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Validating AQoL-8D in an obese population and its use to estimate weight related Burden of Disease in Australia

Dr Munir A Khan

Research Fellow, Centre for Health Economics
Monash University

Professor Jeff Richardson

Foundation Director, Centre for Health Economics
Monash University

Professor Paul O'Brien

Director, Centre for Obesity Research and Education
Monash University

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Correspondence:

Dr Munir A Khan
Centre for Health Economics
Faculty of Business and Economics
Monash University Vic 3800
Australia

Ph: +61 3 9905 0739 Fax: +61 3 9905 8344
Munir.Khan@monash.edu

ABSTRACT

Objectives: The objective of this study was to estimate the obesity related burden of disease arising from a weight related reduction in the quality of life in Australia. The objective entailed two tasks: (i) the validation of the AQoL-8D instrument in the context of overweight and obesity; and (ii) the use of the instrument to measure the loss of Quality Adjusted Life Years (QALYs) associated with this problem.

Methods: Data were obtained from patients awaiting bariatric surgery who had completed the SF36 and AQoL-8D instruments and a general questionnaire including height, weight, demographic and socio economic information. The content validity of the AQoL-8D was assessed by comparing it with the dimension scores from the SF36 and the summary component (physical and mental) scores. Overall scores from both instruments were regressed upon patient BMI and the relationship used to estimate the effect of overweight and obesity upon the quality of life. Results were extrapolated to estimate the loss of Quality Adjusted Life Years (QALYs) for Australians above the age of 20.

Results: AQoL-8D was sensitive to variation in each of the dimensions of the SF36. A statistically significant relationship was obtained between AQoL-8D utilities and BMI which implied an obesity related loss of QALYs approximately twice the size of the loss derived from previous estimates. The estimated QALY loss is large relative to the burden of disease attributable to other problems.

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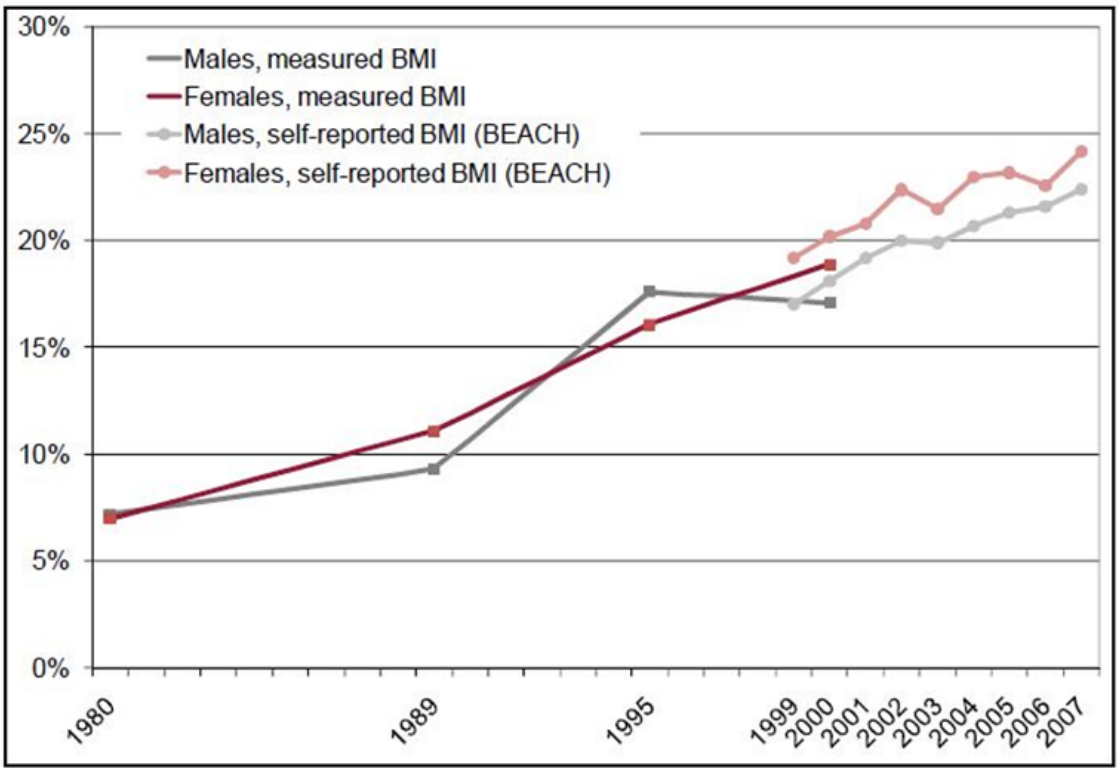
1 Introduction

Obesity is a serious health condition. The risk of death for obese individuals is 50 to 100 percent higher than for those with normal weight (Fontaine et al. 2003; Hart, Gruer and Watt 2011). Higher BMI is responsible for increased morbidity and is associated with a deterioration in the quality of life. It affects both physical and psychological health.

Prevalence rates for obesity show a strong upward trend (Figure 1). By 2008 3.71 million Australians or 17.5 percent of the population were estimated to be obese (Access Economics 2008) and three in five adults were either overweight or obese. Rates were similar across states but obesity was higher for males than females (18.5 versus 16.5 percent respectively). The trend is expected to continue and to follow the USA where, in 2011, obesity varied from a low of 20.1 percent in Colorado to a high of 34.3 percent in West Virginia (Centers for Disease Control and Prevention 2011). The resulting ill health and workforce absenteeism results in a high economic cost. In the US 9 percent of health expenditures are associated with obesity and overweight (Feldstein et al. 2009) and for Canada and the US the annual economic cost in 2009, including excess mortality and disability, has been estimated as $300 billion (Behan and Cox 2010). A review of European studies suggests a total economic burden ranging from 0.09 percent of GDP in France in 1992 to 0.6 percent in Germany in 1990 and Greece in 2002 (Muller-Rienenschneider et al. 2008). The studies reported are dated and the cost has undoubtedly risen with increasing rates of obesity in the past one and a half decades. A recent UK study estimates the cost to the NHS and to the broader economy through lost productivity in 2007 to be £4.2 and £15.8 billion respectively (Butland et al. 2007).

In Australia Colagiuri, Lee et al. (2010) have estimated expenditures of $21 billion arising from overweight and obesity. This does not include mortality or workforce losses but includes health-care related costs and transfer payments arising from government pension and other payments. Excluding transfers but including productivity, carer and health-care costs a figure of $8.3 billion was obtained by Access Economics (2008) for the total financial cost to the economy.

Figure 1 Trends in obesity prevalence for adults, 1980 to 2007



These data represent a partial estimate of the weight related burden of disease. In addition to economic costs and the losses arising from premature mortality there is a significant reduction in the quality of life. The overall objective of this paper is to estimate this burden for Australia by calculating the reduction in Quality Adjusted Life Years (QALYs) associated with overweight and obesity.

