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Title: Estimating the SF-6Dv1 Value Set for a Population-Based Sample in Lebanon

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Highlights:

1. This study is the first population-based value set for SF-6Dv1 health states in Lebanon, and its availability will enable calculating quality adjusted life years and conducting cost utility analysis studies.
2. This research would serve as a block in building infrastructure for conducting local cost-effectiveness analysis and advancing the establishment of health technology assessment practices in Lebanon to support resources allocation decisions.
3. The potential for applications of a standardized utility measure is enormous both in Lebanon and the rest of Arab countries.

Estimating the SF-6Dv1 Value Set for a Population-Based Sample in Lebanon

Abstract

Objectives: The SF-6Dv1 is a preference-based measure derived from the SF-36 for use in quality adjusted life-year (QALY) estimation for cost-utility analysis (CUA). Country-specific value sets for SF-6Dv1 are needed to reflect societal preferences but none are available for Lebanon and other Arabic countries. This study aimed to generate a value set for SF-6Dv1 for Lebanon and to compare results to the UK set.

Methods: A sample of 249 health states defined by the SF-6Dv1 were valued by a representative sample of 577 members of the Lebanon general population, using standard gamble. Several multivariate regression models at mean and individual level were fitted to estimate utilities for all SF-6Dv1 states with selection of best fitting models based on predictive ability, consistency, and model fit. The best fitting models were compared with those fitted in the UK study.

Results: Data from 553 eligible respondents providing 3308 valuations were used for the analysis. Lebanese values were consistently higher than UK values indicating differences in preferences and there were no negative values. The random effects model using only main effects was the best performing model. There were inconsistencies in two dimensions, thereby consistent models were estimated with values ranging from 0.367 to 1. The results are consistent with the UK results.

Conclusion: This study provides the first population-based value set for SF-6Dv1 health states for Lebanon, making it possible to generate QALYS for CUA studies. The potential for applications of a standardized utility measure is enormous both in Lebanon and all Arab countries.

Keywords: Lebanon, SF-6Dv1, preference-based health measure, modelling stated preference data, weighting system.

Introduction

Economic evaluation of healthcare technologies is an important process to assess value for money to support resource allocation [1]. Decision-makers in different countries such as the United Kingdom use this approach to identify cost-effective interventions for use within their healthcare systems [2,3]. In Lebanon, there is little specific guidance regarding how to assess cost effectiveness of health technologies to support priority-setting across the different sectors in the health care system.

In economic evaluation, costs and outcomes are assessed. Cost utility analysis (CUA) is one type of economic evaluation that uses a generic measure of outcome; the quality adjusted life year (QALY), which combines the length of life and health related quality of life (HRQoL) [4,5]. In calculating QALYs, each period of time is assigned a 'quality weight' or 'utility' ranging from 0 to 1. This weight corresponds to preferences for different levels of HRQoL, where a weight of 1 is given to full health, and 0 is equivalent to dead while negative values represent states that are considered to be worse than dead. The most common approach for generating the utilities involves using a questionnaire which is completed by patients and scored using preferences from members of the general population, referred to as the 'indirect utility assessment' approach.

Lebanon, a small low-income Middle Eastern country, facing constant political, economic and security challenges, has a population of 6.8 million citizens (and 2 million Syrian and Iraqi refugees), residing in five governorates. Lebanon spends a small percentage (8%) of its gross domestic products on healthcare and the current reimbursement decisions mainly depend on the lowest price after the evaluation of the safety and efficacy of the drugs [6,7]. In addition, since 2019, the socio-economic situation in Lebanon has gone through what was described by the World Bank as one of the worst economic and financial crises in over 150 years. The currency lost over 90% of its value, inflation is at 600% for most essential goods (second highest in the world), and there has been an increasing shortage in food supplies and medications. Therefore, there is a recognized need to conduct high quality economic evaluations studies to support and inform health policy, pricing and reimbursement decision making and to develop preference-based measures to make comparisons across different disease areas and alternative treatments.

The SF-6Dv1 is a preference-based measure that was developed from the SF-36, one of the most commonly used measures of HRQoL. A valuation study using the Standard Gamble (SG) method to elicit preferences of members of the UK general population was used to generate utilities and a value set that can be applied to the SF-36 to estimate QALYs [8]. It is acknowledged that different countries may have different preferences due to differences in the sociodemographic, health profile and cultures, therefore it is important to generate country-specific value sets. Different country value sets have been developed for the SF-6Dv1, e.g. [8-15], and it is anticipated that the application of this measure will continue to grow worldwide.

Although there are different country SF-6Dv1 values sets, there is none for Lebanon neither for other Arabic speaking countries. The aim of this study was to estimate utilities for the SF-6Dv1 health states in the Lebanon general population and to compare the results with the UK utilities to identify any systematic differences in valuations.

Methods

This study had two major parts: (1) estimation of utilities for the SF-6Dv1 for Lebanon and then (2) comparison to UK utilities. For the first component, the original UK SF-6Dv1 valuation study [8] was replicated by doing a valuation survey using SG in a representative general population sample and modelling the data to estimate a value set for the SF-6Dv1 for Lebanon (LEB SF-6Dv1). The feasibility of this approach was exhibited in a pilot study where a sub-sample of states (n=49) were valued in a small (n=126) unrepresentative sample drawn from the American University of Beirut (AUB) [9]. For the second component, we compared the final Lebanese value set (LEB SF-6Dv1) with the UK value set (UK SF-6Dv1).

