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Selecting bolt-on dimensions for the EQ-5D: examining their contribution to health related quality of life

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Value in Health (in press 2018)

Abstract

Background: Generic preference based measures may miss dimensions important for the HRQoL of patients. When this happens, a possible solution is adding bolt-ons. Finch et al., (2017) have recently shown that bolt-ons can be systematically identified using factor analysis. However, as for each bolt-on option a complete re-evaluation may be required, methods to select between them are needed. This study investigates the possibility of selecting bolt-ons using their ability to predict differences in HRQoL. It tests six factors, energy/vitality, satisfaction, relationships, hearing, vision and speech, and 37 items loading on them, using the EQ-5D as a case study.

Methods: Data were obtained from the Multi Instrument Comparison study, an online survey on health and wellbeing measures in five countries. Two tests were performed. In the first test, linear regressions were fitted to determine whether different bolt-ons helped explain variations of HRQoL as measured by the Health VAS. The Health VAS upper anchor (100) is excellent physical, mental and social health. The Health VAS lower anchor (0) is death. Bolt-on relevance was judged comparing the strength, direction and statistical significance of unadjusted b coefficient. In the second test, linear regressions were fitted to further investigate whether different factors and items helped explain the negative effect of six chronic conditions on HRQoL. A reduction in the coefficients for the chronic conditions dummies meant that the factor or item detected the effect.

Results: Energy/vitality, relationships and satisfaction reported substantially larger coefficients than speech, vision and hearing. Also items loading on energy/vitality, relationships and satisfaction

generally presented larger coefficient than those of items loading on speech, vision and hearing. The second test did not detect consistent decrements in the chronic conditions coefficients when testing factors but it generally did detect consistent decrements when testing items.

Conclusions: The first test appeared useful for bolt-on selection. Further research is needed before employing the second test.

Introduction

The recent history of health related quality of life (HRQoL) measures can be traced back to the early 1970s^{1,2}, when these measures started to be developed to operationalize the definition of health proposed by the World Health Organization (WHO)³. As the WHO definition did not offer any guidance on the content required in a health measure, developers made their own judgments on which indicators i.e. dimensions or items⁴ and which aspects of the definition i.e. physical, mental and social wellbeing to consider^{e.g.5,6}. This resulted in HRQoL measures differing in their dimensions and items¹.

Nevertheless, HRQoL measures generally tap on theoretically interrelated domains, and a number of models have been proposed to explain the relationship between them^{e.g.7-9}. One of the most influential ones is the Wilson and Cleary (W&C) model¹⁰. According to the W&C model, HRQoL measures include domains related to one or more of five constructs, namely physiological factors, symptom status, functioning status, general health, and overall quality of life. Some measures include dimensions and items from multiple levels of the model, while others fit only at one level¹⁰.

A particular type of HRQoL measure use preference weights as a scoring system. These measures differ from others, as their scoring responds to the basic rational of economic calculus and can for this reason be used in the assessment of health care interventions¹. They are sometimes referred to as generic preference based measures (GPBMs), health state utility value measures or multi-attribute utility measures.

Similarly to other HRQoL measures, also GPBMs differ in the health dimensions and items they cover¹¹. In an effort to ensure consistency in decisions, health technology bodies tend to express a preference for using only one GPBM in all assessments e.g. the EQ-5D for the National Institute of Health and Care Excellence¹². Yet, this is not always possible, as some GPBMs may lack validity and responsiveness in some conditions and disease areas¹³. In those cases, using a different generic or specific measure with preferences attached¹ represents the suggested practise. However, the use of a different measure from the reference case undermines the cross-program comparability¹⁴⁻¹⁷, as it implies that different interventions are compared using different dimensions of health.

An option that has gained popularity consists in adding bolt-on dimensions to the measure lacking validity and responsiveness¹⁸. The use of bolt-ons might restore some form of comparability, as it ensures that the same core set of dimensions is used for all interventions. A recent study has shown that factor analysis can be used for identifying bolt-ons¹⁹. This study employed a set of measures that are commonly used in economic evaluations and have been shown to cover most of the domains of interest described in the Wilson and Cleary model²⁰. Hence, these represent an important and broad pool of candidate bolt-ons. By using factor analysis, Finch and colleagues¹⁹ identified 6 factors, and 37 items loading on them, that were not related to the EQ-5D-5L.

A complexity that makes GPBMs different from other HRQoL measures is that the bolt-ons cannot simply be added to the descriptive system of the original measure, but need to be valued in terms of preferences. Current evidence suggests that bolt-ons impact coefficients also for the pre-existing dimensions of GPBMs²¹⁻²⁵. This implies that for each bolt-on option, the new descriptive system needs to undergo a complete re-evaluation, a process that can be costly and complex. Hence, even if the bolt-ons measure distinct constructs relevant to expand the descriptive system of the investigated measure, some form of selection is required. However, methods for choosing between bolt-ons after factor analysis identification do not exist to date.