In principle the task is straight forward. The number of overweight and obese individuals can be multiplied by an estimate of the loss of utility associated with overweight and obesity. In practice the latter step is problematical. There are few estimates of weight related loss of utility using the methods of utility measurement needed for the calculation of QALYs. (For a review see Dennett, Boye and Yurgin 2008). In one of the largest of these studies Kortt and Clarke (2005) use data from the 1995 Australian National Health Survey to obtain utility scores by body weight index (BWI). This survey included the SF36 questionnaire from which SF-6D utility scores may be calculated using the Brazier algorithm (Brazier, Roberts and Deverill 2002). The regression of these upon BWI allowed the calculation of the weight related loss of utility needed to estimate lost QALY.

While the study is perhaps the most reliable to date it is necessarily based upon one of the extant utility instruments (the SF-6D) and the content validity of these instruments is problematical. 'Content invalidity' in the context of economic evaluation does not imply that an instrument is unresponsive to disease severity. Rather, it implies that the instrument is not fully responsive to all of the dimensions of health related quality of life which are relevant for a person's preferences. For example, an instrument with a detailed description of physical wellbeing might produce

scores which correlated highly with the severity of pain. However, if pain also produced psychological distress and reduced social interaction then the instrument may not produce scores which fully reflected a person's health state related preferences. In the context of obesity, concerns with content validity have been the subject of recent review article (Tayyem et al. 2011).

Similar concerns with the content validity of the major multi attribute utility (MAU) instruments used for estimating QALYs have been expressed in a recent review of these instruments (Richardson, McKie and Bariola 2011). The conceptualisation, construction and detail of the instruments differ significantly and the number of health states defined by their questionnaires varies from 3.1×10^{10} (15D) to 243 (EQ-5D). In the two major comparative studies to date an average of 44 and 53 percent of the variation in utility in the instruments was not explained by other instruments despite all purporting to measure the same quantify (utility) and all being administered to the same individuals at the same point in time (Fryback et al. 2010; Hawthorne, Richardson and Day 2001).

The present study employs a new instrument, the AQoL-8D. This, and earlier AQoL instruments were developed as a direct response to the perceived problem of content invalidity of earlier instruments, at least for some disease states. AQoL-8D is the largest MAU instrument to date, defining 2.4×10^{23} health states. This does not ensure content validity but, in contrast with non-AQoL MAU instruments, it was constructed using the psychometric methods designed to achieve content validity (Richardson et al. 2011). Despite this, confidence in content validity must be evidence based and testing of the AQoL-8D to date has been limited. (See Richardson and Khan 2009). The first objective of the present paper is therefore to examine empirical evidence for the content validity of the AQoL-8D in the context of obesity using the SF36 as a comparator. While this is, itself, a generic non obesity-specific instrument, it is nevertheless the most commonly used and validated such instrument and has been widely used in the context of obesity (Tayyem et al. 2011).

Data for the study were obtained from patients awaiting bariatric surgery and from the general population. These are described in Section 2 of the paper below. In Section 3 the discriminative validity of both instruments is investigated by comparing moderately and morbidly obese respondents. The comparison of the SF36 and AQoL-8D is also presented in Section 3. The data are used to obtain a relationship between BMI and estimated utilities and to estimate the QALY loss from weight related loss of utility is discussed in Section 4. This is compared with earlier estimates of utility and QALY loss in the discussion, Section 5.

2 Instruments and data

The Assessment of Quality of Life (AQoL)-8D was developed as the fourth, and most comprehensive, of the AQoL instruments at the Centre for Health Economics, Monash University. Its 35 items may be reduced to a single utility score (for details: www.aqol.com.au). The SF-36 is the most widely used and well-tested generic HRQoL instrument worldwide. Its 36 items may be combined but do not purport to measure 'utility' as economists use this term. Its values cannot be used to produce Quality Adjusted Life Years (QALYs) as the utilities for this purpose must reflect the preferred trade-off between quality and length of life.

The dimensions and items of the two instruments are summarised in Box 1. The AQoL-8D dimensions fall into two parts: a physical 'super dimension' (PSD) and a mental 'super dimension' (MSD). The PSD includes the dimensions of independent living (IL), pain (Pain) and senses

(Sen); and MSD includes mental health (MH), relationships (Rel), happiness (Hap), coping (Cop), and self-worth (SW). The eight dimensions of SF-36 are also grouped into two summary measures: the physical component summary (PCS) and mental component summary (MCS). The PCS consists of physical functioning (PF), role limit physical (RP), bodily pain (BP) and general health (GH). The MCS consists of vitality (VT), social functioning (SF), mental health (MH) and role limit emotional (RE).

Box 1 SF-36 and AQoL-8D Instrument dimensions and items

SF-36	AQoL-8D
Physical functioning (PF) 10 items: vigorous activities, moderate activities, lifting, climbing several flights of stairs, climbing one flight of stairs, bending, walking more than 1 km, walking ½ a km, walking 100 m, bathing	**Independent living (IL) 4 items**: household task, mobility outside the home, walking and self-care
Role limit physical (PF) 4 Items: time spent on work, accomplished, limited to work, difficulty of performing work	**Pain (Pain) 3 items**: experience of serious pain, the degree of pain and the interference with usual activities caused by pain
General health (GH) 6 items: general health, health rating, get sick a little easier, healthy as anybody, get worse, excellent health	**Senses (Sen) 3 items**: vision, hearing and communication
Bodily pain (BP) 2 items: the degree of pain, interference with normal work due to pain	**Happiness (Hap) 4 items**: contentment, enthusiasm, degree of feeling happiness and pleasure
Vitality (VT) 4 items: full of life, energy, fell worn out, feel tired	**Coping (Cop) 3 items**: energy, being in control and coping with problems
Role limit emotional (RE) 3 items: time spent on work, accomplished less than you like, didn't work as carefully as usual	**Self-Worth (SW) 3 items**: feeling like a burden, worthlessness, confidence
Mental health (MH) 5 items: nervous, felt down and nothing could cheer you up, felt calm, felt down, happiness	**Mental health (MH) 8 items**: feelings of depression, trouble sleeping, feelings of anger, self harm, feeling despair, worry, sadness, tranquility/agitation
Social functioning (SF) 2 items: interference with normal activities, interference with social activities	**Relationships (Rel) 7 items**: relationship with family and friends, social isolation, social exclusion, intimate relationship, family and community role

The SF-36 has a relatively greater emphasis upon physical dimensions, with walking and the ability to work having 5 and 4 items respectively. Dexterity is included in the SF-36 but excluded from the AQoL-8D. However, SF-36 includes no items relating directly to the physical senses or communication whereas AQoL-8D has 3 and 1 items respectively relating to these elements.

AQoL-8D has a relatively greater emphasis upon psychological and social dimensions with 5 and 4 items dedicated to the broad concept of depression/anxiety and social relationships respectively. AQoL-8D, but not SF-36, includes items for self-esteem and intimacy/sexual relationships. SF-36 has more items directly concerned with emotion related vitality.

The comparison of dimensions suggests a broad similarity in the content of the two instruments but this is potentially misleading. The content of items – the elements to which responses are sensitive – depends upon the construction and wording of items and these differ. Concepts embodied in the items' overlap and omitted or superficially under-represented elements may be detected by items from another dimension. The final scores for the two instruments also depend upon the combination formula, the way in which individual item responses are scored and combined. The SF-36 combines unweighted items. Each is treated as having equal importance and item scores are set equal to the response level (1…n, where n is the number of response levels). Scoring mechanism of SF-36 is summarised in Box 2. AQoL-8D has a scoring formula which weights response levels and combines them to obtain an overall index calibrated to equal the utilities obtained from the time trade-off (TTO) technique.