The SF-6Dv1

The SF-6Dv1 version 1 (SF-6Dv1 v1), derived from the SF-36, is a descriptive system of six health dimensions: *physical functioning, role limitation, social functioning, bodily pain, mental health, and vitality*, each having between four and six levels [8]. It is constructed from 11 items selected from the SF-36 to minimize the loss of descriptive information. Forward and backward translations were used to translate the descriptive system to Arabic, and this was validated in [9]. The SF-6Dv1 uniquely describes 18,000 possible health states based on the combination of the dimensions and levels. For example, individuals at full health have levels at '1' and their overall state is therefore 111111, whereas those at the worst state or "pits" have different levels representing being at the worst level in each dimension and their state is 645655.

Selection of respondents

As the utilities from SF-6Dv1 are used in societal decision-making, a representative sample of the Lebanese general population was used [16]. Representativeness was based on age, gender, socio-economic status, and level of education. The estimated sample size was 577 participants, with a 95% CI and a margin of error of 5%. The sample required in this study would be to enable modeling of a value set based on the direct valuations obtained for the 249 health states.

To identify participants, a stratified cluster random sampling design was used. Lebanese governorates were the strata, the clusters in each stratum were chosen at the level of districts where clusters were 100-150 households. Within each cluster, households were chosen using systematic random sampling, based on the probability proportional to size technique using the Lebanese Central

Administration of Statistics [17-18]. Households were the main sampling units with one literate adult aged 18 years old or above drawn from each household. Individuals who had physical or mental incapacity that would impact on reading and understanding required in the valuation tasks were excluded. In the case where more than one eligible subject was present in the household, random selection of the adult participant was done using the Kish method. The sampling frame distribution of the study sample across the various governorates is described in Appendix A.

Selection of health states

The SF-6Dv1 has 18,000 health states which cannot all be valued therefore a sub-set needed to be identified. The same 249 health states valued in the UK study [8] were used here to enable comparisons. States were allocated to blocks of six states with a mix of mild, moderate, and severe states, which included the worst state [19]. Participants valued states from one block with allocation to ensure each health state would be valued by an equal number of respondents apart from the worst state which was valued by all respondents.

The survey

The interview was conducted in the same way as the original UK study. At the beginning of the interview, respondents self-completed questions about their health including the SF-6Dv1 to familiarize them with the measure. Next, to familiarize respondents with the states they would value, a ranking exercise was undertaken. Respondents were requested to arrange a collection of eight cards, each representing one of the six health states that needed to be evaluated, as well as the best health state defined by the SF-6Dv1 and immediate death.

During the interview, the focus was on evaluating the six states using a modified version of the SG, which included props developed by a team at McMaster University [20]. For each of the five intermediate health states, respondents were asked to choose between two prospects: either living in a certain SF-6Dv1 health state or an uncertain prospect of two possible outcomes, the best or "pits" state [8]. The probability of living in the best state was varied (using a ping-pong method) until the respondent was indifferent between the two prospects. Respondents then valued the "pits" state using a modified version of the SG based on whether the respondent had ranked the "pits" better or worse than immediate death in the ranking exercise. If the worst state was ranked better than immediate death, the respondent had to choose between the certainty of experiencing the worst state and the uncertainty of either experiencing full health or immediate death. On the other hand, if the worst state was considered worse than death, the choice was between the certainty of death and the uncertainty of either experiencing full health or the worst state. To place the intermediate health states on the dead (0) to full health (1) scale, with negative values bounded at -1, the values of the worst state were used [21]. The following formula was then used to create adjusted SG values for all intermediate health state valuations is:

$$SGADJ = SG + (1 - SG) * P,$$

where P is the value of the "pits" state and SG is the SF-6Dv1 health state valuation.

Finally, respondents completed a set of sociodemographic questions (sex, age, marital status, education, housing type, and total household monthly income). However, these were not included in the analysis following the approach taken in other valuation studies [8–15,22–26]. All study instruments were in English and Arabic and administered by a trained interviewer in either language depending on the respondent's preferences. The study was approved ethically by the University's Institutional Review Board at AUB.

Interviews

Interviewers were graduate students from health-related courses who were trained intensively on the interview protocol. The interviews were done in the respondents' own place. All respondents signed an Informed Consent Form. Interviews were initiated in 2019, with data collection planned from mid-2019 to mid-2020. Data collection was paused in October 2019 (n=316 respondents), initially due to massive protests and road closures, through to the global COVID-19 pandemic and lockdown measures. The data collection process was later resumed between February and July 2022 to meet the recommended 577 respondents.

Modelling

The modeling approach used in the UK study [8] was applied here. The general model for health state valuations is:

$$y_{ij} = g\left(\beta' \mathbf{x}_{ij} + \theta' r_{ij}\right) + \varepsilon_{ij} \qquad (1)$$

where *j* = 1, 2, …, m represents respondents and *i* = 1, 2, …, n_j represents individual health state values by respondent *j*, g is a function specifying the appropriate functional form, and ε_{ij} is a random error term [6]. The dependent variable, y_{ij}, represents the adjusted SG score for health state *i* evaluated by respondent *j*, **x** is a vector of binary dummy explanatory variables ($x_{\delta\lambda}$) for each λ of dimension δ of the SF-6Dv1, where the best level of each dimension represents the baseline for that dimension resulting in 25 dummy variables. Finally, ***r*** is a vector of terms to test for interactions for different dimensions of the SF-6Dv1, as presented in the original UK study [8].

