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Exploring the relationship between two health state classification systems and happiness using a large patient data set

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Abstract

The economic evaluation of health care technologies employs a standard economic approach based on preferences to provide utility information. This paper investigates an alternative approach that uses happiness to weight the health states of two preference-based measures (EQ-5D and SF-6D) in a follow-up of a large hospital patient sample (N=15,184). Logit models relating the health state classifications of these two measures to happiness suggests a different weighting across dimensions to that from preference elicitation techniques such as time trade-off. While mental health (depression and anxiety), vitality and social functioning were found to have a large significant association to a patients' own happiness assessment, pain was less so and physical health had none. The implications of these results for health policy are discussed.

JEL classification: D11, I10

Keywords: happiness; utility; preferences; health state valuation

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1 Introduction

Current practice in the economic evaluation of health care technologies is to use the Quality Adjusted Life Year (QALY) to measure the health effects of medical interventions. The QALY is estimated by weighting survival with the health related quality of life enjoyed in each time period using health state utility values . Increasingly, these health state values are obtained using a preference based measure, such as the EQ-5D, SF-6D and the Health Utilities Index (HUI 2 and HUI 3). These combine a health state classification (HSC) system describing health states typically in terms of physical, mental and social functioning and then score them using values obtained using a preference elicitation technique such as the standard gamble (SG) and time trade-off (TTO). Valuation surveys have been undertaken on representative samples of the general public to generate these values, since it is argued that the cost and consequences of health care are borne by the general public (Gold et al. 1996).

However, there has been increasing criticism of the use of preferences in general and in the economic evaluation of health technologies to inform public policy (Kahneman et al. 1997; Kahneman and Sugden 2005; Dolan 2007; Kahneman 2009). The criticism stems from the poor relationship found between ex ante or expected utility and that actually experienced due to a range of factors. These include failing to take into account adaptation, focusing effects and loss aversion (Dolan 2008). Some economist have began to explore the use of other well-being measures, particularly those related to subjective notions of well-being such as happiness and life satisfaction and to examine the relationship between them and other factors including health (see Dolan et al. 2006 for a review). However, most of this

work to date has focused on overall health or profile measures of health. Furthermore, this work has not explored the way measures of patient well-being, such as happiness, might value the different components of the widely used health state classification systems like EQ-5D and SF-6D compared to general public preferences and this study aims to address this gap. This will help to better understand the potential policy implications of a greater use of patient experienced utility rather than the expectations of the general public.

In this paper we use a large patient data set containing both routinely collected data and survey data from a large hospital in Wales, the Health Outcomes Data Repository (HODaR), to achieve this. The next section sets out the background literature followed by a description of HODaR and the methodology. The association between the different dimensions of the health state classifications and happiness are quantified, along with the relationship between the preference-based indices and well-being.

2 Background

QALYs represent individual preferences or utility for health states H_i (Brazier et al. 2007). In general, it is assumed that for the QALY model to be valid, among other things it needs to meet the same general assumptions made about preferences in standard economic theory. This includes assumptions that individuals have well-defined preferences that are rational and that they are well-informed regarding their options. However, this is often not the case, particularly in health care markets. Evidence indicates that most individuals use bounded rationality, using a limited information set to make decisions (Kahneman 2003). Individuals may learn what their preferences are by continued consumption which may help them

correct for errors that they make. However, this is may not be the case for health states as most individuals are unlikely to experience many health states multiple times (Dolan and Kahneman 2008). Furthermore, standard economic theory ignores aspects related to adaptation which may occur over time (for a model addressing this issue see Bradford and Dolan 2010). We will consider this aspect further when we consider the particular case of preference elicitation in health state valuation.

It has become a widespread practice to obtain the health state values from members of the general public rather than patients following the recommendations of the Washington Panel, with the National Institute of Health and Clinical Excellence (NICE) in England recommending this approach (National Institute for Health and Clinical Excellence 2008) . However, patient values of hypothetical health states tend to be higher than those of the general public (De Wit et al. 2000). There are several reasons why the general public may have different values compared to those who experience conditions and briefly they are as follows. Adaptation to poorer health states in patient groups leads to a reduced perceived effect of theses health states (Menzel et al. 2002). Adaptation occurs in many areas of life but individuals often fail to consider that it will occur (Ubel et al. 2005). Individuals also mispredict how quickly they would adapt to changes in their own lives (Kahneman and Sugden 2005). As health state valuation is undertaken by the general public, who may or may not have experience of conditions, they are likely to ignore adaptation when undertaking valuations. However, this problem can also affect patients as they may overestimate the duration and intensity of different health states when they are considering positive changes (Dolan 2008).

In addition to adaptation, the valuation task may lead to focusing illusions where individuals focus on either particular aspects such as the particular health states or transition into these health states at the expense of other domains of life (Ubel et al. 2003; Ubel et al. 2005). Where individuals have no experience of particular health states, focusing illusion can lead to overestimation of the values provided.