This study aims at covering this gap by exploring the possibility of using the ability of bolt-ons to predict differences in HRQoL to inform on their selection. This is an important aspect as the dimensions added to an HRQoL measure should tap on constructs that are relevant for patients and the general population. It uses linear regressions, a technique that was chosen as it is extremely common and easy to conduct²⁶. This maximizes the utility of this research for future applications. The EQ-5D-5L was chosen as a case study, as previous research has identified bolt-on factors and items for this measure¹⁹.

Methods

Data

This study used a large cross-sectional, observational online survey, the multi-instrument database. Data were collected by Richardson and colleagues^{20,27} and covered 12 HRQoL and wellbeing measures, among which those employed in the current study. This is to date the largest dataset on health and wellbeing measures available worldwide²⁰. A detailed description of collection methods is available elsewhere²⁷. Broadly, data were obtained using quotas to ensure a sample with similar socio-demographic characteristics across six countries (Australia, Canada, Germany, Norway, United Kingdom and United States). Responders were members of the general public who had previously agreed to participate in online surveys. Respondents were excluded if: i) they completed the survey in less than 20 minutes; ii) they stated not to have a health problem but reported a self assessed health status below 65 on the Health VAS scale; iii) large differences were found between duplicated questions; iv) more than 2 response levels difference were found in pain questions of the EQ-5D and the Assessment of Quality of Life (AQoL 8D). The final sample comprised 8022 individuals, 6262 of whom self reported to be affected by one of the following 9 chronic health conditions: asthma, cancer, chronic obstructive pulmonary disease (COPD), depression, diabetes, hearing problems, arthritis, heart diseases and stroke. The remaining 1760 individuals did not report to be affected by any chronic health condition.

Questionnaires, items and factors

This study used the Health VAS as a dependent variable. This was intended as a proxy of HRQoL. The Health VAS is a self reported rating scale of health today where 100 and 0 are anchors for excellent health and death, respectively. It differs from the EQ VAS as it describes perfect health from a broader perspective. More specifically, perfect health is defined as excellent physical, mental and social health. Physical health is defined as no pain, discomfort or itching, perfect hearing vision and speech, excellent strength, flexibility, movement and energy. Mental health is defined as very happy, enthusiastic and contented, never sad or depressed, confident and with high self worth. Social health is defined as excellent social and family relationships. As the Health VAS reported an approximately normal distribution, this was considered as a continuous variable.

The current study used the 5L version of the EQ-5D. In addition, items from the Short form 6 dimensions (SF-6D), the Health Utility Index Mark 3 (HUI3), the AQoL 8D, the 15D, the Personal Wellbeing Index (PWI), the Satisfaction with Life Scale (SWLS), the Office of National Statistics (ONS) and the ICEpop CAPability measure (ICECAP) were employed. These items are the 37 identified as potential bolt-ons related to factors not already covered by the EQ-5D presented in Finch and colleagues²⁰. This choice was made to allow comparability of results between item and factor regressions. All items from the GPBMs (EQ-5D, SF-6D, HUI3, AQoL 8D and 15D) and subjective wellbeing measures (SWBMs) (PWI, SWLS, ONS and ICECAP) were ordinal categorical, reporting levels varying between 4 and 11. Items for the PWI, SWBMs and ONS were recoded to report level 1 as perfect satisfaction. The EQ-5D and selected items from the SF-6D, HUI3, AQoL 8D, 15D, PWI, SWLS, ONS and ICECAP were used as independent variables, where each item was assigned a dummy for each of its levels. Wording for the items tested is presented in Appendix Table 1.

Finally, the 6 latent factors identified in Finch et al.,¹⁹ namely satisfaction, hearing, vision, energy/sleep, relationships and speech cognition, were employed. Latent factors are continuous variables and were used as independent variables.

Analyses

Two tests were performed. The first test was carried out to discriminate between bolt-ons in terms of their ability to detect variations in HRQoL not already accounted for by the EQ-5D-5L. The second test further examined whether detected variations helped explaining differences in HRQoL between patients and the general population in 9 chronic conditions. These information may be used to select between factor and items as for bolt-ons to be relevant they should be able to detect aspects of HRQoL not already covered by the parent measure i.e. EQ-5D, and these aspects should help explaining differences in HRQoL between patients and the general population for one or more conditions. The ability of factors and items to detect differences in HRQoL might suggest that their addition would improve the validity and responsiveness of the EQ-5D.