In a simple linear model, the intercept represents the best state 111111, while the sum of the SF-6D dimension dummies gives the values for the other states [8]. It was expected that SF-6Dv1 dummy variables would be negative and increasing in magnitude as severity increased i.e., larger disutility was expected for more severe levels of health. Where there was an inconsistency in this regard, adjacent inconsistent dummy variables were combined, so that both levels received the same weight resulting in a consistent model.

Ordinary least squares (OLS) was used to estimate mean level models. However, given that there are repeated observations for each respondent, random and fixed effects models were estimated using Generalized least square (GLS) and maximum likelihood estimation [8]. For the random effects (RE) model the error term, ε_{ij}, was made up of:

$$u_j + e_{ij} \qquad (2)$$

where u_j represents the individual specific variation, assumed to be random across individual respondents, and e_{ij} represents the error term for the health state valuation *i* of individual *j*, also assumed to be random across observations.

Selection of model

Only the best fitting models were reported. The models were assessed based on: 1) consistency of statistically significant (at the 5% level) estimates i.e. no inconsistencies; 2) accuracy of estimates when comparing predicted and observed values using mean absolute error (MAE) and root mean square error (RMSE), with models with smaller MAE and RMSE values preferred. We also assessed the error based on differences between the observed and predicted values of 0.05 (% absolute error > 0.05) and 0.10 (% absolute error > 0.10) with models with smaller proportions preferred; 3) model goodness of fit assessed using Akaike's information criterion (AIC), Bayes information criterion (BIC) and log-likelihood value. Models were also assessed for bias (t-test), normality of residuals (Jarque-Bera [JB]) and the presence of autocorrelation in the prediction errors (Ljung-Box [LB]). All analyses were performed using SPSS version 24.0 [27] (SPSS Inc., Chicago, IL) and R 4.2.3 [28] (R Development Core Team, Vienna, Austria).

Results

Study sample

In total, 577 participants were recruited to the study. There were 24 respondents who were excluded: 14 (2.4%) because they did not value the worst state and 10 (1.7%) because they gave the same value for the five intermediate states. The 24 excluded cases were older, marginally more likely to be female and married, with lower educational qualifications and lower household income (Table 1). The included respondents (n=553) had 10 missing values, which resulted in 3308 observed SG valuations across 249 health states and these form the data set reported and analysed below. Compared with the general population [6,18], the study sample was older because it was age-stratified. It also had higher education levels and fewer people were single because the subjects were older.

SF-6Dv1 valuation

The values were skewed to the left (**Figure 1**) and there were no negative values (states considered worse than dead) in comparison to 6.9% in the UK study. Further, over 26% of observations lie between 0.9 and 1.0, while in the UK the rate was over 23%. Interestingly, the proportion of valuations at the maximum value (1.0) was 10.61% (351/3308) in comparison to 0.5% in the UK study.

Descriptive statistics for 40 of the 249 health states show that overall, the Lebanese mean health-state valuations were higher, with mean value of 0.679 (SD=0.275) compared to 0.541 (SD=0.388) in the UK study (Table 2). The observed values for the worst state (645655) ranged between 0.01 and 1.00, with a mean value of 0.340 (±0.236) for Lebanese values compared to a range of -0.980 and 0.980 with a mean of 0.213 (±0.428) for the same state in the UK study. For the mildest state (211111), values ranged from 0.810 and 1.00, with a mean value of 0.928 (±0.062), but in the UK the values were from 0.190 and 1.000 with a mean value of 0.778 (±0.276). There was an average difference of 0.135 (±0.111) between Lebanese and UK values for 219 states, with Lebanese values exceeding the UK ones. The overall level of agreement was 0.765 (95% CI 0.699, 0.817), which was above the standard of 0.7 for group comparison.

Modelling results

The best fitting model was the random effects models with and without the intercept restricted to unity (Table 3). In Model 1 where the intercept was not constrained, 18 of 25 coefficients were statistically significant. There were two inconsistencies in physical functioning (level 2 to level 3) and social functioning (level 3 to level 4). The mental health levels 3 and 4 had the same sized coefficients. Level 3 of the vitality dimension was positive instead of negative. The equivalent model for the UK had fewer statistically significant coefficients (16 of 25 coefficients) with two inconsistencies. The percentage of prediction errors under 0.1 and 0.05 was 86% and 60% respectively, compared to 79% and 51% in the UK. The MAE for Lebanon was found to be better than that of UK, 0.058 and 0.073 respectively. The predictions were unbiased (p>0.05), but prediction errors were not normally distributed (JB test). Further, there was autocorrelation in the prediction errors (LB statistics) (Figure 2). This shows a tendency to over (under) predict at low (high) health state values respectively. A similar result is found for the UK model. Combining levels for the two dimensions with inconsistencies to estimate a consistent model resulted in similar results to Model 1 in terms of predictive ability but led to level 3 in vitality becoming positive (Model 2, Table 3).

In Model 3 where the intercept constrained to unity, there were more variables with significant coefficients compared to Model 1 (20/25), but the same inconsistencies. Unlike the unconstrained model, all coefficients were negative as expected but Model 3 had a higher percentage of absolute errors bigger than 0.05 and 0.1, as well as higher MAE compared to Model 1. Similar results were found in the UK results. As in Model 1, the residuals were not normally distributed and there was autocorrelation in the prediction errors (LB test significant), however, unlike Model 1, the predictions were biased (p<0.05). From the observed and predicted values for the 249 states, Model 3 predicts the values quite well especially the good health states but there is still over-prediction for poor health states (Figure 3). A similar result was found for the UK model. In the consistent model (Model 4, Table 3), similar results were found in terms of predictive ability compared to Model 3 (Appendix B).