Loss aversion may also have an impact. Individuals value losses more than gains and when considering preferences for health states, those who do not have the experience of a health state may place larger weight on the potential loss of health. Patients may on the other hand place a smaller weight on gains to be made from interventions (Baron et al. 2003). There is evidence that patients are unwilling to trade life years or take risks due to other factors which may be as a result of loss aversion (De Wit et al. 2000; Menzel et al. 2002) whereas those who do not suffer from the condition do not have these problems.

The problems associated with violation of assumptions associated with preferences in general and QALYs as well as problems with health state valuation need to be addressed. One option that has been promoted is to use actual experiences of patients in the form of subjective well-being as the source of valuation information (Dolan et al. 2009). The subjective well-being of individuals with particular conditions can provide information regarding the effect of experiencing different health states. By asking individuals to report their well-being over time alongside other factors known to affect well-being, changes in well-being can be used to assess the effect of changes in health states while controlling for the other factors (Dolan 2007).

Reviews of well-being indicate that having a disability, functional limitation or lower self-reported health status is associated with lower levels of subjective well-being even when controlling for other factors such as gender and income (Diener et al. 1999; Ryan and Deci 2001; Michalos 2004; Dolan et al. 2006). However, many of well-being studies use either single item or non-preference-based profile measure of health to investigate the relationship between health and well-being. The relationship between well-being and the descriptive content of widely used generic measures of preference-based health such as the EQ-5D or SF-6D has not been investigated. We aim to fill this gap by exploring the relationship between health dimension levels from preference-based measures of health and well-being in a large patient dataset.

3 Data

3.1 Health Outcomes Data Repository (HODaR)

We use the HODaR which is a postal survey of individuals who are either treated as inpatients or outpatients at the Cardiff and Vale NHS hospitals that has been on-going since June 2002. Ethical approval was sought and gained from the Local Research Ethics Committee.

All inpatients that are 18 years or over are included in the survey, except for individuals with psychological illness or learning disability if their primary diagnosis was a psychological illness. Individuals who die are also excluded. In addition a sample of outpatient clinics are selected each year on a rotational basis with all patients from a selected clinic being surveyed. Patients can do the survey multiple times if they attend the hospital more than

once. Inpatients are surveyed 6 weeks after they have been discharged by postal survey. Outpatients are given the survey pack when they attend by the clinic receptionist. There are no reminders sent. HODaR data is closely matched demographically to that of England and Wales but subjects are slightly more deprived and have higher levels of morbidity (Currie et al. 2005).

We use data from completed surveys sent from August 2002 to January 2004. The inpatient dataset has 19,283 observations from 19,162 individuals and the outpatient dataset has 5378 observations from 5212 individuals. Response rates over this period are 36% with evidence that non-responders were systematically different from responders with the latter being older and more likely to have an elective admission (Currie et al. 2005). Our analysis focuses on those with non-missing data, 15,184 observations, 11,998 inpatient and 3,186 outpatients.

3.2 Dependent variable – happiness

Subjective well-being is commonly measured using questions relating to happiness or life satisfaction. We use a happiness question (question SF-30) that is embedded in the SF-36 (version 2) Questionnaire, where respondents are asked about their feelings over the past four weeks. The happiness question asks: "Have you been happy?" Respondents have 5 options to choose from: 'all of the time', 'most of the time', 'some of the time', 'a little of the time' or 'none of the time', coded 1-5. The responses to this question are reverse coded so that 1 is 'none' and 5 is 'all the time' in order to reflect increasing happiness[1].

[1]Note that the SF-30 question is not used in the construction of the SF-6D classification which is used in the health part of the analysis presented in the next section. This is important as although there is some association as both the SF-30 question and the SF-6D are derived from the same instrument (SF-36), one does not contain the other and any direct circularity and potential endogeneity arising from this is avoided.

The largest category of responses is being happy "most of the time" (≈ 46%) while the smallest category are those reporting being happy "none of the time" (≈ 4%) (Table I). There is no significant difference in the reporting of happiness between inpatients and outpatients with mean happiness of 3.5 for both inpatients and outpatients. Other studies report similarly high levels of SWB using different scales .

[Insert Table I]

3.3 Independent variables - health

We use the health state classifications (HSC) of two preference-based measures, the SF-6D and the EQ-5D, to explore the relationship between happiness and the health dimensions. There is some evidence that different measures of health are related in different ways to different measures of well-being (Shields and Price 2005; Dolan et al. 2006) and the use of two measures allows us to investigate whether this is the case.

EQ-5D

The EQ-5D instrument was developed by a multidisciplinary group of researchers from seven centres across five countries (Brooks 1996). The descriptive system, which has five dimensions, was included in the survey. The dimensions are mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension has three levels: no problems, some problems, major problems and in total they define 243 health states (Brooks 1996) . Patients are classified into the EQ-5D by self completion or interviewer

administration. Preferences for the scoring function were measured using TTO on a random sample of more than 3000 members of the adult population in UK with scores 0.0 (dead) and 1.0 (perfect health) (Dolan et al. 1996).