Box 2 2 SF-36 Scoring mechanism

Item or question number	Item score
1, 2, 20, 22, 34, 36	1= 100; 2 = 75; 3 = 50; 4 = 25, 5 = 0.
3, 4, 5, 6, 7, 8, 9, 10, 11, 12	1 = 0; 2 = 50; 3 = 100.
13, 14, 15, 16, 17, 18, 19	1 = 0; 2 =100.
21, 23, 26, 27, 30	1=100; 2=80; 3= 60; 4=40, 5 = 20; 6 =0.
24, 25, 28, 29, 31	1 = 0; 2 =20; 3 = 40; 4 = 60; 5 = 80; 6 = 100

While measurement units therefore differ, the two instrument scores would be expected to correlate if they were sensitive to the same differences in the quality of life. This property is used in Section 3 to test the content validity (sensitivity) of AQoL-8D using the SF-36 as the criterion. An overall correlation between the instruments is a weak test of content as it would only occur if a subset of the instrument dimensions correlated and the AQoL-8D was insensitive to other dimensions of the SF-36. Section 3 therefore reports dimension specific sensitivity: the extent to which AQoL-8D and its dimensions correlate with the 8 dimensions of the SF-36.

Data: The study employed a sample of 196 obese patients who were recruited from the Centre for Bariatric Surgery in Melbourne. Eligible patients over 18 years of age were approached by their clinicians to participate in the research. Data were collected through self-completion questionnaires. The composite questionnaire included the 35 items of the AQoL-8D, the 36 items of the SF-36, demographic questions and personal details including height and weight. Surveys were completed over the 21 month period to December 2009. AQoL-8D data for the general population were taken from various research projects carried out at the Monash Centre for Health Economics. The SF-36 population norm for the Australian general public were obtained independently from the Australian Bureau of Statistics (ABS).

Figure 2 reports the frequency distribution of patient respondents by BMI. Reflecting the fact that patients were awaiting bariatric surgery the distribution is heavily skewed towards the right hand

side: 61 percent were morbidly obese and 28 percent were moderately obese. Only 11 percent were slightly obese and none fell in the normal weight range. The frequency distributions by SF-36 and AQoL-8D score are shown in Figure 3. AQoL-8D exhibits a right hand skew reflecting the fact that it measures utilities (in the economist's sense), and with many imperfect health states people resist sacrificing life for improved quality of life.

Figure 2 Proportion obese people by age within BMI group

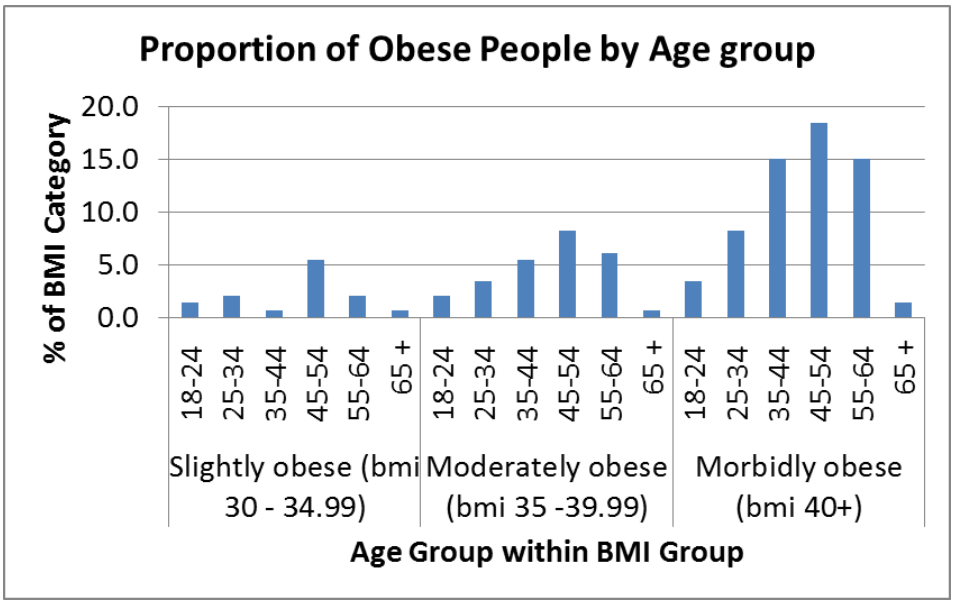
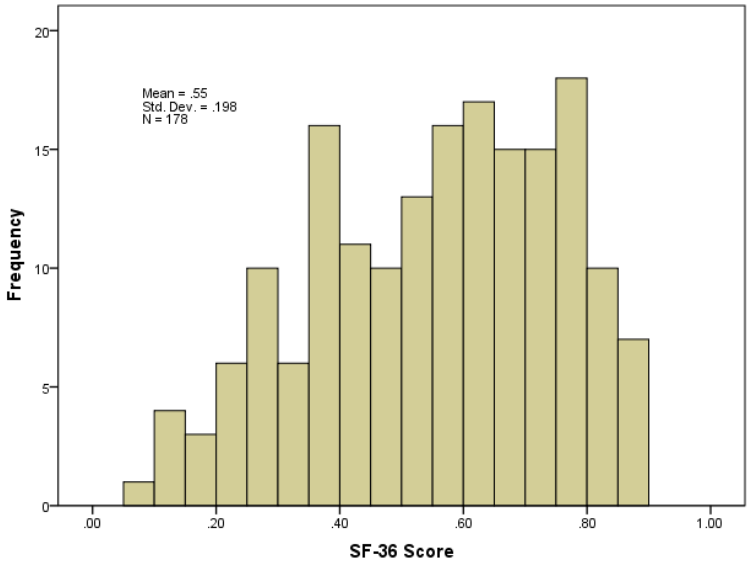
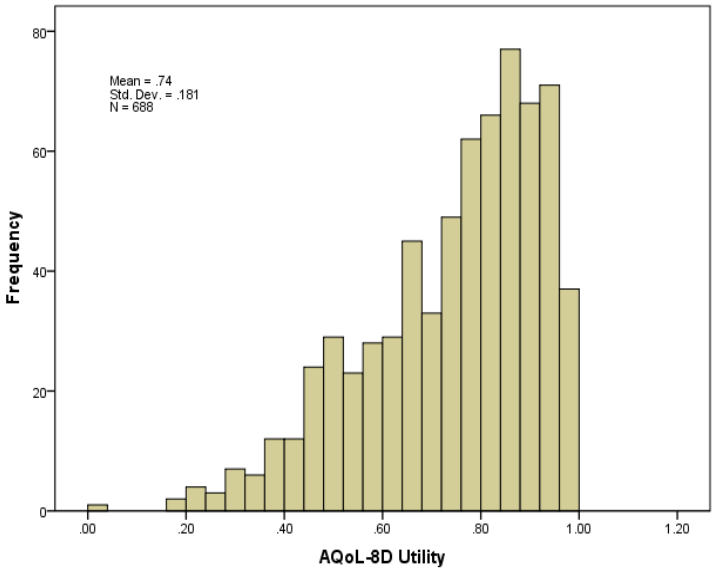


Figure 3 Frequency Distributions SF-36, AQoL-8D

(a) SF-36



(b) AQoL-8D



Summary statistics are reported in Tables 1 and 2. Measurement units and content of the SF-36 and AQoL-8D differ which results in different values for the sample mean (0.55 *vs* 0.69) and

different inter-quartile ranges, IQR (0.33 *vs* 0.28). For comparative purposes the coefficients of relative variation (CRV) were calculated. These express the standard deviation as a percentage of the mean. From Table 1 the SF-36 displays more variation by gender but AQoL-8D has greater variation in the physical and mental summary scores. From Table 2 both SF-36 and AQoL-8D identify significant differences by gender and age but not by educational status. SF-36, but not AQoL-8D, detects differences in the physical summary scores between employment categories.