Selected model

The MSE, RMSE and the percentage of predictions outside 0.05 and 0.10 ranges in Model 4 were higher than Model 2 with smaller AIC and BIC, though log-likelihood values were similar. However, Model 4 has the advantage of having the intercept fixed to unity as per the conventional utility scale. For these reasons, Model 4 was then selected.

Discussion

This study reports the results of the survey conducted to estimate the first population-based value set for the SF-6Dv1 health states for Lebanon, which would enable generation of QALYs for CUA to inform decision-making. A larger proportion of valuations were at the maximum value (10.61%) compared to 0.5% in the UK study, which indicated the willingness of respondents to risk a worse health state in order to have the chance of a better state of health. The Lebanese mean health-state valuations were higher with mean value of 0.679 (SD=0.275) compared to 0.541 (SD=0.388) in the UK study. For many of the states (219/249), Lebanese values were higher than UK values, despite the fact that data on HRQoL were collected during a period of economic and financial crisis and the COVID-19 pandemic [29]. The high utility scores could be related to cultural differences and to high religiosity in Lebanese society, where religious and spiritual practice improves patients' QoL [30] especially when combined with use of standard gamble which is known to result in higher values compared to other preference elicitation methods. In addition, Lebanese people could have adapted to the series of recurrent crises in the past five decades. Furthermore, patients could have assessed their QoL positively after periods of lockdown, when social interactions were restored.

There were no negative values for any of the health states in this study. Although the proportion of negative values is usually small e.g. 7% in the UK study [8,22], the lack of negative values in this study was surprising. The lack of negative values may be due to Lebanese population attitudes to risk, characteristics of the survey sample, and the perceived severity of the states. Lebanese population views may also be influenced by cultural or religious reasons which may have influenced why participants were not willing to value health states as being worse than being dead, see for example [31,32]. Future research is recommended to explore this further, potentially using other elicitation techniques such as time trade-off that do not include probability or discrete choice experiments with duration where direct references to states worse than being dead are avoided.

Different models were estimated, and the best model based on consistency, predictive ability and application was selected. Of all the tested models, the random effects models performed best. This was consistent with the UK valuation study [8]. Even in the best fitting model, not all coefficients were statistically significant and inconsistencies were observed. This result is similar to that found by the authors of the original study and other researchers in different countries [8–15]. There may be a number of possible explanations for the presence of inconsistencies. The SF-6Dv1 describes a large number of states (18,000) whereas only a relatively small number is valued (n=249), which may impact on how accurately values can be estimated. One way to address inconsistencies would be to value more health states which in turn require more respondents [22]. The valuation task in SG is also cognitively difficult which may have an impact on the level of precision in valuing the different health states. A small proportion of participants were excluded as they were unable to complete the valuation task and valued all health states equally. These participants tended to be in lower economic groups which may indicate lower education and therefore difficulties with engaging with SG. As valuation studies are costly, rather than undertake additional valuation studies, inconsistencies can be dealt with by merging levels where they occur. Inconsistencies in the best fitting model were merged for three dimensions (physical functioning, social functioning, and mental health).

The selected model estimates utility values ranging from 0.367 (observed value=0.340) to 1. This compared to the UK values which range from 0.257 (observed value=0.213) to 1. The results can be used to estimate utility values when the SF-36 is used in a Lebanese population. There are a limited number of value sets for preference-based measures that can be used in a Middle East context. A previous pilot study was undertaken on the valuation of the SF-6Dv1 in Lebanon, but this was based on a small and unrepresentative sample [9]. Other studies in North Africa were undertaken to generate a value set generated for the EQ-5D-5L value set using the international EuroQol standardized protocol (EQ-VT-2.1) [33-35]. This new SF-6Dv1 value set therefore increases the potential number of value sets that are available for use in the Middle East. It also has the advantage of being linked to the SF-36 and can therefore be applied to historic data to generate utility values e.g. where modelling is required.

The protocol and approach to valuation and modelling that was used in the original study was applied here which relied on an additive model. However, multiplicative models have been recommended by some authors [36-42] as they can potentially be more realistic and can capture interactions between the attributes to a limited degree. Future studies should test these alternative approaches which can offer more flexibility than additive models [36-42]. The Lebanese valuation data also includes ranking data which has been used to estimate value sets; future studies can estimate a rank-data based value set and compare it to the SG value set generated here.

The value set that was estimated is for SF-6Dv1 but a new revised version of the descriptive system was derived, the SF-6Dv2 [43,44], which contains the same dimensions, but differ from the original SF-6Dv1 in terms of the dimension content and response options. In the current study, we used SF-6Dv1 as this is widely used and highly regarded worldwide due to its longevity. However, it would be interesting to investigate whether different results would be obtained when the new instrument (SF-6Dv2) is applied.

The SF-36 is widely used and the availability of a population-based value set for SF-6Dv1 for Lebanon enables local CUA to be undertaken using country relevant utilities rather than value sets from other countries which has previously been the case. A Lebanese value set will be more appropriate for the decision-making process for resource allocation and public health policies in Lebanon and potentially in other Arabic speaking Middle Eastern countries.

Conclusion

In this study, a Lebanese value set for the SF-6Dv1 was estimated using a sample of the Lebanon general population. This is the first population-based value set for SF-6Dv1 health states in Lebanon, and its availability will enable calculating QALYS and conducting CUA studies. The potential for applications of a standardized utility measure is enormous both in Lebanon and in the rest of Arab countries.

