**	**0.82**

AQoL-6D (scores)							
Male				Female			
Mean	SD	95% CI		Mean	SD	95% CI	
AQoL-6D							
Male				Female			
Mean	SD	95% CI		Mean	SD	95% CI	
0.92	0.15	0.89	0.99	0.96	0.09	0.94	0.97
0.93	0.11	0.92	0.95	0.93	0.14	0.90	0.95
0.93	0.13	0.91	0.93	0.91	0.15	0.88	0.93
0.92	0.15	0.90	0.94	0.91	0.16	0.89	0.94
0.90	0.16	0.87	0.93	0.90	0.16	0.87	0.93
0.90	0.14	0.87	0.89	0.87	0.18	0.83	0.90
0.92	**0.14**	**0.91**	**0.93**	**0.91**	**0.15**	**0.90**	**0.92**

Table S.2 Utilities and dimension scores by educational attainment (n=1568)

Scale		Male School n=264 Diploma n=195 Degree n=312		Female School n=227 Diploma n=220 Degree n=350		Total School n=491 Diploma n=415 Degree n=662	
		mean	se	mean	se	mean	se
AQoL-6D	School	0.85	0.028	0.83	0.028	0.84	0.019
	Diploma	0.86	0.032	0.82	0.025	0.84	0.022
	Degree	0.89	0.022	0.85	0.019	0.87	0.016
AQoL-8D	School	0.81	0.032	0.79	0.032	0.80	0.022
	Diploma	0.82	0.035	0.77	0.031	0.80	0.025
	Degree	0.84	0.024	0.81	0.023	0.83	0.016
Independent Living	School	0.95	0.016	0.94	0.019	0.94	0.013
	Diploma	0.94	0.022	0.94	0.016	0.94	0.016
	Degree	0.95	0.016	0.95	0.016	0.95	0.013
Pain	School	0.84	0.035	0.83	0.041	0.84	0.025
	Diploma	0.85	0.044	0.83	0.041	0.84	0.032
	Degree	0.90	0.028	0.84	0.032	0.87	0.022
Senses	School	0.89	0.019	0.91	0.019	0.90	0.013
	Diploma	0.90	0.022	0.90	0.016	0.90	0.013
	Degree	0.91	0.016	0.92	0.016	0.91	0.013
Mental Health	School	0.69	0.028	0.66	0.028	0.67	0.019
	Diploma	0.70	0.032	0.65	0.028	0.67	0.022
	Degree	0.72	0.022	0.65	0.022	0.69	0.016
Happiness	School	0.80	0.025	0.82	0.025	0.81	0.019
	Diploma	0.82	0.032	0.79	0.025	0.80	0.019
	Degree	0.82	0.019	0.81	0.019	0.82	0.013
Coping	School	0.82	0.028	0.81	0.028	0.82	0.019
	Diploma	0.84	0.028	0.80	0.025	0.82	0.019
	Degree	0.85	0.019	0.84	0.016	0.85	0.013
Relationships	School	0.78	0.028	0.79	0.028	0.79	0.019
	Diploma	0.80	0.032	0.77	0.028	0.78	0.022
	Degree	0.80	0.025	0.81	0.022	0.81	0.016
Self-Worth	School	0.89	0.025	0.83	0.028	0.86	0.019
	Diploma	0.89	0.025	0.84	0.025	0.86	0.019
	Degree	0.89	0.019	0.87	0.019	0.88	0.013
Physical Super Dimension	School	0.80	0.032	0.80	0.032	0.80	0.025
	Diploma	0.81	0.032	0.80	0.032	0.80	0.028
	Degree	0.85	0.028	0.82	0.028	0.83	0.019
Mental Super Dimension	School	0.49	0.012	0.46	0.013	0.48	0.009
	Diploma	0.52	0.015	0.44	0.012	0.48	0.010
	Degree	0.53	0.010	0.48	0.009	0.50	0.007

References

ABS (1995). Austalian Bureau of Statistics, National Health Survey SF-36 Population Norms Australia ABS Catalogue No. 4399. Canberra, http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4399.01995?OpenDocument [Accessed 19 April 2012].

ABS (2013). Australian Demographic Statistics, Population by Age and Sex, Cat 3201.0. Canberra, Australian Bureau of Statistics http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3201.0Jun%202010?OpenDocument [accessed 12 August 2013].

Bowling, A. (2005). Measuring Health: A Review of Quality of Life Measurement Scales. Maidenhead, Berkshire, Open University Press.

Brazier, J., J. Ratcliffe, J. Salomon and A. Tsuchiya (2007). Measuring and Valuing Health Benefits for Economic Evaluation. Oxford, Oxford University Press.

Brazier, J., J. Roberts and M. Deverill (2002). "The estimation of a preference-based measure of health from the SF-36." Journal of Health Economics **21**: 271-292.

Brazier, J., J. Roberts, A. Tsuchiya and J. Busschbach (2004). "A comparison of the EQ-5D and Sf-6D across seven patient groups." Health Economics **13**: 873-884.

Cummins, R. A., T. M. Knapp, J. Woerner, J. Walter and K. Page (2005). The Personal Wellbeing of Australians Living within Federal Electoral Divsions, Report No: 13.1. Melbourne, Deakin University.

Dolan, P., C. Gudex, P. Kind and A. Williams (1995). A social tariff for EuroQoL: Results from a UK general population survey, Discussion Paper No 138. York, Centre for Health Economics, University of York.

EuroQol Group (1990). "EuroQol - a new facility for the measurement of health-related quality of life." *Health Policy* **16**: 199-208.

Feeny, D., W. Furlong, G. Torrance, C. Goldsmith, Z. Zhu, S. DePauw, M. Denton and M. Boyle (2002). "Multi attribute and single attribute utility functions for the Health Utilities Index Mark 3 System." Medical Care **40**(2): 113-128.