SF-6D

The SF-6D is a HSC that is derived from the SF-36 data in the survey. It is composed of six multi-level dimensions of health. The six dimensions are: physical functioning, role limitation, social functioning, pain, mental health and vitality. It is used to derive a preference-based single index measure of health from the SF-36 and was developed by a research team at the University of Sheffield (Brazier et al. 2002). It was constructed from a sample of 11 items selected from the SF-36 to minimise the loss of descriptive information and defines 18000 health states. A selection of 249 states defined by the SF-6D have been valued by a representative sample of the UK general population (n=611) using the standard gamble (SG) valuation technique.

We convert the n levels of the EQ-5D and SF-6D dimensions into n-1 dummy variables with the first level omitted as the reference (Appendix I). We combined health levels where there were a small proportion of individuals reporting the poorest levels of health, viz., mobility and self-care in the EQ-5D. This resulted in 8 dummy variables for the EQ-5D and 25 for the SF-6D. Using the unscored levels of the EQ-5D and SF-6D allows us to capture differences across the dimensions of these measures. As the dummy variables represent worse health within each dimension compared to a reference health state with no problems a negative effect on happiness is expected. It is also expected to increase this negative impact as levels in each dimension increase, i.e. increasing limitation.

3.4 Control Variables

Well-being is affected by many factors such as life events, socio-demographic factors and individual factors such as personality (Diener et al. 1999; Frey and Stutzer 2002; Easterlin 2003). The HODaR data set contains some socio-demographic variables including age, gender, ethnicity, marital status and employment status, all of which are known to affect well-being and we include these in the analysis. Descriptive statistics of these factors are reported in Table I.

4 Method

In the main analysis, we assume that happiness is interpersonally ordinally comparable but the numeric value of the categories do not have quantitative meaning, but are ranked so that a level 2 of happiness is greater than a level 1 of happiness. An ordered logit model is therefore employed (Maddala 1983; Greene 2000; Simonoff 2003; Ferrer-i-Carbonell and Frijters 2004) where it is assumed that there is an underlying latent variable 'Happy' defined by the regression relationship:

$$Happy^{*} = \beta' x_i + u_i \qquad (1)$$

Where x_i represents a vector of independent variables of the health dimension dummies and control variables and u_i is the error term. Logit models assume that the error term u_i has a logistic distribution (Maddala 1983; Greene 2000).

The variable Happy* is unobserved but we can model the probability of choosing different levels of happiness from the available choices 1 to 5 using an ordered logit.

$$\text{Logit}\,[P(\text{Happy} \leq j)] = \mu_j - \beta' x \qquad (2)$$

Where j is 1 to 5 and the μs are unknown parameters representing cut-off points that are the thresholds where individuals move from one level of happiness to another.

We report odds ratios which indicate the odds of reporting different levels of happiness with odds ratio greater than one indicating the likelihood of reporting higher levels of happiness and less than one indicating the likelihood of reporting lower levels of happiness. HSC dimension dummy variables are expected to have odds ratios that are less than one. As the data includes some individuals who have completed more than one survey, we take this into account by using Huber-White robust standard errors (Long and Freese 2006).

In the ordered logit, the βs are assumed to be the same for different levels of happiness while thresholds, the μs, capture transition into different levels of happiness, i.e. the proportional odds assumption. We assess this assumption using a Brant test and where the assumption is violated we fit a partial proportional odds ordered logit model using a generalised model. This relaxes the proportional odds assumption for each independent variable that violates it while leaving the assumption in place for the all the others . The results are interpreted in the same way as ordered logit but there are multiple coefficients for each independent variable that violates the proportional odds assumption.

McKelvey and Zavoina's R^2 are reported based on the variance of the latent variables. Simulations have shown this R^2 to be the closest to the OLS R^2 and it provides information as to how the model is performing. However, this R^2 is not equivalent to OLS R^2 and cannot be assessed without comparing it to another R^2 from a different model. We use the R^2 from the model that contains only the control variables (Appendix II) to assess whether inclusion of the dummies from the classification system represents an improvement (Long and Freese 2006). Data analysis was undertaken using STATA 9.2.

5 Results

5.1 Happiness and the health dimensions

The ordered logit model results for EQ-5D are presented in Table II. Brant test of the proportional odds assumption was not violated for the EQ-5D dimensions. McKelvey and Zavoina's R^2 is 0.34 across the three data sets compared to 0.05 when only control variables are included (Appendix II) indicating that including the HSC dimension variables improves the explanatory power of the models.