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Table 1. Sociodemographic characteristics of respondents

	Included (N=553)	Excluded (N=24)	Lebanese general adult population* (N=6,100,075)
Mean age in years (SD)	48.97 (17.49)	53.54 (19.89)	31.1*
Male/female (%)	49.4/50.6	45.8/54.2	50.2/49.8**
Educational level (%)			
Intermediate or secondary	265 (48.4)	13 (54.2)	36.8***
Degree and above	282 (51.6)	11 (45.8)	13.4%
Marital status (%)			
Single	137 (24.8)	18 (16.7)	56%****
Married	354 (64)	3 (75)	39%
Widowed/Divorced	62 (11.2)	2 (8.3)	5%
Housing type (%)			
Private	403 (73)	18 (75)	-
Rental	85(15.4)	4 (16.7)	-
Living with parents/ roommates	64 (11.6)	2 (8.3)	-
Monthly household income (%)			
Less than 2,399,000LL ~1,599.33USD	219 (40.7)	11 (47.7)	-
2,400,000-3,299,000LL~1,600-2,199.33USD	78 (14.5)	2 (8.7)	-
Greater than 3,300,000 LL~2,200USD	240 (44.7)	10 (43.5)	-

**CIA Factbook, 2019; **World Bank, 2016; ***CAS, 2004; ****CAS, 2007*

Table 2. Descriptive statistics for 40 SF-6Dv1 health state valuations comparing Lebanon and the UK

	Lebanon						United Kingdom					
Health State	Mean	S.D.	Minimum	Maximum	Median	N	Mean	S.D.	Minimum	Maximum	Median	N
111621	0.769	0.293	0.190	1.000	0.925	14	0.620	0.414	-0.060	0.990	0.845	10
113411	0.905	0.244	0.190	1.000	1.000	11	0.597	0.363	-0.140	0.980	0.610	12
115653	0.865	0.077	0.680	0.955	0.870	10	0.581	0.273	0.100	0.980	0.590	8
121212	0.911	0.095	0.730	1.000	0.920	12	0.783	0.235	0.280	0.970	0.783	7
122233	0.906	0.079	0.760	1.000	0.900	11	0.827	0.233	0.140	1.000	0.905	14
122425	0.859	0.143	0.520	1.000	0.910	12	0.657	0.357	0.100	1.000	0.855	10
131542	0.681	0.298	0.098	1.000	0.773	10	0.424	0.414	-0.660	0.960	0.450	17
132524	0.848	0.242	0.190	1.000	0.922	10	0.580	0.352	0.000	1.000	0.615	8
133132	0.815	0.137	0.595	1.000	0.820	12	0.569	0.364	0.000	1.000	0.670	11
142154	0.891	0.163	0.525	1.000	0.970	12	0.513	0.378	0.280	0.950	0.310	10
144341	0.806	0.208	0.460	1.000	0.871	10	0.727	0.247	0.120	0.990	0.825	30
211111	0.928	0.062	0.810	1.000	0.925	12	0.778	0.276	0.190	1.000	0.905	10
213323	0.900	0.079	0.820	1.000	0.860	10	0.743	0.255	0.120	0.980	0.790	12
224612	0.804	0.149	0.525	0.940	0.835	10	0.540	0.380	-0.240	0.880	0.670	9
232111	0.902	0.137	0.520	1.000	0.933	12	0.759	0.359	0.000	1.000	0.960	9
235224	0.740	0.248	0.190	1.000	0.855	12	0.468	0.307	0.100	0.990	0.430	11
241531	0.797	0.216	0.415	1.000	0.860	9	0.753	0.237	0.280	0.990	0.880	17
312332	0.882	0.133	0.600	1.000	0.940	11	0.778	0.267	0.190	1.000	0.910	12
315515	0.604	0.315	0.145	0.960	0.717	10	0.559	0.254	0.190	0.970	0.550	15
321122	0.873	0.155	0.460	1.000	0.915	11	0.757	0.248	0.190	0.990	0.850	17
323644	0.619	0.219	0.280	0.875	0.725	9	0.397	0.309	0.100	0.990	0.290	10
332411	0.922	0.111	0.680	1.000	1.000	11	0.770	0.269	0.190	1.000	0.835	12
341123	0.857	0.151	0.550	1.000	0.850	9	0.757	0.313	0.100	0.990	0.920	10
412152	0.766	0.173	0.460	0.950	0.820	11	0.501	0.284	0.100	0.930	0.590	10
414522	0.721	0.284	0.190	1.000	0.820	11	0.541	0.390	-0.010	1.000	0.570	11
421314	0.850	0.165	0.460	1.000	0.875	11	0.713	0.341	0.100	1.000	0.845	12
431443	0.681	0.289	0.190	0.985	0.800	11	0.613	0.384	0.000	1.000	0.805	12

443215	0.846	0.147	0.550	1.000	0.900	9	0.673	0.345	-0.060	1.000	0.805	12
511114	0.828	0.184	0.430	1.000	0.887	11	0.604	0.316	0.100	1.000	0.590	13
512242	0.756	0.122	0.505	0.925	0.775	11	0.705	0.188	0.250	0.910	0.750	11
522321	0.735	0.276	0.190	1.000	0.790	11	0.675	0.317	0.120	0.990	0.700	11
531635	0.624	0.298	0.145	0.980	0.685	12	0.439	0.950	-0.850	0.950	0.450	14
545422	0.661	0.280	0.098	1.000	0.690	14	0.604	0.325	0.100	0.990	0.620	9
614434	0.641	0.109	0.505	0.800	0.625	11	0.652	0.292	0.110	0.960	0.710	13
622513	0.729	0.219	0.288	0.960	0.815	12	0.567	0.368	0.000	1.000	0.640	13
625141	0.622	0.238	0.190	0.940	0.640	11	0.703	0.312	0.140	0.990	0.860	10
631355	0.597	0.209	0.190	0.910	0.610	12	0.657	0.300	0.100	0.980	0.700	15
633122	0.669	0.223	0.190	0.980	0.645	12	0.466	0.353	0.000	0.910	0.470	8
642612	0.625	0.239	0.190	0.910	0.650	11	0.484	0.397	-0.280	1.000	0.675	18
645655	0.340	0.236	0.010	1.000	0.300	563	0.213	0.428	-0.980	0.980	0.050	622

***SD**: Standard Deviation;*

Table 3. SF-6Dv1 parameter estimates for main effects models and consistent models.