Table 1 Comparison of reliability and variability of scores of the two measures

Measures	Mean	SE	Range	Interquartile range (IQR)	Coefficient of relative variation (CRV)
AQoL-8D	**0.69**	**0.013**	**0.78**	**0.28**	**26.96%**
Male	0.74	0.025	0.7	0.23	23.11%
Female	0.67	0.016	0.76	0.28	28.11%
Physical SS*(AQoL-8D)	0.63	0.011	0.65	0.23	24.92%
Mental SS*(AQoL-8D)	0.31	0.012	0.84	0.27	55.48%
SF-36	**0.55**	**0.015**	**0.79**	**0.33**	**36.00%**
Male	0.62	0.029	0.67	0.29	30.16%
Female	0.53	0.117	0.79	0.30	37.17%
Physical SS*(SF-36)	0.40	0.007	0.54	0.14	22.50%
Mental SS*(SF-36)	0.48	0.006	0.45	0.12	16.67%

Population sample: Patient – 196 (male 23%, Female 77%); general public 494
Age group (%): 18-24 (6.6), 25-34 (13.8), 35-44 (13.8). 45-54 (32.7), 55-64 (21.9), 65+ (3.1)
SEIFA Group: 1 (lowest SES) -5.8%, 3 – 12.9%, 4 – 25.8% and 5 (highest SES) – 49.7%
SS* Summary Score

Table 2 Mean and standard error of SF-36 and AQoL-8D utility by patient characteristics – p values were derived from one-way ANOVA

Characteristic	SF-36						AQoL-8D					
	PCS			MCS			PSD			MSD		
	Mean	SE	p	Mean	SE	p	Mean	SE	p	Mean	SE	p
Gender												
Male	0.43	0.013	0.01	0.49	0.01	0.126	0.67	0.024	0.02	0.35	0.026	0.096
Female	0.39	0.008		0.47	0.007		0.62	0.012		0.3	0.014	
Age												
>35	0.4	0.014	0.98	0.45	0.013	0.004	0.67	0.025	0.24	0.25	0.028	0.005
35-54	0.4	0.01		0.48	0.008		0.62	0.015		0.3	0.016	
55+	0.4	0.017		0.51	0.012		0.62	0.022		0.37	0.024	
Education level												
High school or less	0.38	0.013	0.14	0.46	0.01	0.267	0.61	0.02	0.15	0.29	0.019	0.39
Trade or TAFE	0.4	0.012		0.49	0.012		0.63	0.021		0.33	0.026	
University or College	0.42	0.012		0.48	0.009		0.66	0.018		0.32	0.021	
Employment status												
Fulltime	0.42	0.01	0.03	0.48	0.008	0.611	0.64	0.014	0.4	0.32	0.017	0.42
Part time	0.38	0.014		0.48	0.013		0.63	0.028		0.3	0.028	
Not employed	0.38	0.015		0.47	0.013		0.61	0.024		0.29	0.025	

3 Validating AQoL-8D

The overall correlation between AQoL-8D and SF-36 (a utility and non-utility instrument) is 0.82. By comparison, in the two multi instrument comparisons of utility instruments referred to earlier, the highest correlation found by Hawthorne et al between any two instruments was 0.8 (15D and AQoL-4D) and in the US study, the highest correlations were between SF6D and HUI 3 (0.72) and 0.82 between HUI 2 and HUI 3). When data are ranked according to the their AQoL-8D score and divided into 20 equal sized categories the correlation between pooled data rises to 0.96 (Figure 4). When data are ranked by patient BMI the correlation is 0.69 (Figure 5).

Figure 4 SF36 mean score and AQoL-8D utility

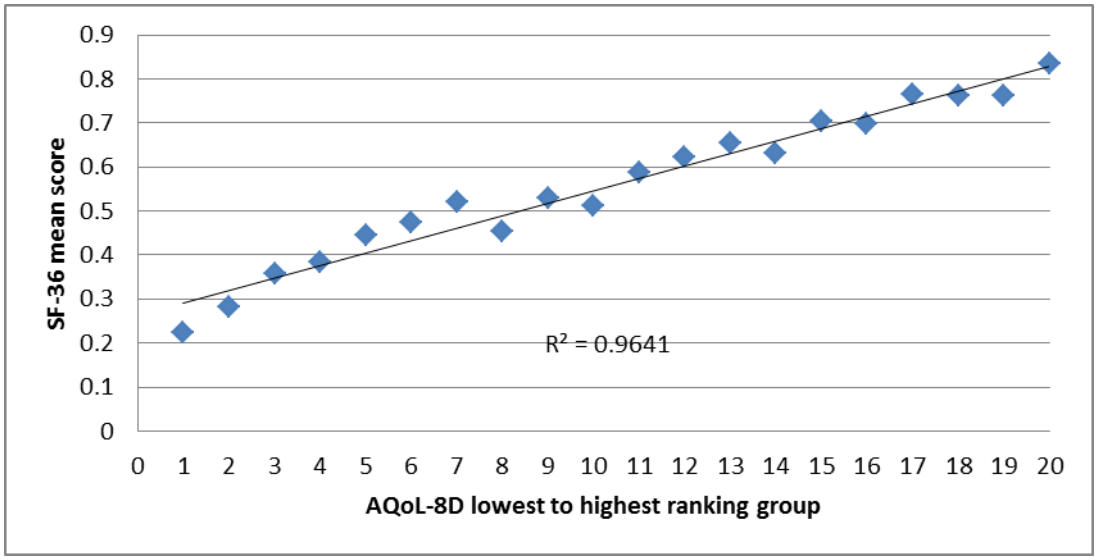
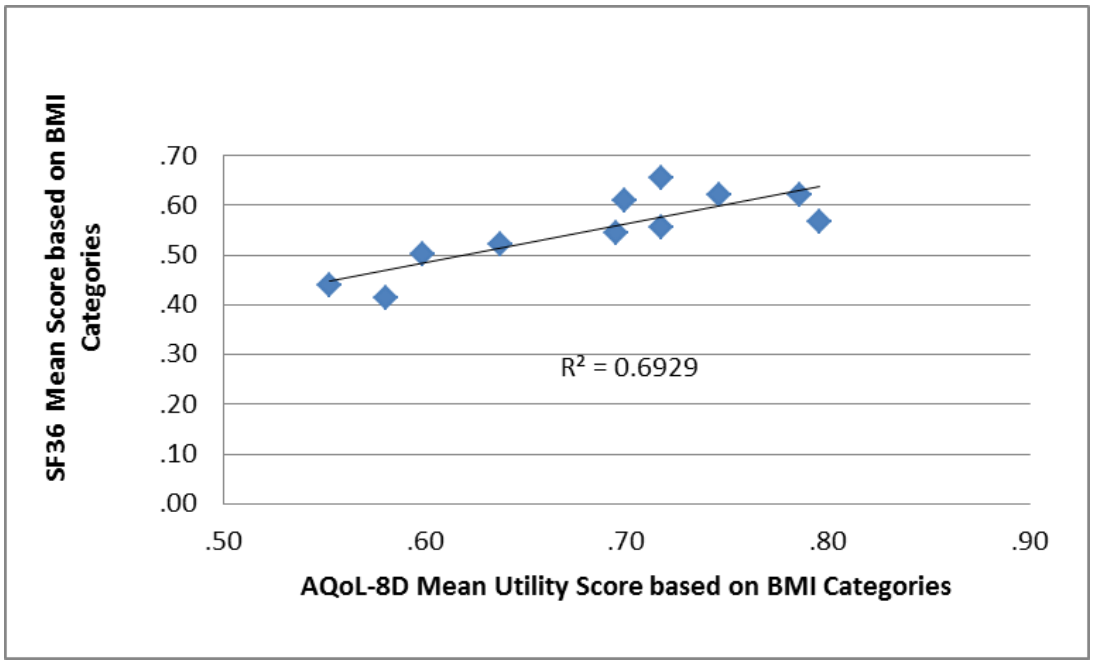