In the full data set the largest odds ratios are for the mobility dimension which is close to 1 at 0.91. This is followed by self-care (0.85), pain/discomfort (0.71, 0.64) and usual activities (0.69, 0.58). Anxiety/depression has the smallest odds ratios (0.16, 0.04). These odds ratios are all statistically significant at the 5% level. This indicates that the relationship between the EQ-5D dimensions and happiness is as expected, as all odds ratios are less than 1. Having a problem in any of the dimensions therefore increases the likelihood of reporting lower levels of happiness compared to having no problem. The pattern in the magnitude of

odds ratios is repeated when focusing on inpatients only. However, for outpatients, there are notable changes as the ordering of magnitude across the dimensions has changed for usual activities and pain/discomfort with the latter having lower odds ratios (0.57, 0.46) compared to the latter (0.74, 0.60). This indicates that pain/discomfort has a larger impact on happiness compared to usual activities for outpatients than for inpatients. In addition to this, both mobility and self care are not statistically significant for the outpatients.

[Insert Table II]

SF-6D

We report our findings for the ordered logit for the SF-6D in Tables 5 and 6. The Brant test of the proportional odds assumption was violated for all the SF-6D dimensions apart from the physical functioning dimension. We therefore present both the constrained ordered logit (Table III) and the partial proportional odds ordered logit (Table IV). For the constrained ordered logit, McKelvey and Zavoina's R^2 is approximately 0.5 across the three data sets compared to 0.05 in the model with control variables.

As with the EQ-5D, in the constrained ordered logit, the largest odds ratios are those for physical functioning (1.09 to 1.62) in the full data set. However, unlike the EQ-5D, the odds ratios are greater than 1 indicating that those with poor functioning have greater odds of reporting higher levels of happiness when controlling for all other dimensions. Furthermore, the pattern across the levels indicates that the odds ratios increase as functioning worsens indicating that having lower levels of physical functioning is associated with higher odds of reporting being happy.

The odds ratio for the first level of role limitation, 'limitations in work or other activities by physical health', is also larger than one (1.30) which indicates that having problems in this level compared to no problems increases the odds of reporting higher levels of happiness. The other two levels for role limitation refer to emotional health, either on its own (level 3) or in addition to physical health (level 4). This may explain why the odds ratios for levels 3 and 4 in this dimension are less than one but, the order is reversed with level 4, which includes references to physical health, higher than level 3. The role limitation dimension coefficients are all statistically significant at the 5 % level.

The pain dimension has odds ratios ranging from 0.97 to 0.70. These odds ratios are all less than one but only three levels are statistically significant at the 5% level in the full data set, levels 3, 5 and 6 (odds ratio 0.86, 0.85 and 0.70 respectively). Social functioning dimensions odds ratios are all less than one ranging from 0.76 to 0.35 with decreasing odds ratios as functioning worsens, as expected, indicating that poor social functioning is associated with lower levels of happiness. The odds ratios are all statistically significant.

Problems with mental health are associated with odds ratios ranging from 0.35 to 0.05 indicating that they have a large negative impact on happiness. Ordering is as expected, with greater problems in mental health associated with lower odds of reporting high levels of happiness. The same is true for vitality which has odds ratios ranging from 0.28 to 0.04 which means that this dimension has the largest negative impact on happiness when controlling for all other dimensions. The odds ratios on both these dimensions are statistically significant at the 5 % level.

The SF-6D results for the in-patients follow a similar pattern to the full data set, although only two levels in the pain dimensions are statistically significant (levels 2 and 6). In the outpatient sample, although the pattern is similar to the full sample, both physical functioning and pain dimensions are not statistically significant. In addition, levels 2 for both role limitation and social functioning are not statistically significant.

[Insert Table III]

Table IV is the results of the partial proportional odds ordered logit model for the full data set. All the SF-6D dimensions apart from physical functioning violated the proportional odds assumption and they therefore have multiple coefficients for the different happiness levels.

The odds ratios for physical functioning remain similar to the fully constrained model, with all of them larger than one (1.21 to 1.70) and increasing in order as problems in functioning increase. The odds ratios for role limitations are also similar with level 2 (role limitation because of physical health) greater than one (1.21 to 1.36) and less than one for the other two levels.

For the other dimensions, the largest difference occurs when comparing the lowest level of happiness "none of the time" to all other levels of happiness. Social functioning, mental health and vitality dimension coefficients are less than one (0.92 to 0.05) apart from for this level of happiness where odds ratios are greater than one particularly for mental health where these are up to 4 for levels 2 and 3 of this dimension. Mild to moderate problems in

these dimensions is more likely to be associated with reporting higher levels of happiness. For social functioning and mental health, the odd ratios for comparisons with the top category (Column D) are not ordered according to severity. The pain dimension has odds ratios larger than one for the two lowest levels of happiness (Columns A and B) compared to higher levels of happiness but these are not statistically significant when controlling for all other dimensions. The rest of the odds ratios for this dimension are similar to those of the constrained model (0.92 to 0.64). There are therefore significant differences for those reporting the lowest levels of happiness compared to other levels of happiness.