First test

In order to assess whether factors and items were able to detect differences in HRQoL as measured by the Health VAS, a base model was estimated regressing the Health VAS over the EQ-5D-5L dummies and socio-demographic controls. The model was subsequently extended with the inclusion of factors and items, each of which was added individually. Unstandardized β coefficients for factors and items are reported. For factors, these indicated the amount of decrease in HRQoL as a result of a unit change in the latent factor tested. For items, these indicated the amount of decrease in HRQoL associated with the level of the dummy variable compared to the reference case (best possible health/ satisfaction). The size, direction and statistical significance of the β coefficients were used to compare factors and items. Comparatively larger β coefficients meant that the factor /

item was better in predicting differences in HRQoL not already captured by the EQ-5D-5L. Non statistically significant β coefficients suggested no impact of the factor or item in predicting difference in HRQoL. If the addition of a factor or item made one or more of the EQ-5D-5L dimensions not statistically significant, this meant that it was able to take full account of variations of HRQoL for those dimensions. If the factor or item substantially reduced the coefficient of one or more of the EQ-5D-5L dimensions, this showed a possible interaction between that factor or item and the dimension for which the coefficient was reduced. These latter two pieces of information may be used for selecting factors or items e.g. if a choice between two items related to the same factor has to be made, the item having less impact on the remaining dimensions of the EQ-5D should be chosen as this shows that it has less overlap with the aspects of health already covered by the questionnaire.

Analyses of observable variables (item regressions) were conducted in STATA/MP 14 ©. Analyses of latent variables (factor regressions) were performed in Mplus version 7©.

Second test

In order to assess whether different factors and items were able to explain differences in HRQoL between patients and the general population, the second test replicated the methods employed by Bockerman et al.,²⁸. The Health VAS was firstly regressed upon EQ-5D-5L dimensions dummies, socio-demographic controls and dummy variables for asthma, cancer, COPD, depression, diabetes, hearing problems, arthritis, heart diseases or stroke. β coefficients for the conditions indicated the difference in HRQoL between responders in a disease group and the general population, not accounted by the EQ-5D-5L. Subsequently, the model was extended including also factors and items, each of which was added individually. If the factor or item took full account of variations in HRQoL for one condition, then the dummy variable for that condition was expected to be

insignificant. A reduction in the condition β coefficient represented the responsiveness of the bolt-on to differences in HRQoL for that condition, controlling for the EQ-5D-5L. Non statistically significant β coefficients suggested no impact of the factor or item in predicting differences in HRQoL between patients and the general population. If the addition of a factor or item made one or more of the EQ-5D-5L dimensions not statistically significant, this meant that the factor or item was able to take full account of variations in HRQoL for those dimensions in the general population group. If the factor or item substantially reduced the coefficient of one or more EQ-5D-5L dimensions, this showed a possible interaction between that factor or item and the dimension for which the coefficient was reduced in the general population group.

Analyses of observable variables (item regressions) were conducted in STATA/MP 14©. Analyses of latent variables (factor regressions) were performed in Mplus version 7©.

Results

Table 1 summarizes the background characteristics and health status, as measured by the 5L version of the EQ-5D, of the survey responders.

[Insert table 1]

First test

Table 2 presents the results for the base model using the first test. All EQ-5D-5L dimensions except self care were able to explain variations in HRQoL. Removal of usual activities from the regression model resulted in self care level 3 and level 4 becoming statistically significant with coefficients of -3.227 and -5.567, showing a possible interaction between usual activities and self care. β coefficients were larger at increasing levels of severity/ problems for all statistically significant dimensions but for usual activities, where level 4 was associated with a worst decrement than level 5. Mobility reported the smallest β coefficients, while anxiety and depression the largest.

[Insert table 2]

Table 3 presents the results for the regressions using factors and items (each added individually). As it can be seen, all factors explained variations in HRQoL over and above the EQ-5D-5L. The size of the β coefficients varied, with coefficients for relationships and satisfaction being approximately double, and of energy/sleep almost triple, than those for the remaining factors. All statistically significant dummies for the EQ-5D-5L dimensions in the base model remained statistically significant with the addition of latent factors, with their coefficients registering small or no changes.

[Insert table 3]

In the item regressions, the items' performance differed depending on the factor on which they loaded. Items loading on energy/sleep, relationships and satisfaction registered statistically significant results for most of their levels, while items loading on speech/cognition, vision and hearing were frequently non-significant. β coefficients were generally larger for the items loading on energy/sleep, relationships and satisfaction.

Systematic differences in the items' ability to detect variations in HRQoL were seen also between items loading on the same factor. For example, the items measuring energy in the energy/sleep factor reported substantially larger coefficients compared to the two items measuring sleep on the same factor. Similarly, while the two items measuring cognition on the speech/ cognition factor reported moderate and statistically significant coefficients, none of the speech items were statistically significant.