Figure 5 Comparison of Mean SF-36 and AQoL-8D scores with BMI



For the reasons outlined earlier, overall correlation is a relatively weak test of validity. An additional test is the ability of instruments to discriminate between groups where different scores are expected. Figure 5 implies that if SF-36 discriminates between those with high and low BMI then AQoL-8D would be expected to do so. A more direct test is reported in Figure 6 and Table 3. As no one in the patient sample had a normal BMI, scores for morbidly obese patients were compared with those with moderate or mild obesity. The comparisons indicate that both instruments discriminate, but not strongly, between the groups. With the exception of the AQoL dimension for 'senses' (vision, hearing, communicating) the morbidly obese had a lower score than the moderately obese for every dimension for both instruments. However, the differences in the mean scores were only statistically significant in the physical dimensions and for the physical summary scores (PCS, PSD). Overall the SF-36 had marginally greater discriminatory power reflecting its greater emphasis upon physical health but the differences between the respective results are small.

Figure 6 Patient summary scores standardised by population scores

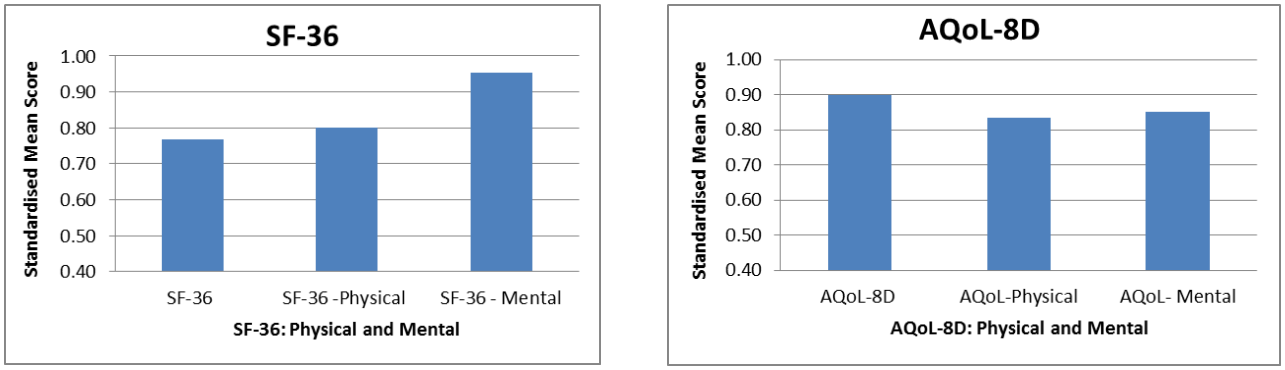


Table 3 Dimension sensitivity: morbidly versus moderately obese respondents

SF36		AQoL-8D	
Mean Difference/se		Mean Difference/se	
Physical function (PF)	4.76***	Independent Living	5.00***
Role: Physical (RP)	2.28 ^{o}	Senses	0.00^{ns}
Pain (BP)	3.15*	Pain	3.10*
Gen Health (GH	2.78^{ns}	Happiness	1.54^{ns}
Vitality (VT)	0.36^{ns}	Coping	0.77^{ns}
Social function (SF)	1.25^{ns}	Relationships	0.71^{ns}
Role limit (RE)	1.18^{ns}	Self worth	1.76^{ns}
Mental health (MH)	1.11^{ns}	Mental health	0.83^{ns}
PCS	5.00**	PSD	4.29**
MCS	0.00^{ns}	MSD	0.63^{ns}
SF36	3.13*	AQoL-8D	2.5*

Key:

(***) (**) (*) (o) Significant at 1 percent, 5 percent, 10 percent (F test)

A more demanding test of AQoL-8D is that it correlates, not simply with the overall SF-36 summary score, but with each of the component scores ('content validity'). Failure to meet this test would mean that the overall correlation was attributable to a correlation with a subset of dimensions implying insensitivity to health states which affected the remaining dimensions.

Correlation with the 8 SF-36 component scores, reported in Table 4, are uniformly high (cf the average correlation of 0.66 and 0.73 between predicted overall utilities in the two multi instrument studies. The relationship between physical and mental summary scores for the two instruments are shown in Figures 7 and 8 (physical and mental component scores – PCS and MCS – for the SF-36; physical and mental super dimensions – PSD and MSD – for the AQoL-8D). The line of 'best fit' shown between each combination of scores is calculated using a geometric mean squares technique which allows for errors in both of the variables and permits left hand and right hand side variables in the equation to be interchanged.