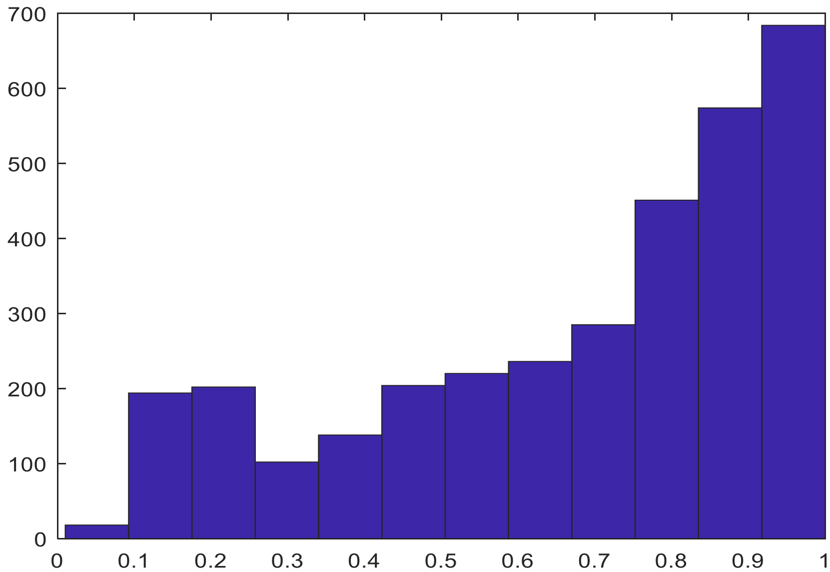
								Constant forced to unity							
	RE (Model 1)				RE consistent model (Model 2)				RE (Model 3)				RE consistent model (Model 4)		
	C	**SE**	**p**		**C**	**SE**	**p**		**C**	**SE**	**p**		**C**	**SE**	**p**
C	-0.034	0.015	0.019	**C**	-0.036	0.015	0.013	**C**	1.000			**C**	1.000		
PF2	-0.060	0.011	0.000					**PF2**	-0.068	0.010	0.000				
PF3	-0.048	0.011	0.000	**PF23**	-0.056	0.009	0.000	**PF3**	-0.053	0.011	0.000	**PF23**	-0.063	0.009	0.000
PF4	-0.093	0.011	0.000	**PF4**	-0.097	0.011	0.000	**PF4**	-0.099	0.011	0.000	**PF4**	-0.103	0.011	0.000
PF5	-0.128	0.011	0.000	**PF5**	-0.130	0.010	0.000	**PF5**	-0.132	0.010	0.000	**PF5**	-0.133	0.010	0.000
PF6	-0.213	0.011	0.000	**PF6**	-0.214	0.011	0.000	**PF6**	-0.218	0.011	0.000	**PF6**	-0.220	0.011	0.000
RL2	-0.007	0.008	0.422	**RL2**	-0.006	0.008	0.489	**RL2**	-0.013	0.008	0.111	**RL2**	-0.012	0.008	0.130
RL3	-0.013	0.009	0.158	**RL3**	-0.013	0.009	0.160	**RL3**	-0.017	0.009	0.052	**RL3**	-0.017	0.009	0.050
RL4	-0.043	0.009	0.000	**RL4**	-0.043	0.009	0.000	**RL4**	-0.048	0.009	0.000	**RL4**	-0.048	0.009	0.000
SF2	-0.014	0.009	0.138	**SF2**	-0.014	0.009	0.143	**SF2**	-0.021	0.009	0.018	**SF2**	-0.021	0.009	0.017
SF3	-0.044	0.010	0.000					**SF3**	-0.050	0.009	0.000				
SF4	-0.028	0.010	0.005	**SF34**	-0.036	0.008	0.000	**SF4**	-0.033	0.009	0.000	**SF34**	-0.042	0.008	0.000
SF5	-0.077	0.010	0.000	**SF5**	-0.078	0.010	0.000	**SF5**	-0.081	0.010	0.000	**SF5**	-0.083	0.010	0.000
PAIN2	-0.004	0.010	0.695	**PAIN2**	-0.003	0.010	0.761	**PAIN2**	-0.014	0.010	0.147	**PAIN2**	-0.013	0.009	0.153
PAIN3	-0.023	0.010	0.024	**PAIN3**	-0.023	0.010	0.025	**PAIN3**	-0.028	0.010	0.005	**PAIN3**	-0.028	0.010	0.005
PAIN4	-0.024	0.011	0.020	**PAIN4**	-0.026	0.010	0.014	**PAIN4**	-0.030	0.010	0.003	**PAIN4**	-0.032	0.010	0.002
PAIN5	-0.054	0.011	0.000	**PAIN5**	-0.054	0.011	0.000	**PAIN5**	-0.062	0.010	0.000	**PAIN5**	-0.062	0.010	0.000
PAIN6	-0.113	0.010	0.000	**PAIN6**	-0.114	0.010	0.000	**PAIN6**	-0.118	0.010	0.000	**PAIN6**	-0.119	0.009	0.000
MH2	-0.025	0.010	0.010	**MH2**	-0.023	0.010	0.017	**MH2**	-0.030	0.010	0.002	**MH2**	-0.027	0.010	0.004
MH3	-0.049	0.011	0.000					**MH3**	-0.053	0.011	0.000				
MH4	-0.049	0.011	0.000	**MH34**	-0.048	0.009	0.000	**MH4**	-0.053	0.010	0.000	**MH34**	-0.052	0.009	0.000
MH5	-0.097	0.011	0.000	**MH5**	-0.095	0.011	0.000	**MH5**	-0.101	0.011	0.000	**MH5**	-0.099	0.011	0.000
VIT2	-0.001	0.009	0.933	**VIT2**	0.001	0.009	0.947	**VIT2**	-0.008	0.009	0.347	**VIT2**	-0.007	0.009	0.413
VIT3	0.002	0.010	0.818	**VIT3**	0.005	0.010	0.660	**VIT3**	-0.003	0.010	0.783	**VIT3**	-0.001	0.010	0.937
VIT4	-0.011	0.010	0.269	**VIT4**	-0.008	0.010	0.400	**VIT4**	-0.017	0.010	0.072	**VIT4**	-0.014	0.009	0.127
VIT5	-0.063	0.010	0.000	**VIT5**	-0.060	0.010	0.000	**VIT5**	-0.067	0.010	0.000	**VIT5**	-0.064	0.010	0.000
N		3308				3308				3308				3308	
IC		2				0				2				0	
MAE		0.058				0.058				0.083				0.085	