[Insert Table IV]

6 Discussion

An alternative that focuses on subjective well-being as a measure of utility instead of preferences has been proposed for health state valuation. Problems associated with mental health and vitality have a large negative association with happiness with odds ratios ranging from 0.04 to 0.29 in both measures. This indicates that having even some problems in these dimensions is associated with much lower levels of happiness compared to the other dimensions represented in the two measures.

Social functioning, role limitation (associated with mental health) and usual activities are also significantly associated with happiness with odds ratios ranging from 0.33 to 0.74. This indicates a smaller impact on happiness compared to the mental health or vitality dimensions, but this is consistently negative regardless of the sample. Pain is also negatively

associated with happiness, but to a lesser degree, especially for the SF-6D where odds ratios are close to one indicating a small association between pain and happiness when controlling for all other dimensions. Self-care also has less impact with odds ratios between 0.8 and 0.9. The surprising result is physical functioning when the SF-6D is used as this has odds ratios ranging from 1.09 to 1.73 meaning problems with this dimension are associated with higher levels of happiness, which is counterintuitive. This is a statistical effect that occurs when all other dimensions of health are added to the model. Individually physical functioning is negatively associated with happiness. This phenomenon was also reported by Michalos (2000) when looking at the relationship between well-being and SF-36 dimensions. Other studies that have focused on non-preference-based measures of HRQoL have found that physical limitations (problems walking, seeing), had a significant negative effect only when emotional dimensions were excluded (Michalos et al. 2001; Arnold et al. 2004; Heinonen et al. 2004; Perneger et al. 2004; Heyl et al. 2005; Uppal 2006) with some indication that the effect was indirect through other dimensions such as activity limitation (Bookwala et al. 2003; Heyl et al. 2005). This indirect effect is a plausible explanation for the findings that we report.

We also sought to establish whether the relationship between happiness and the two preference-based measures would be the same. The results show that there are similarities for some dimensions across the two measures such as mental health and anxiety/depression. The differences between mobility (EQ-5D) and physical functioning (SF-6D) as well as the lack of statistical significance of pain (SF-6D) in the outpatients' dataset may indicate that the descriptive systems of health are an important consideration when exploring the relationship between well-being and health. Dolan et al (2006) note the effect

of including/excluding different variables when identifying the factors associated with well-being. This would be of particular concern for the use of well-being measures in health state valuation if excluded dimensions had an impact on the included health dimensions. We also detect slight differences in the way happiness and health dimensions are related when looking at groups with different levels of morbidity. In particular, dimensions related to physical functioning appear to be less important to outpatients compared to inpatients. There are also differences in the way the health dimensions of the SF-6D are related to happiness depending on the level of happiness that is reported. This is particularly the case for the lowest level of happiness. For this level, odds ratios from partial proportional odds model results were larger than one. It may be that those who report the lowest levels of happiness are significantly different making their responses to all questions different.

These results have potentially important implications since they would suggest that the conventional preference-based scoring of EQ-5D and SF-6D – that give more weight to physical functioning – do not reflect experience. This may reflect previous evidence that general population respondents fail to take adaptation to physical health problems into account when valuing these states. At the same time, mental health seems even more prominent for EQ-5D and SF-6D than suggested by the preference-based weights. The judgement about source of value is ultimately normative and there are strong arguments either way. However, this study exemplifies the differences. Using experience suggest greater weight should be given to mental health than suggested by preferences. One solution is to make general public respondents more aware of these differences by providing evidence of adaptation (McTaggart-Cowan et al. 2010).

However, these results and such conclusions need to be made with care – since there are a number of issues with the data set and the methodology. The HODaR data set has a response rate of 36% with evidence of bias which limits the generalisability of the results since non-response may be related to health states and/or well-being. Additionally, we can only refer to associations and not causality between happiness and the health dimensions due to the cross-sectional nature of the data. We cannot verify whether adaptation has occurred either, because of the nature of our data. However, physical functioning may work indirectly via other dimensions and so there may be less adaptation than suggested by the results. Quantitative measures that are used in this analysis are also limited in the level of explanation that they can provide as they do not allow us to explore why some dimensions do not have a direct impact on happiness when other dimensions are controlled for.

In the analysis, we use a single happiness item that is from the same measure on which the SF-6D is based which may introduce bias related to the questions that are asked before the happiness question (Schwarz and Strack 1999). Furthermore, it is not possible to compare the relationship observed with this happiness measure with other well-being measures (Pavot 2008). Our results are based on a latent scale of happiness which is not anchored on the zero to one scale of dead to full health; we are therefore unable to estimate the values associated with different health states which would be necessary to estimate the utility associated with them. This limits its applicability in economic evaluation of health care technologies.

In addition, focusing illusions cannot be entirely avoided when asking individuals about well-being when they have particular conditions (Brooks 2002; Smith et al. 2008). This is

especially the case when individuals know that they have been selected because of their condition. The data we use comes from a hospital survey and respondents would have focused on their health when answering the whole questionnaire.