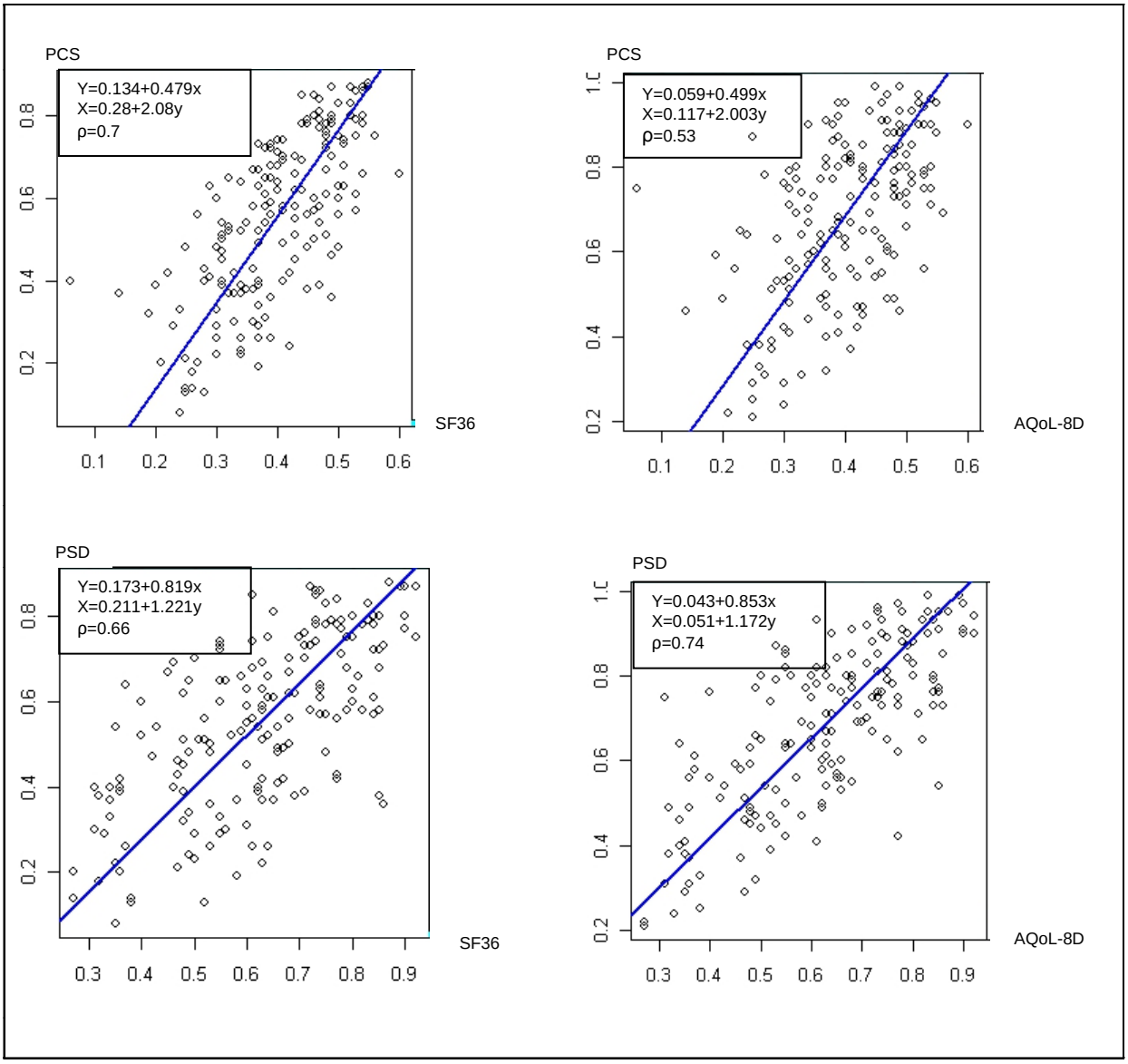
Table 4 Content validity: correlation of AQoL-8D with SF-36 dimension scores

AQoL-8D Correlation with SF36 component scores			
Physical		**Mental**	
Physical function	0.62	Vitality	0.70
Role limit	0.55	Role limit (emotion)	0.63
Bodily pain	0.58	Mental health	0.77
General health	0.60	Social functioning	0.73

Each of the summary scores is compared with both instruments for comparative purposes. From Figure 7 the SF-36's PCS has a relatively low correlation with AQoL-8D – 0.53 – but only a correlation of 0.7 with the SF-36 itself of which it is a component. That is, the correlation with AQoL-8D is 0.53/0.70 or 72 percent as large as the PCS correlation with the SF-36. From Figure 8 the SF36 mental summary score – MCS – has virtually the same correlation with the AQoL-8D as it does with the SF-36 while the correlation between the AQoL-8D mental summary score – MSD – and the SF-36 – 0.76 – is higher than for any other pairwise comparison except for the MSD with AQoL-8D itself. Surprisingly, the SF-36 correlates more highly with the MSD, the AQoL-8D summary score for mental health than it does with its own summary score.

Figure 7 Physical summary scores vs SF-36 and AQoL-8D

Geometric Mean Regressions*



*Geometric mean regressions are derived from the geometric mean of parameters from the regression of each variable on the other. Results are independent of the choice of dependent and independent variable and are appropriate when both variables are subject to independent error.

Figure 8 Mental/Social health summary scales vs SF-36 and AQoL-8D

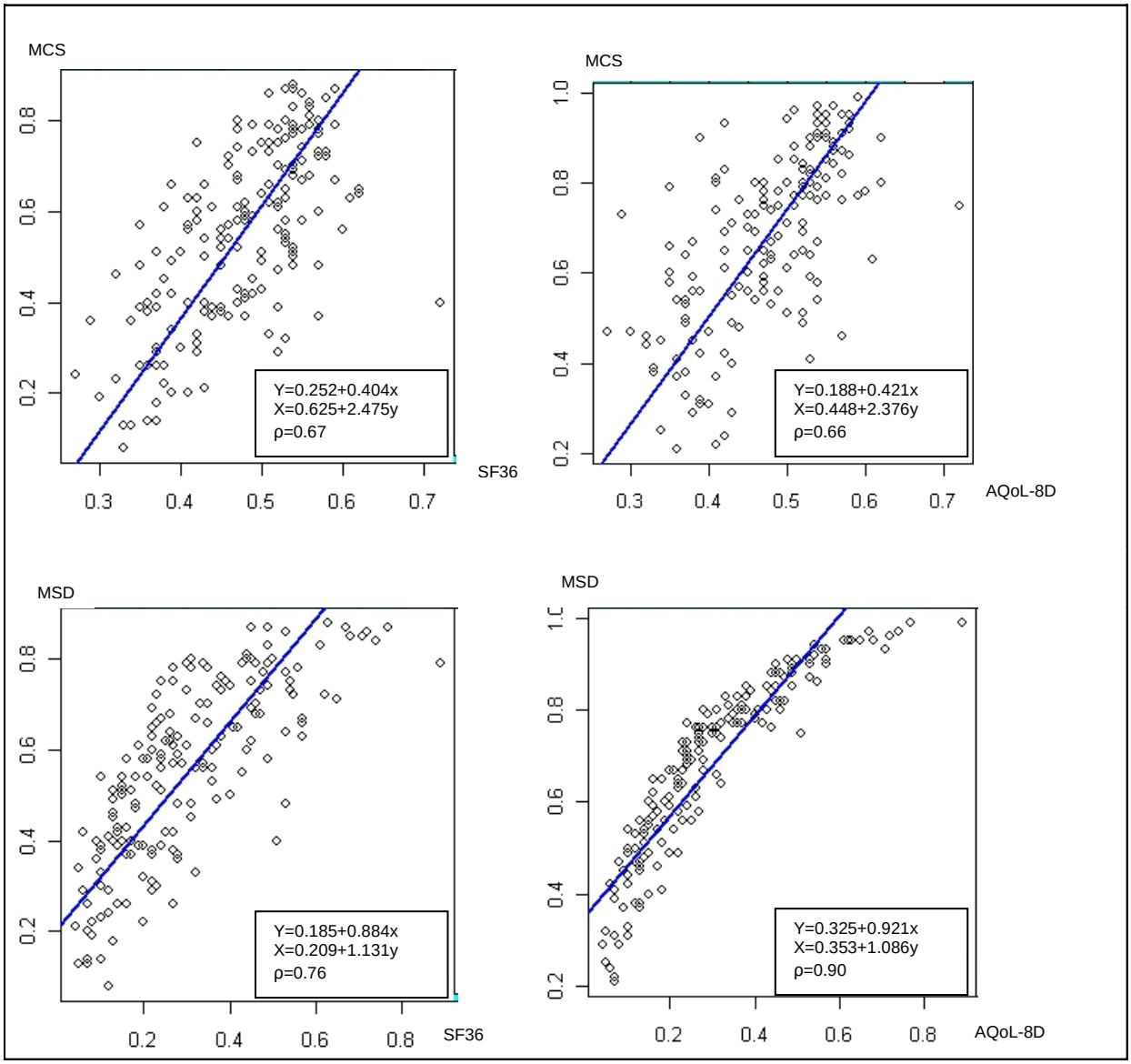
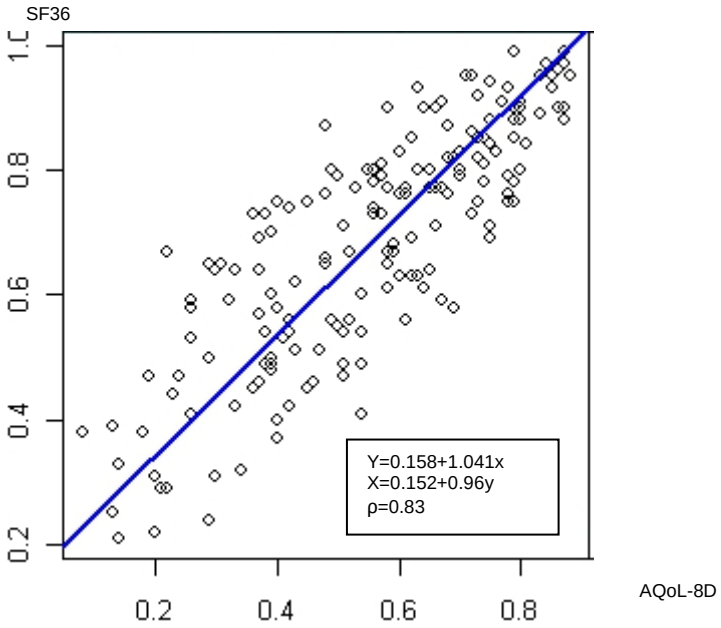