Finally, some items reported β coefficient decrements that were inconsistent with the increase in the level of severities/problems. For example, 15D mental function reported a larger coefficient for

level 2 of the dummy variable than for level 3, and AQL close relationships (family and friend) a larger coefficient for level 5 than for level 6.

All statistically significant dummies for the EQ-5D-5L in the base model remained statistically significant with the addition of the items. Generally, their coefficients registered small or no changes. However, coefficients for the EQ-5D anxiety and depression dimension often registered large decrements when items related to satisfaction were added, large to moderate decrements when items related to energy were added and moderate reductions when items related to relationships were added. The greatest reductions were noticed for items related to life satisfaction. Coefficients for the EQ-5D usual activities registered moderate decrements when energy items were added.

Second test

Appendix Table 2 presents the base model for the second test. Table 4 and Table 5 report the change in coefficients associated with the inclusion of factors and selected items. In the base model, dummies were statistically significant for all chronic conditions, showing that the EQ-5D-5L only partially captures differences in Health VAS between disease groups and the general population. The smallest coefficients were seen for hearing problems, arthritis and asthma, followed by depression, diabetes and heart diseases. Cancer, COPD and stroke reported the largest coefficients.

[Insert table 4]

[Insert table 5]

None of the factors was able to take full account of differences in Health VAS between patients and the general population, as chronic conditions dummies remained statistically significant and negative for all of them. However, five factors had an impact on one or more of the coefficients of the chronic conditions, reducing their magnitude. More specifically, satisfaction decreased COPD dummy by 0.617, vision decreased depression, diabetes, COPD and stroke dummies by 0.863,

0.503, 0.436 and 2.623, and hearing, speech/cognition and energy/sleep decreased stroke dummy by 0.589, 0.580 and 1.561. Decrements for COPD and stroke dummies should be interpreted with care, as they are based on small samples i.e. 23 observations for stroke and 66 for COPD.

All EQ-5D-5L dimensions that were statistically significant in the base model remained statistically significant with the addition of the latent factors, with their coefficients generally reporting small or no changes.

Also none of the items was able to take into full account differences in HRQoL between patients and the general population, as chronic conditions dummies remained statistically significant and negative. However, numerous items decreased chronic conditions β coefficients, with some of them having a general impact and other a specific one. For example, AQoL energy produced decrements on all chronic condition dummies that varied between -0.907 for arthritis and -3.059 for COPD. By contrast, the 15D hearing and HUI3 hearing substantially reduced only hearing problems (decrement of 0.974 and decrement of 0.706), with the next largest reduction being 4 and 3 times smaller i.e. COPD decreased by 0.226 for 15D hearing and by 0.221 for HUI3 hearing.

As for the first test, all the EQ-5D-5L dimensions that were statistically significant in the base model remained statistically significant with the addition of the items. Once again, coefficients for the EQ-5D anxiety and depression dimension often decreased when items loading on satisfaction, relationships and energy were added, with items related to life satisfaction causing the largest switches.

Items related to energy once again produced decrements in the coefficients for the EQ-5D usual activities. The largest reduction was registered with the addition of AQoL energy.

Discussion

This study investigated the potential of using linear regressions for selecting bolt-ons after factor analysis identification. It assessed the usefulness of two tests. The first test appeared appropriate for selecting between potential independent factors and items. Results for factors and items were concordant in pointing at relationships, energy/sleep and satisfaction factors, and items loading on them, as the mostly relevant bolt-ons. The study also showed systematic differences in items' ability to detect differences in HRQoL when they loaded on the same factor. These results suggest that despite loading on the same factor and being interrelated, energy and sleep measure partially different concepts, as do cognition and speech. As energy and cognition appeared better in explaining variations of HRQoL than sleep and speech, items related to these concepts should be preferred when adapting them into bolt-on dimensions. These findings agree with those of previous research^{29,30} that found "happiness", "emotional health", "cognition", "relationships" and "sensory deprivation" (e.g. vision loss) to be the most important aspects of health not covered by the EQ-5D. They also provide additional evidence compared to these studies on the relative importance of these aspects as add-on dimensions.

The second test generated results that are sometimes difficult to interpret. While none of the factors and items was able to fully account for differences in HRQoL between patients and the general population, they were frequently able to explain part of these differences. Decrements for items generally occurred in chronic conditions that were theoretically related to the aspects of health measured by the item. Some reductions occurred in chronic conditions not related to the aspects of health measured by the factor. Despite the number of observations for those conditions were generally small and therefore these results should be taken with care, the discrepancies in the results of factor and item regressions raise some doubts as to the ability of the second test to discriminate between bolt-ons. Further investigation is needed before using this technique.