The strengths of the HODaR data set are that it allows us to exploit the experiences of patients rather than the general public, adding to current knowledge on the relationship between well-being and health. This paper has shown that it is possible to use well-being measures like happiness to weight the dimensions of health. It suggests very different weightings to those generated by preferences elicited from the general populations for EQ-5D and SF-6D. Further research is required on longitudinal data sets to see whether the relationships are replicated using a range of well-being variables and in-depth qualitative methods to explore further the reasons for the relationships over time. Assessment of well-being scales and how they could be mapped onto a zero to one scale would also be helpful for use in economic evaluation.

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Table I Sample Characteristics

	All **%**	**Inpatients** **%**	**Outpatients** **%**
Male	45.7	47.0	40.5
Mean Age (s.d.)	57.5 (17.5)	57.8 (17.5)	56.3 (17.5)
Age distribution			
18-40	20.0	19.6	21.5
41-65	41.9	41.6	43.2
Over 65	38.1	38.8	35.3
Marital status			
Single	12.9	12.6	13.8
Married	61.7	61.8	61.2
Remarried	2.0	2.1	1.9
Cohabiting	4.9	4.9	5.1
Separated	1.2	1.1	1.4
Divorced	6.9	6.9	7.2
Widowed	10.4	10.7	9.3
Employment Status			
Professional	38.9	38.7	39.5
Skilled	15.6	15.6	15.6
Skilled-Manual	16.8	17.1	15.5
Manual	7.4	7.5	7.4
Unskilled	6.7	6.8	6.4
Never employed	1.8	1.7	2.0
Unemployed	12.7	12.5	13.6
Ethnic group			
White	97.5	97.7	96.8
How much of the time during the last 4 weeks have you been happy?			
None of the time	4.1	4.3	3.3
A little of the time	12.0	12.0	12.1
Some of the time	27.0	26.8	27.8
Most of the time	45.7	45.6	45.8
All of the time	11.2	11.3	11.0
Mean Self-reported happiness (s.d.)	3.48 (0.98)	3.48 (0.99)	3.49 (0.96)
Mean EQ-5D score (s.d.)	0.68 (0.31)	0.68 (0.32)	0.69 (0.31)
Mean SF-6D score (s.d.)	0.66 (0.15)	0.66 (0.15)	0.67 (0.15)
N	15184	11998	3186

Table II Multivariate Ordered Logit Regression: EQ-5D Dimensions

	All		*Inpatients*		*Outpatients*	
Explanatory variables	*Odds ratio*	*SE*	*Odds ratio*	*SE*	*Odds ratio*	*SE*
Mobility 2	0.887*	(0.042)	0.872*	(0.047)	0.948	(0.099)
Self care 2	0.842***	(0.042)	0.825***	(0.046)	0.920	(0.105)
Usual activities 2	0.692***	(0.032)	0.679***	(0.036)	0.745**	(0.075)
Usual activities 3	0.549***	(0.042)	0.545***	(0.046)	0.574**	(0.107)
Pain/discomfort 2	0.714***	(0.030)	0.752***	(0.036)	0.591***	(0.054)
Pain/discomfort 3	0.634***	(0.044)	0.682***	(0.053)	0.474***	(0.071)
Anxious/ depressed 2	0.156***	(0.006)	0.156***	(0.007)	0.155***	(0.013)
Anxious/ depressed 3	0.037***	(0.003)	0.038***	(0.004)	0.036***	(0.007)
Control variables	Yes		Yes		Yes	
Threshold						
1	-7.261***	(0.391)	-7.158***	(0.439)	-7.631***	(0.870)
2	-5.476***	(0.388)	-5.410***	(0.436)	-5.675***	(0.863)
3	-3.596***	(0.386)	-3.545***	(0.434)	-3.737***	(0.860)
4	-0.699	(0.385)	-0.649	(0.433)	-0.822	(0.857)
Observations	15184		11998		3186	
McKelvey & Zavoina's R^2	0.34		0.34		0.33	
Log Likelihood	-17478.50		-13841.34		-3623.99	
Likelihood Ratio χ^2	5825.63		4649.16		1195.19	
Degrees of freedom	28		28		28	

Exponentiated coefficients; Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Reference categories: no problems - walking about, with self-care & performing usual activities; no pain or discomfort; not anxious or depressed; female, married, white, professional