Figure 9 SF-36 vs AQoL-8D



4 The effect of obesity upon utility and QALYs

Regression analyses were carried out with the full dataset and separately for males and females. For comparative purposes both the SF-36 and AQoL-8D were used as dependent variables. In both cases they were regressed upon the BMI and the other explanatory variables shown in Table 5. Regression results are presented in Tables 6 and 7.

Table 5 Variables used in regression analysis

Variable	Description	Mean (se)	Max	Min
AQoL-8D	Utility score of AQoL-8D	0.69 (.013)	.99	.21
SF-36	Numerical value of SF-36	0.55 (.015)	.88	..08
BMI	Body Weight Index: weight (kg)/height (m)	42.62 (.633)	90.80	30.30
Age	Dummy variable = 1 in range = 0 out of range		1	0
Education	Dummy variable = 1 in range = 0 out of range		1	0
	Trade = 1 if TAFE/Trade		1	0
	Degree = 1 if graduate		1	0
Illness	Dummy = 1 if yes		1	0
Female	Dummy = 1 if female		1	0

Table 6 Regressions; all respondents, AQoL-8D, SF-36

Dependent / Independent	AQoL-8D				SF36			
	b	t	b	t	b	t	b	t
BMI	-0.006	-3.16***	-0.006	-3.39***	-0.005	-2.67	-0.005	-2.70***
Age								
<35			-0.116	-2.66***			-0.044	-0.108^{ns}
35-54			-0.074	-2.14**			-0.058	1.51^{ns}
Education								
Trade			0.053	1.43^{ns}			0.062	1.55^{ns}
Degree			0.018	0.54^{ns}			0.041	1.11^{ns}
Illness			-0.059	-2.04**			-0.060	-1.88*
Female			-0.072	-2.12**			-0.085	-2.29**
Constant	0.941		1.083		0.79		0.85	
R^2	0.061		0.16		0.047		0.14	
F	10.00		3.94		7.12		3.22	

Key * Diabetes, CHD, etc dummy

Approach: Estimate regressions; delete variables which are ns at 5%

Table 7 Regressions males, females, AQoL-8D

	Males				Females			
Independent	**b**	**t**	**b**	**t**	**b**	**t**	**b**	**t**
BMI	-0.006	-2.40***	-0.007	***-2.55	-0.006	-2.47***	-0.006***	2.35**
Age dummy								
<35			ns	ns			-0.151	2.92***
35-54			-0.053	-0.843^{ns}			-0.085	2.00**
Education								
Trade			ns	ns				ns
Degree			ns	ns				ns
Illness			-0.057	-0.97^{ns}			-0.060	-1.73*
Constant	1.025		1.16		0.924		1.031	
R^2	0.14		0.22		0.05		0.13	
F	5.74**		1.43^{ns}		6.07*		2.79*	
n	37		37		119		119	

Key

(***) (**) (*): Significant at 1, 5, 10 percent

Age: omitted variable = age 55+

Education: omitted variable: completed only high school

Table 8 Estimated 'normal' QALY loss form overweight and obesity

BMI category	**% Pop[(a)] age 20+ [(a)]**	**Mean[(b)] BMI**	**Popul-ation[(a)]**	**Fraction of QALY lost[)]**			**Total QALY loss**		
				AQoL (A)[(1)]	**AQoL (B) [(2)]**	**SF-6D [(3)]**	**AQoL (A)**	**AQoL (B)**	**SF-6D**
< 25	37.60	21.5	6248						
25-29.9	37.25	27.28	6,184	0.035	0.021	0.016	215.389	97.707	99.872
30-34.9	17.05	32.14	2,822	0.065	0.045	0.030	182.866	127.075	83.995
35-39.9	5.95	37.03	988	0.092	0.073	0.044	90.432	72.588	43.670
40+	2.15	43.71	357	0.132	0.113	0.064	47.135	21.152	22.759
Total	100	140.16	16,599				535.822	318.522	250.256

Source: Australian Bureau of Statistics (2010)

Notes

(1) Loss equals the difference in BMI times its incremental effect upon AQoL in Table 6 (0.006).

(2) Loss from BMI 21.5 to 27.28 equals the loss calculated from the SF6D by Kortt (2005); subsequent incremental loss equals the incremental loss in AQoL (A).

(3) Loss calculated by inserting BMI values in the regression SF6D equation reported by Kortt (2005).

The combined results (Table 6) were very stable with little variation in coefficients with the inclusion or exclusion of different combinations of variables. Those with a serious illness had AQoL-8D scores which were, on average, 0.059 lower than for others and female respondents had lower scores. Those below age 35 and between 35 and 54 had average AQoL-8D scores 0.116 and 0.074 lower than others. These unexpected results possibly reflect the greater effect of

overweight and obesity upon the psychological wellbeing of younger people. Results for the educational dummy variables were insignificant. The coefficient on BMI was -0.006 in all iterations of the model.