This study used a set of strategies that were broadly based on the statistical significance of the factors and items tested, the size and direction of their coefficients and the consistency in HRQoL

decrements at increasing levels of severity to discriminate between candidate bolt-ons. The same set of strategies could be also employed to identify dimensions that need bolting off the investigated GPBM. This could be done in isolation, by selecting those dimensions that perform poorly, or comparatively, by comparing the size, direction and interaction of coefficients for the EQ-5D-5L and other measures' dimensions. Using the first approach would suggest, in the case of the current study, to bolt-off the EQ-5D-5L self care dimension, as most of its levels were not statistically significant due to an interaction with usual activities. Using the second approach would suggest, again in the context of the current research, to substitute the EQ-5D-5L self care or the EQ-5D-5L mobility dimensions with a dimension adapted from the items loading on the relationship or the satisfaction factors. Choice between these items could be informed by their impact on the remaining dimensions of the EQ-5D, where items causing smaller interactions should be preferred as they tap into aspects less related to those already covered in the EQ-5D. In addition, as some items reported decrements that were inconsistent with the increase in the levels of severity, it would be preferable to choose an item for a bolt-on dimension that had consistent decrements in HRQoL across severity levels.

Similarly, the size of β coefficients could also be used to set an empirical threshold of bolt-ons relevance. For example, coefficients for the “worst performing item” could be set as a threshold to compare coefficients from bolt-on items. If coefficients for the items are at least as large as those of the worst performing pre-existing dimension, then those items would be considered relevant bolt-on additions. This would result in retaining only items that are at least “as good” as the worst performing GPBM dimension. However, the usefulness of this approach depends on a number of aspects, among which the method used for the current analysis e.g. linear regression, the HRQoL proxy used and the inclusion of possible interaction terms.

This study has some limitations that need mentioning. First, it used linear regressions to model the impact of factors and items on HRQoL. Although this technique has been seen in numerous

occasions to produce reliable estimates in models with self reported rating scales as dependent variable³¹⁻³², other models could have been used to account for the bounding of the Health VAS variable e.g. Two limit tobit models. Second, possible interactions were noticed among some of the items and the EQ-5D dimensions. Interactions were initially calculated but were not reported as the large number of coefficients generated were difficult to interpret. Inclusion of interaction would have improved the precision of the estimates for those items. Third, factors and items tested in this study were identified through previous research that did not use disease specific measures. Hence, other factors and items not tested might be equally relevant additions to the EQ-5D-5L. Fourth, the second test covered only 9 chronic conditions, but also other conditions might have been relevant. Finally, sample sizes for the lowest levels of the scale were small in most of the variables tested. It is important to treat estimates generated from these dummies with care.

Despite these limitations, this study presents a useful method to select between alternative factors and items that can be developed/adapted into bolt-on dimensions. It is generalizable to other HRQoL measures, whether preference based or not, generic or disease specific, and for this reason it has a wide application in the field of measuring health. In addition, it provides evidence on the comparative relevance of a set of bolt-ons for the EQ-5D-5L.

Table 1. Background characteristics and health status of survey participants

Variable	Category	Frequencies	Percentages
Gender	Male	3848	48%
	Female	4174	52%
Age	18-24	513	6%
	25-34	944	12%
	35-44	1137	14%
	45-54	1689	21%
	55-64	2008	25%
	65+	1731	22%
Highest education achieved	High school	2522	31%
	Diploma or Certificate	3241	41%
	University	2259	28%
Self reported chronic health condition	None	1760	22%
	Asthma	856	11%
	Cancer	772	10%
	Chronic obstructive pulmonary disease	66	1%
	Depression	917	11%
	Diabetes	924	11%
	Hearing problems	832	10%
	Arthritis	929	11%
	Heart	943	12%
	Stroke	23	1%
EQ-5D mobility	No problems	5337	67%
	Slight problems	1491	19%
	Moderate problems	824	10%
	Severe problems	340	3%
	Extreme problems / Unable to	30	1%
EQ-5D self-care	No problems	7033	88%
	Slight problems	646	8%
	Moderate problems	273	3%
	Severe problems	62	1%
	Extreme problems / Unable to	8	<1%
EQ-5D usual activities	No problems	5182	65%
	Slight problems	1739	22%
	Moderate problems	794	9%
	Severe problems	256	3%
	Extreme problems / Unable to	51	1%
EQ-5D pain/discomfort	No problems	2340	29%
	Slight problems	3251	41%
	Moderate problems	1619	20%
	Severe problems	697	9%
	Extreme problems / Unable to	115	1%

EQ-5D anxiety / depression	No problems	4012	50%
	Slight problems	2348	29%
	Moderate problems	1107	14%
	Severe problems	393	5%
	Extreme problems / Unable to	162	2%

Note: each variable has a total number of responders of 8022.