Table III Multivariate Ordered Logit Regression: SF-6D Dimensions

	All		*Inpatients*		*Outpatients*	
Explanatory variables	*Odds ratio*	*SE*	*Odds ratio*	*SE*	*Odds ratio*	*SE*
Physical functioning 2	1.093	(0.062)	1.164*	(0.076)	0.901	(0.105)
Physical functioning 3	1.243**	(0.085)	1.289**	(0.100)	1.105	(0.161)
Physical functioning 4	1.564***	(0.139)	1.635***	(0.163)	1.354	(0.269)
Physical functioning 5	1.612***	(0.125)	1.695***	(0.149)	1.368	(0.230)
Physical functioning 6	1.632***	(0.147)	1.733***	(0.177)	1.311	(0.256)
Role limitation 2	1.301***	(0.080)	1.297***	(0.091)	1.280	(0.171)
Role limitation3	0.603***	(0.046)	0.591***	(0.052)	0.652**	(0.107)
Role limitation 4	0.702***	(0.046)	0.706***	(0.053)	0.673**	(0.094)
Social functioning 2	0.754***	(0.042)	0.747***	(0.047)	0.793	(0.095)
Social functioning 3	0.614***	(0.035)	0.648***	(0.042)	0.501***	(0.061)
Social functioning 4	0.455***	(0.032)	0.460***	(0.036)	0.439***	(0.068)
Social functioning 5	0.351***	(0.029)	0.359***	(0.033)	0.325***	(0.063)
Pain 2	0.976	(0.057)	0.980	(0.065)	0.946	(0.118)
Pain 3	0.865*	(0.052)	0.869*	(0.060)	0.831	(0.107)
Pain 4	0.899	(0.061)	0.904	(0.069)	0.874	(0.129)
Pain 5	0.856*	(0.061)	0.866	(0.069)	0.801	(0.126)
Pain 6	0.702***	(0.062)	0.690***	(0.069)	0.763	(0.155)
Mental health 2	0.345***	(0.017)	0.321***	(0.018)	0.446***	(0.046)
Mental health 3	0.191***	(0.010)	0.180***	(0.011)	0.235***	(0.028)
Mental health 4	0.073***	(0.005)	0.068***	(0.006)	0.100***	(0.016)
Mental health 5	0.049***	(0.005)	0.046***	(0.005)	0.063***	(0.014)
Vitality 2	0.280***	(0.029)	0.286***	(0.034)	0.250***	(0.057)
Vitality 3	0.123***	(0.013)	0.129***	(0.016)	0.098***	(0.023)
Vitality 4	0.064***	(0.007)	0.066***	(0.008)	0.055***	(0.013)
Vitality 5	0.041***	(0.005)	0.042***	(0.005)	0.036***	(0.009)
Control variables	Yes		Yes		yes	
Threshold						
1	-10.460***	(0.413)	-10.392***	(0.467)	-10.640***	(0.904)
2	-8.564***	(0.410)	-8.522***	(0.464)	-8.617***	(0.896)
3	-6.439***	(0.408)	-6.399***	(0.461)	-6.464***	(0.892)
4	-2.917***	(0.404)	-2.863***	(0.457)	-2.954***	(0.884)
Observations	15184		11998		3186	
McKelvey & Zavoina's R^2	0.50		0.51		0.48	
Likelihood Ratio χ^2	9131.51		7342.65		1829.14	
Degrees of freedom	45		45		45	

Exponentiated coefficients; Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Reference categories: health does not limit physical, role and social functioning, has no pain, does not feel tense or downhearted and has a lot of energy all the time; female, married, white, professional.

Table IV Multivariate Generalised Logit Regression: SF-6D Dimensions

All patients				
Happiness Level	**A**	**B**	**C**	**D**
	Odds ratios	**Odds ratios**	**Odds ratios**	**Odds ratios**
Physical functioning 2	*1.121*			
Physical functioning 3	*1.274****			
Physical functioning 4	*1.588****			
Physical functioning 5	*1.677****			
Physical functioning 6	*1.700****			
Role limitation 2	1.208	1.356*	1.347***	1.309**
Role limitation3	0.522*	0.487***	0.513***	0.820
Role limitation 4	0.401***	0.508***	0.687***	1.096
Social functioning 2	1.242	0.660***	0.772***	0.644***
Social functioning 3	1.165	0.609***	0.541***	0.736**
Social functioning 4	0.711	0.411***	0.436***	0.445***
Social functioning 5	0.351***	0.319***	0.451***	0.540***
Pain 2	0.805	1.245	0.924	1.018
Pain 3	1.201	1.129	0.828*	0.808*
Pain 4	1.191	1.162	0.832*	0.950
Pain 5	1.463	1.206	0.736***	0.896
Pain 6	1.221	0.943	0.637***	0.897
Mental health 2	4.107***	0.869	0.387***	0.210***
Mental health 3	3.697***	0.645***	0.173***	0.128***
Mental health 4	1.116	0.187***	0.063***	0.105***
Mental health 5	0.414***	0.149***	0.106***	0.319***
Vitality 2	1.164	0.923	1.214	0.181***
Vitality 3	0.985	0.637*	0.346***	0.083***
Vitality 4	0.608	0.282***	0.160***	0.060***
Vitality 5	0.231***	0.175***	0.109***	0.047***
Control variables	yes	yes	yes	yes
Observations	15184			
Likelihood Ratio χ^2	7430.54			
Degrees of freedom	105			
P value	0.00			

Exponentiated coefficients; Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A - Happiness level 1 compared to 2,3,4 and 5
B - Happiness level 1 and 2 compared to 3,4 and 5
C - Happiness level 1,2 and 3 compared to 4 and 5
D - Happiness level 1,2,3 and 4 compared to 5

Reference categories: health does not limit physical, role and social functioning, has no pain, does not feel tense or downhearted and has a lot of energy all the time; female, married, white, professional.