The separate results for males and females reported in Table 7 do not provide additional useful information but are consistent with the combined results. Age and illness coefficients for females were significant at 5 percent. Male coefficient had the same sign but were statistically insignificant reflecting the small number of males in the sample. The coefficient on BMI remained equal to 0.006 except for equation 2 (-0.007). The overall explanatory power of regressions was low reflecting the large number of influences impinging upon the quality of life which were outside the scope of the survey.

In both tables results for the SF-36 parallel the AQoL-8D results to a surprising extent (considering the utility weighting of AQoL-8D but not SF-36 responses). Consistent with the linear relationship between AQoL-8D and SF-36 displayed in Figure 4, the coefficient on BMI is almost identical with the coefficient for AQoL-8D. Signs on other variables are uniformly consistent but, with the exception of the dummy variable for females, insignificant. The overall explanatory power of the models is also lower.

Table 8 uses the results from Table 6 to calculate the QALY loss as the product of the number of individuals in the different BMI categories and the fraction of the QALY lost as a result of overweight or obesity. Two estimates are made using the AQoL-8D. The first derives the reduction in the QoL directly from the regression results in Table 6. The effect of overweight is calculated as the difference obtained when the average BMI of normal and overweight individuals are inserted in the regression. This might result in an overestimate. The data used to estimate the regression did not include observations from individuals in the normal weight range and the extrapolated result would exaggerate differences if there was a nonlinear relationship between BMI and utility. In the second estimate, therefore, the effect of overweight was replaced with the more conservative result from Kortt and Clarke (2005) and the incremental decrements in utility for the slightly and morbidly obese were estimated from the present regression results which employed data in this weight range. The third estimate shown in Table 8 is based entirely on the earlier estimates from Kortt and Clarke (2005).

Results reported in Table 8 vary significantly. Based upon AQoL (A) an estimated 535,822 QALYs are lost due to the effects of overweight and obesity upon the quality of life. This drops to 318,522 QALYs using AQoL (B), and to 250,256 QALYs using the SF6D based estimates.

5 Discussion

An important caveat in the interpretation of these (and other) results is that the causal path in the association between obesity and quality of life cannot be demonstrated by the statistical association. In Kortt and Clarke (2005) variables were included for the major diseases associated with obesity. In the present study a cruder, single variable was included for the existence of significant illness. Especially in the latter case this does not preclude the possibility that the loss of utility was causally related to the other illnesses and not to obesity per se. However if the causation was from obesity to the disease to the loss of QoL then conclusions for the importance of obesity with respect to QoL need little qualification. It is possible that independently contracted illnesses result in obesity and that the former not the latter are the reason for decreasing utility. While this hypothesis cannot be disproven it does not appear particularly compelling.

The estimated QALY loss is a direct reflection of the estimated loss of utility associated with overweight and obesity. This is contrasted with previous estimates in Table 9. AQoL (A) and AQoL (B) again refer to the two estimates described above. Both suggest a significantly greater effect of obesity than found in earlier studies. In comparison with the other Australian study (Kortt and Clarke 2005) this may be, in part, attributable to the present analysis being based upon overweight and obese respondents, not the general population. If the effects upon QoL rose disproportionately with BMI then AQoL (A) would exaggerate the loss. However, the linear regression used in Kortt would underestimate effects in the higher BMI range where the present study obtained its data.

Table 9 Loss of utility by instrument, various studies

BMI	HUI 3	EQ-5D	SF-6D	QWB	SF-6D	SF-6D*	AQoL (A)[(a)]	AQoL (B)[(b)]
25-29.9	-0.00	-0.013	-0.01	-0.014	-0.016	-0.012	-0.0345	-0.016
30.9-34.9	-0.02	-0.033	-0.06	-0.044	-0.030	-0.024	-0.0645	-0.046
35+	-0.04	-0.073	-0.11		-0.052	-0.041	-0.101	0.083
Source	Trakas (2001)	Haomiao (2005)	Sach (2007)	Groessl (2004)	Kortt (2005)	Kortt (2005)	Regression Table 6	Regression Table 6

*Standardised for diabetes, CHS, MSD, Depression, Cancer

*Back projection from regression

(a) Change predicted from regression equation, back projecting to 'normal' weight.

(b) Assuming the SF-6D lower estimate for the effect of overweight. Incremental effects of estimated from the regression equation, Table 6.

Table 10 QALY loss vs prevalent Burden of Disease in 2003[(1)]

Equivalent years lost (PYLD) 2003 all ages (000)		QALY loss (2010) age 20+ (000)	
Communicable diseases	21.4	AQoL(A)	535.8
Malignant neoplasms	89.1	AQoL (B)	318.5
Mental disorders	394.5		
Nervous disorder	263.9		
CVD	119.8		
Chronic respiratory	150.4		
Musculoskeletal	94.8		
Diabetes	93.5		
Other	332.0		
All causes 2003	1,559.4		
All causes 2010[(2)]	1751.1		

Source: PYLD: Annex Table 5, Begg et al (2007); QALY loss: Table 8 (total)

(1) The prevalent burden of disease' (or prevalent years lost due to disease – PYLD) is defined as the prevalence of a disease (number of cases in a year) times the severity weight estimated for the Burden of Disease Study (Begg et al 2007).

(2) 2003 all cause total inflated for 12.32% population growth.

The second possible reason for the discrepancy is a greater sensitivity to obesity by the AQoL-8D. Its mental health dimensions are significantly more sensitive than in other MAU instruments, but the relationship between these dimensions and mental health was weak when they were independently analysed. The combined psycho-social dimensions and the three physical dimensions may also have been more sensitive to BMI. However the available data do not allow the testing of this hypothesis.

While there is significant variation in the three estimates of the QALY loss all three indicate that overweight and obesity imposes a significant burden of disease. In Table 10 the estimates are contrasted with results derived for other diseases as part of the burden of disease study conducted in conjunction with the Australian Institute of Health and Welfare (Begg et al. 2007). In this, a different methodology was employed and applied to the entire population. Nevertheless, the final measurement units are conceptually the same as the units employed in the present study, namely quality of life weights times the population affected by the illness or disability. Comparison therefore gives broad perspective to the present results.

From Table 10 the upper estimate of the burden – AQoL (A) – exceeds the PYLD in any disease category and represents a 30.6 percent increase in the total burden. The lower estimate is equivalent to an 18 percent increase in the total burden. The results are attributable to the fact that almost two thirds of the population over the age of 20 is affected. This is more than 6 times the prevalence of the next largest problem area in the Australian population (anxiety and depression).

6 Conclusion

This study set out to validate the AQoL-8D in the context of overweight and obesity and to use it to estimate the quality-specific burden of disease associated with overweight and obesity. Comparison demonstrated AQoL-8D to be sensitive to each of the areas measured by the SF-36. Extrapolation from the incremental loss of utility with BMI implies a very significant burden of disease from reduced quality of life, which is equivalent to between 18 and 30 percent of the previously estimated loss of utility from total disease prevalence.

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