Table 2. β coefficients, statistical significance and standard errors of dummy variables for the base model assessing the impact on HRQoL (Health VAS dependent variable)

Variables	β coefficients	Standard error
Constant	80.449**	0.830
Highschool education	(omitted)	(omitted)
Diploma education	-0.283	0.438
University education	0.991*	0.482
Age 18-24	(omitted)	(omitted)
Age 25-34	1.105	0.912
Age 35-44	0.009	0.887
Age 45-54	-0.580	0.852
Age 55-64	-0.653	0.843
Age >65	1.250	0.865
Male	(omitted)	(omitted)
Female	2.729**	0.378
EQ5D-5L mobility level 1	(omitted)	(omitted)
EQ5D-5L mobility level 2	-3.346**	0.573
EQ5D-5L mobility level 3	-5.788**	0.852
EQ5D-5L mobility level 4	-9.479**	1.302
EQ5D-5L mobility level 5	-10.543**	3.249
EQ5D-5L self care level 1	(omitted)	(omitted)
EQ5D-5L self care level 2	-2.202**	0.762
EQ5D-5L self care level 3	0.296	1.213
EQ5D-5L self care level 4	-0.941	2.313
EQ5D-5L self care level 5	1.710	5.924
EQ5D-5L usual activities level 1	(omitted)	(omitted)
EQ5D-5L usual activities level 2	-7.495**	0.560
EQ5D-5L usual activities level 3	-12.164**	0.900
EQ5D-5L usual activities level 4	-17.338**	1.428
EQ5D-5L usual activities level 5	-16.764**	2.584
EQ5D-5L pain discomfort level 1	(omitted)	(omitted)
EQ5D-5L pain discomfort level 2	-4.043**	0.474
EQ5D-5L pain discomfort level 3	-7.834**	0.646
EQ5D-5L pain discomfort level 4	-10.341**	0.912
EQ5D-5L pain discomfort level 5	-14.691**	1.776
EQ5D-5L anxiety depression level 1	(omitted)	(omitted)
EQ5D-5L anxiety depression level 2	-6.221**	0.448
EQ5D-5L anxiety depression level 3	-12.851**	0.603
EQ5D-5L anxiety depression level 4	-21.522**	0.921
EQ5D-5L anxiety depression level 5	-26.102**	1.378
R ²	0.439	

Note: * $P \leq 0.05$; ** $P \leq 0.01$

Table 3. β coefficients, statistical significance and standard errors of factors and items for the first test

Factor to which the item is related	Factor / Item tested	VAS dependent variable	
		β coefficients	Standard errors
/	Satisfaction	-4.323**	0.112
/	Relationships	-5.298**	0.235
/	Hearing	-1.209**	0.353
/	Speech / cognition	-2.269**	0.287
/	Vision	-2.185**	0.257
/	Energy / Vitality	-7.648**	0.217
Satisfaction	PWI satisfaction standard of living 1	(omitted)	(omitted)
	PWI satisfaction standard of living 2	-1.010	0.811
	PWI satisfaction standard of living 3	-2.830**	0.751
	PWI satisfaction standard of living 4	-6.449**	0.776
	PWI satisfaction standard of living 5	-8.040**	0.844
	PWI satisfaction standard of living 6	-10.477**	0.87
	PWI satisfaction standard of living 7	-9.834**	0.937
	PWI satisfaction standard of living 8	-12.078**	0.993
	PWI satisfaction standard of living 9	-14.152**	1.108
	PWI satisfaction standard of living 10	-12.871**	1.402
	PWI satisfaction standard of living 11	-11.483**	1.438
Satisfaction	PWI satisfaction achievement 1	(omitted)	(omitted)
	PWI satisfaction achievement 2	-0.102	0.86
	PWI satisfaction achievement 3	-2.648**	0.815
	PWI satisfaction achievement 4	-5.257**	0.832
	PWI satisfaction achievement 5	-8.485**	0.89
	PWI satisfaction achievement 6	-11.226**	0.869
	PWI satisfaction achievement 7	-12.363**	0.998
	PWI satisfaction achievement 8	-14.630**	1.058
	PWI satisfaction achievement 9	-17.779**	1.123
	PWI satisfaction achievement 10	-18.501**	1.258
	PWI satisfaction achievement 11	-18.922**	1.330
Satisfaction	ONS satisfaction with life 1	(omitted)	(omitted)
	ONS satisfaction with life 2	-0.361	0.88
	ONS satisfaction with life 3	-4.489**	0.845
	ONS satisfaction with life 4	-7.720**	0.883
	ONS satisfaction with life 5	-10.704**	0.946
	ONS satisfaction with life 6	-11.733**	0.949
	ONS satisfaction with life 7	-14.496**	1.050
	ONS satisfaction with life 8	-17.586**	1.081
	ONS satisfaction with life 9	-20.457**	1.095
	ONS satisfaction with life 10	-22.250**	1.217
	ONS satisfaction with life 11	-24.863**	1.236
Satisfaction	PWI satisfaction with life as a whole 1	(omitted)	(omitted)
	PWI satisfaction with life as a whole 2	-1.018	0.875
	PWI satisfaction with life as a whole 3	-4.575**	0.8
	PWI satisfaction with life as a whole 4	-8.823**	0.829
	PWI satisfaction with life as a whole 5	-12.252**	0.911
	PWI satisfaction with life as a whole 6	-12.376**	0.916
	PWI satisfaction with life as a whole 7	-15.976**	1.043
	PWI satisfaction with life as a whole 8	-19.238**	1.060
	PWI satisfaction with life as a whole 9	-21.300**	1.149
	PWI satisfaction with life as a whole 10	-19.737**	1.558
	PWI satisfaction with life as a whole 11	-22.271**	1.604
Satisfaction	SWLS satisfaction with life 1	(omitted)	(omitted)