Appendix I Definition of variables used in analysis

Variable	**Definition**
Dependent Variables	
Happy	Happy (Have you been happy? 1 = None of the time; 2= a little of the time; 3 = Some of the time; 4= Most of the time; 5=All of the time)
Independent Variables	
SF-6D dimensions	
Physical Functioning	= 1 for each level number 2-6 of physical functioning dimension
Role Limitation	= 1 for each level number 2-4 of role limitations dimension
Social Functioning	= 1 for each level number 2-5 of social functioning dimension
Pain	= 1 for each level number 2-6 of pain dimension
Mental Health	= 1 for each level number 2-5 of mental health dimension
Vitality	= 1 for each level number 2-5 of vitality dimension
	Base category: no limitations in each dimension
EQ-5D dimensions	
Mobility	= 1 for levels 2 & 3 of mobility dimension
Self-care	= 1 for levels 2 & 3 of self-care dimension
Usual Activities	= 1 for each level number 2-3 of usual activities dimension
Pain/Discomfort	= 1 for each level number 2-3 of pain/discomfort dimension
Anxiety/Depression	= 1 for each level number 2-3 of anxiety/depression dimension
	Base category: no problems in each dimension
Control Variables	
Sex	=1 if male
Age, Age2, Age3	=age, age squared, age cubed
Marital Status	=1 for single, re-married, cohabiting, separated, divorced and widowed *base category: married*
Employment Status	= 1 for skilled, skilled manual, manual, unskilled, never employed and unemployed *base category: professional*
Ethnicity	= 1 for mixed, Asian, black and other ethnic groups. *base category: white*

Appendix II Multivariate ordered logit: happiness and control variables

	All		*Inpatients*		*Outpatients*	
Explanatory variables	*Odds ratio*	*(SE)*	*Odds ratio*	*(SE)*	*Odds ratio*	*(SE)*
Male	0.943	(0.031)	0.968	(0.036)	0.831*	(0.062)
Age	0.824***	(0.018)	0.818***	(0.020)	0.850***	(0.042)
Age Squared	1.417***	(0.058)	1.434***	(0.066)	1.352**	(0.125)
Age Cubed	0.827***	(0.020)	0.823***	(0.023)	0.844**	(0.047)
Reference: Married						
Single	0.744***	(0.040)	0.742***	(0.045)	0.764*	(0.091)
Remarried	1.137	(0.123)	1.153	(0.139)	1.032	(0.255)
Living With Partner	0.977	(0.072)	1.021	(0.085)	0.842	(0.132)
Separated	0.451***	(0.062)	0.415***	(0.066)	0.564*	(0.152)
Divorced	0.586***	(0.035)	0.579***	(0.039)	0.615***	(0.080)
Widowed	0.641***	(0.036)	0.628***	(0.039)	0.703**	(0.090)
Reference: White						
Mixed	0.698	(0.128)	0.572**	(0.120)	1.310	(0.498)
Asian	0.813	(0.124)	0.791	(0.143)	0.840	(0.238)
Black	0.829	(0.167)	0.805	(0.194)	0.892	(0.328)
Other	0.962	(0.291)	0.934	(0.318)	1.100	(0.739)
Reference: Professional						
Skilled	0.832***	(0.038)	0.851**	(0.043)	0.770**	(0.076)
Skilled Manual	0.676***	(0.031)	0.683***	(0.035)	0.649***	(0.066)
Manual Non-Skilled	0.573***	(0.035)	0.578***	(0.039)	0.558***	(0.074)
Unskilled	0.581***	(0.037)	0.575***	(0.041)	0.603***	(0.086)
Never Employed	0.589***	(0.070)	0.579***	(0.078)	0.629	(0.155)
Unemployed	0.414***	(0.020)	0.409***	(0.023)	0.427***	(0.045)
thresholds						
1	-6.293	(0.377)	-6.296	(0.423)	-6.272	(0.843)
2	-4.745	(0.375)	-4.782	(0.421)	-4.563	(0.837)
3	-3.292	(0.374)	-3.340	(0.419)	-3.063	(0.835)
4	-0.840	(0.373)	-0.888	(0.419)	-0.604	(0.834)
Observations	15184		11998		3186	
McKelvey & Zavoina's R^2	0.05		0.05		0.05	
Likelihood Ratio χ^2	759.97		626.90		147.64	
Degrees of freedom	20		20		20	

Exponentiated coefficients; Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$