Hawthorne, G., H. Herrman and B. Murphy (2006). "Interpreting the WHOQoL-Brèf: Preliminary population norms and effect size." Social Indicators Research **77**: 37-59.

Hawthorne, G., S. Korn and J. Richardson (2013). "Population norms for the AQoL derived from the 2007 Australian National Survey of Mental Health and Wellbeing." Australian and New Zealand Journal of Public Health **37**(1): 17-23.

Hawthorne, G. and R. Osborne (2005). "Population norms and meaningful differences for the Assessment of Quality of Life (AQoL) measure." Australian and New Zealand Journal of Public Health **29**(2): 136-142.

Hawthorne, G., R. Osborne, J. Sansoni and A. Taylor (2007). "The SF-36 Version 2: critical analysis of population weights, scoring algorithms and population norms." Quality of Life Research **16**(4): 661-673.

Hawthorne, G., J. Richardson and R. Osborne (1999). "The Assessment of Quality of Life (AQoL) instrument: A psychometric measure of health related quality of life." Quality of Life Research **8**: 209-224.

Kaplan, R., J. Bush and C. Berry (1976). "Health status: Types of validity and the index of wellbeing." Health Services Research **11**(4): 478-507.

McDonald, R. P. (2005). "Semiconfirmatory Factor Analysis: The Example of Anxiety and Depression." Structural Equation Modeling: A Multidisciplinary Journal **12**(1): 163-172.

McDowell, I. (2006). Measuring Health: A Guide to Rating Scales and Questionnaires. Oxford, Oxford University Press.

Misajon, R., G. Hawthorne, J. Richardson, J. Barton, S. Peacock, A. Iezzi and J. Keeffe (2005). "Vision and quality of life: The development of a utility measure." Investigative Ophthalmology & Visual Science **46**(11): 4007-4015.

Norman, R., J. Church, B. van den Berg and S. Goodall (2013). "Australian health-related quality of life population norms derived from the SF-6D." Aust N Z J Public Health **37**(1): 17-23.

Richardson, J., G. Chen, A. Iezzi and M. Khan (2011). Transformations between the Assessment of Quality of Life (AQoL) Instruments, Research Paper 66. Melbourne, Centre for Health Economics, Monash University.

Richardson, J., N. A. Day, S. Peacock and A. Iezzi (2004). "Measurement of the quality of life for economic evaluation and the Assessment of Quality of Life (AQoL) Mark 2 Instrument." Australian Economic Review **37**(1): 62-88.

Richardson, J., G. Elsworth, A. Iezzi, M. A. Khan, C. Mihalopoulos, I. Schweitzer and H. Herrman (2011). Increasing the Sensitivity of the AQoL Inventory for Evaluation of Interventions Affecting Mental Health, Research Paper 61. Melbourne, Centre for Health Economics, Monash University.

Richardson, J., A. Iezzi, M. A. Khan, K. Sinha, C. Mihalopoulos, H. Herrman, G. Hawthorne and I. Schweitzer (2009). Data used in the development of the AQoL-8D (PsyQoL) Quality of Life Instrument, Research Paper 40. Melbourne, Centre for Health Economics, Monash University.

Richardson, J., A. Iezzi, S. Peacock, K. Sinha, R. Misajon and J. Keeffe (2012). "Utility weights for the Vision Related Assessment of Quality of Life (AQoL) 7D instrument." Ophthalmic Epidemiology **19**(3): 172-182.

Richardson, J., M. A. Khan, G. Chen, A. Iezzi and A. Maxwell (2012). Population norms and Australian profile using the Assessment of Quality of Life (AQoL) 8D utility instrument, Research Paper 72. Melbourne, Centre for Health Economics, Monash University.

Richardson, J., M. A. Khan, A. Iezzi and A. Maxwell (2012). Cross-national comparison of twelve quality of life instruments, MIC Paper 2: Australia, Research Paper 78. Melbourne, Centre for Health Economics, Monash University http://www.buseco.monash.edu.au/centres/che/pubs/researchpaper78.pdf [Accessed 3 September 2013].

Richardson, J., A. Maxwell and M. A. Khan (2012). Health System Related Values: Survey Results and Using the Conflict Scale, Research Paper 75. Melbourne, Centre for Health Economics, Monash University.

Richardson, J., J. McKie and E. Bariola (2014). Multi attribute utility instruments and their use. Encyclopedia of Health Economics. A. J. Culyer. San Diego, Elsevier Science**:** 341-357.

Richardson, J., S. Peacock, N. A. Day, G. Hawthorne, A. Iezzi and G. Elsworth (2012). "Construction of the descriptive system for the Assessment of Quality of Life (AQoL)-6D utility instrument." Health and Quality of Life Outcomes **10**(38): http://www.hqlo.com/content/10/11/38/abstract.

Simmons, C. A. and P. Lehmann (2013). Tools for Strengths-Based Assessment and Evaluation. New York, Springer.

Sintonen, H. and M. Pekurinen (1989). "A generic 15 dimensional measure of health-related quality of life (15D)." Journal of Social Medicine **26**: 85-96.

Slade, T., A. Johnston, M. A. Oakley Brown, G. Adnrews and H. Whitefor (2009). "National Survey of Mental Health and Wellbeing: methods and key findings." Australian and New Zealand Journal of Psychiatry **43**(7): 594-605.

Torrance, G., D. Feeny, W. Furlong, R. Barr, Y. Zhang and Q. Wang (1996). "Multiattribute utility function for a comprehensive health status classification system." Medical Care **34**(7): 702-722.

Von Winterfeldt, D. and W. Edwards (1986). Decision Analysis and Behavioral Research. Cambridge, Cambridge University Press.