	SWLS satisfaction with life 2	-3.511**	0.68
	SWLS satisfaction with life 3	-7.887**	0.721
	SWLS satisfaction with life 4	-12.342**	0.819
	SWLS satisfaction with life 5	-14.587**	0.828
	SWLS satisfaction with life 6	-19.591**	0.891
	SWLS satisfaction with life 7	-24.868**	1.145
Satisfaction	SWLS condition of life are excellent 1	(omitted)	(omitted)
	SWLS condition of life are excellent 2	-3.293**	0.821
	SWLS condition of life are excellent 3	-6.843**	0.828
	SWLS condition of life are excellent 4	-11.123**	0.884
	SWLS condition of life are excellent 5	-14.229**	0.902
	SWLS condition of life are excellent 6	-19.105**	0.951
	SWLS condition of life are excellent 7	-23.262**	1.130
Satisfaction	SWLS life close ideal 1	(omitted)	(omitted)
	SWLS life close ideal 2	-2.136	0.951
	SWLS life close ideal 3	-6.733**	0.952
	SWLS life close ideal 4	-9.657**	1.014
	SWLS life close ideal 5	-11.826**	1.031
	SWLS life close ideal 6	-17.383**	1.049
	SWLS life close ideal 7	-20.917**	1.192
Satisfaction	SWLS gotten important things in life 1	(omitted)	(omitted)
	SWLS gotten important things in life 2	-1.909*	0.623
	SWLS gotten important things in life 3	-6.409**	0.658
	SWLS gotten important things in life 4	-8.394**	0.75
	SWLS gotten important things in life 5	-10.542**	0.781
	SWLS gotten important things in life 6	-14.878**	0.859
	SWLS gotten important things in life 7	-17.962**	1.064
Satisfaction	ONS life is worthwhile 1	(omitted)	(omitted)
	ONS life is worthwhile 2	-0.991	0.752
	ONS life is worthwhile 3	-4.001**	0.729
	ONS life is worthwhile 4	-6.368**	0.76
	ONS life is worthwhile 5	-10.142**	0.81
	ONS life is worthwhile 6	-11.748**	0.808
	ONS life is worthwhile 7	-15.392**	1.057
	ONS life is worthwhile 8	-17.329**	1.129
	ONS life is worthwhile 9	-18.589**	1.127
	ONS life is worthwhile 10	-19.099**	1.234
	ONS life is worthwhile 11	-22.434**	1.403
Satisfaction	SWLS if I could live life over 1	(omitted)	(omitted)
	SWLS if I could live life over 2	-1.143	0.83
	SWLS if I could live life over 3	-3.139**	0.838
	SWLS if I could live life over 4	-4.461**	0.885
	SWLS if I could live life over 5	-6.846**	0.838
	SWLS if I could live life over 6	-8.685**	0.857
	SWLS if I could live life over 7	-12.862**	0.898
Satisfaction	ONS happiness yesterday 1	(omitted)	(omitted)
	ONS happiness yesterday 2	-1.693	0.719
	ONS happiness yesterday 3	-4.224**	0.712
	ONS happiness yesterday 4	-7.323**	0.749
	ONS happiness yesterday 5	-11.050**	0.816
	ONS happiness yesterday 6	-12.203**	0.793
	ONS happiness yesterday 7	-13.346**	1.002
	ONS happiness yesterday 8	-15.807**	1.095
	ONS happiness yesterday 9	-17.041**	1.061
	ONS happiness yesterday 10	-18.303**	1.203
	ONS happiness yesterday 11	-19.570**	1.139
Satisfaction	PWI satisfaction personal relationships 1	(omitted)	(omitted)
	PWI satisfaction personal relationships 2	-1.220	0.611
	PWI satisfaction personal relationships 3	-2.475**	0.627
	PWI satisfaction personal relationships 4	-4.891**	0.683
	PWI satisfaction personal relationships 5	-5.323**	0.793
	PWI satisfaction personal relationships 6	-7.147**	0.729