RMSE	0.066	0.066	0.067	0.067
t(mean=0)	-0.030	-0.028	**-2.286**	**-2.417**
JBPRED	**150.42**	**150.28**	**145.08**	**144.45**
LB	**1263.5**	**1257.3**	**1256**	**1249.3**
AE > 0.05	100	102	104	103
AE > 0.10	36	35	35	37
AIC	-2060	-2084	-2063	-2087
BIC	-1889	-1931	-1899	-1940
LogLik	1058	1068	1058	1068

- RE: Random Effects; **SE**: standard error; **C**: coefficients; **p**: *p*-value; **PF**: Physical Functioning; **RL**: Role Limitation; **SF**: Social Functioning; **PAIN**: Pain; **MH**: Mental Health; **VIT**: Vitality; **IC**: Inconsistencies; **MAE**: Mean Absolute Error; **RMSE**: Root Mean Square Error; **JB:** Jarque-Bera; **LB:** Ljung-Box; **AE**: Absolute Error; **AIC:** Akaike's information criterion; **BIC:** Bayes information criterion; **LogLik**: Log-likelihood.

- Coefficients **PF2** and **PF3** were inconsistent, so they were merged in **PF23** coefficient
- Coefficients **SF3** and **SF4** were inconsistent, so they were merged in **SF34** coefficient
- Coefficients **MH3** and **MH4** were inconsistent, so they were merged in **MH34** coefficient

Figure 1. Histogram and descriptive statistics for the adjusted health state valuations



Observations	3308
Mean	0.679
Median	0.775
Maximum	1.000
Minimum	0.010
Std.Dev.	0.275
Skewness	-0.768
Kurtosis	-0.571

Figure 2. Actual and predicted health state valuations for the RE model (1).

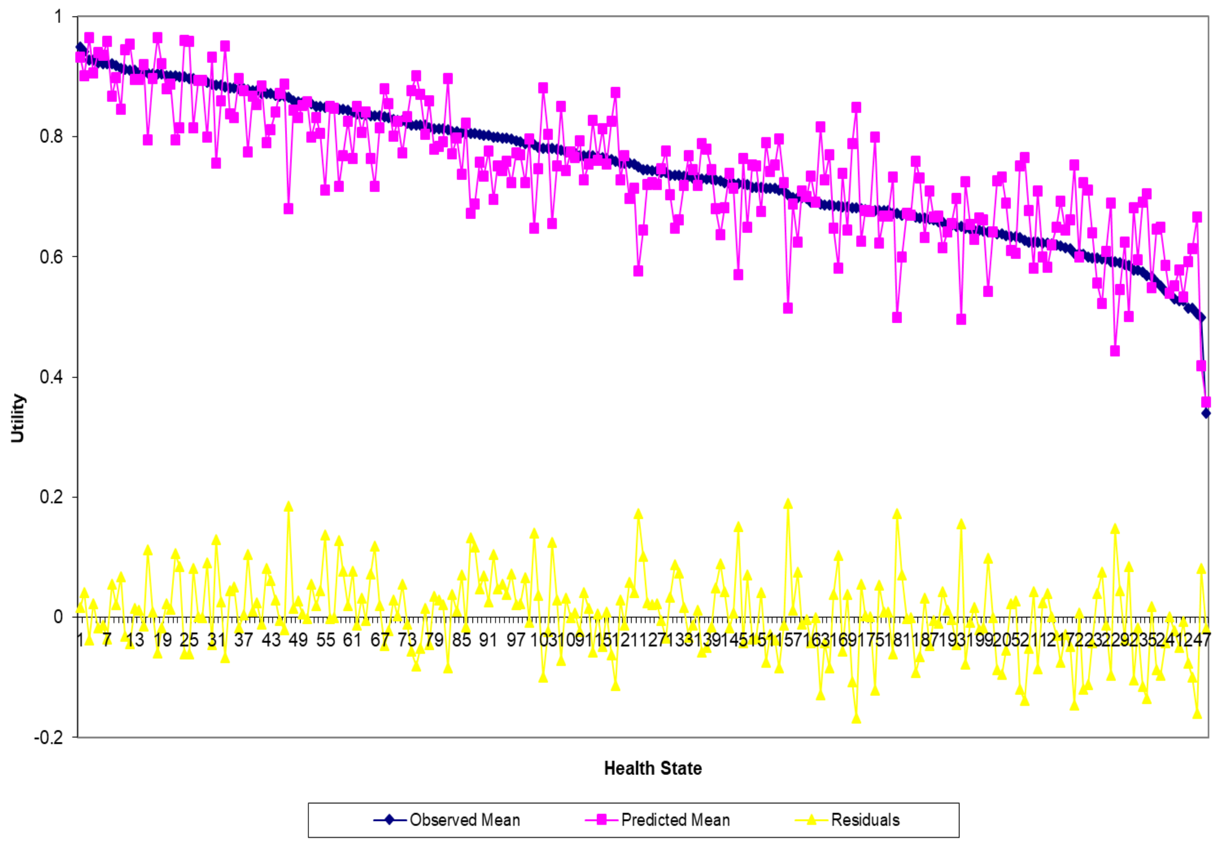
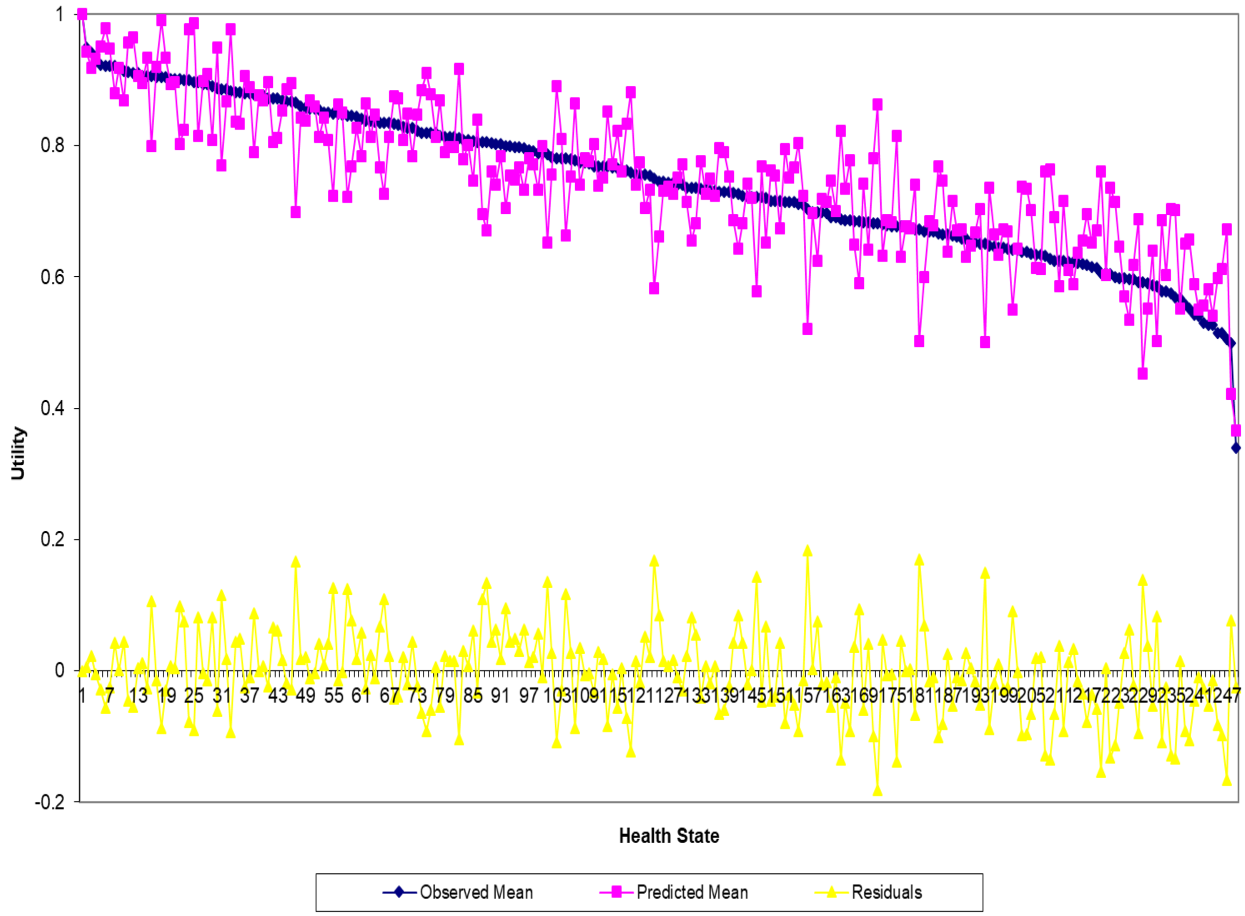


Figure 3. Actual and predicted health state valuations for the RE model with constant fixed to unity (3)



Appendix A. Final number of respondents by Governorate

Governorate	Lebanon general population (%)*	Study sample (N)
Beirut	10	60
Mount Lebanon	40	231
North	20	118
Bekaa	13	72
South	17	96
Total	100	577

** Lebanese Central Administration of Statistics [17-18]*

Appendix B. Actual and predicted health state valuations for the consistent RE model with constant fixed to unity (4)