	PWI satisfaction personal relationships 7	-8.671**	0.963
	PWI satisfaction personal relationships 8	-10.254**	1.004
	PWI satisfaction personal relationships 9	-10.511**	1.059
	PWI satisfaction personal relationships 10	-11.847**	1.210
	PWI satisfaction personal relationships 11	-13.028**	1.248
Satisfaction	PWI satisfaction part of the community 1	(omitted)	(omitted)
	PWI satisfaction part of the community 2	-1.042**	0.801
	PWI satisfaction part of the community 3	-3.284**	0.753
	PWI satisfaction part of the community 4	-5.634**	0.783
	PWI satisfaction part of the community 5	-7.638**	0.845
	PWI satisfaction part of the community 6	-9.274**	0.757
	PWI satisfaction part of the community 7	-10.975**	1.029
	PWI satisfaction part of the community 8	-14.776**	1.112
	PWI satisfaction part of the community 9	-14.396**	1.149
	PWI satisfaction part of the community 10	-15.078**	1.298
	PWI satisfaction part of the community 11	-15.551**	1.380
Satisfaction	PWI satisfaction future security 1	(omitted)	(omitted)
	PWI satisfaction future security 2	-1.059	0.88
	PWI satisfaction future security 3	-2.746**	0.832
	PWI satisfaction future security 4	-4.238**	0.849
	PWI satisfaction future security 5	-6.783**	0.905
	PWI satisfaction future security 6	-8.868**	0.863
	PWI satisfaction future security 7	-9.674**	0.977
	PWI satisfaction future security 8	-10.433**	1.013
	PWI satisfaction future security 9	-13.005**	1.060
	PWI satisfaction future security 10	-13.540**	1.138
	PWI satisfaction future security 11	-14.227**	1.153
Satisfaction	PWI satisfaction spirituality 1	(omitted)	(omitted)
	PWI satisfaction spirituality 2	0.01	0.619
	PWI satisfaction spirituality 3	-0.236	0.628
	PWI satisfaction spirituality 4	-3.311**	0.729
	PWI satisfaction spirituality 5	-4.225**	0.875
	PWI satisfaction spirituality 6	-5.102**	0.517
	PWI satisfaction spirituality 7	-7.263**	1.160
	PWI satisfaction spirituality 8	-6.449**	1.345
	PWI satisfaction spirituality 9	-8.618**	1.593
	PWI satisfaction spirituality 10	-6.562**	1.738
	PWI satisfaction spirituality 11	-10.234**	1.348
Satisfaction	PWI satisfaction safety 1	(omitted)	(omitted)
	PWI satisfaction safety 2	-1.557	0.617
	PWI satisfaction safety 3	-3.609**	0.618
	PWI satisfaction safety 4	-6.792**	0.68
	PWI satisfaction safety 5	-7.524**	0.808
	PWI satisfaction safety 6	-9.551**	0.761
	PWI satisfaction safety 7	-10.360**	1.053
	PWI satisfaction safety 8	-13.351**	1.156
	PWI satisfaction safety 9	-13.584**	1.209
	PWI satisfaction safety 10	-16.936**	1.587
	PWI satisfaction safety 11	-15.295**	1.574
Relationships	AQoL enjoyment close relationships 1	(omitted)	(omitted)
	AQoL enjoyment close relationships 2	-2.410**	0.411
	AQoL enjoyment close relationships 3	-6.705**	0.633
	AQoL enjoyment close relationships 4	-9.235**	0.986
	AQoL enjoyment close relationships 5	-11.097**	3.265
Relationships	ICECAP Love and support 1	(omitted)	(omitted)
	ICECAP Love and support 2	-1.468**	0.42
	ICECAP Love and support 3	-5.282**	0.604
	ICECAP Love and support 4	-7.657**	1.561
Relationships	AQoL close relationships (family and friends) 1	-2.964**	0.425
	AQoL close relationships (family and friends) 2	-6.841**	0.619
	AQoL close relationships (family and friends) 3	-11.169**	0.885
	AQoL close relationships (family and friends) 4	-15.310**	1.815

	AQoL close relationships (family and friends) 5	-7.748**	2.095
Relationships	AQoL close relationships (including sexual) 1	(omitted)	(omitted)
	AQoL close relationships (including sexual) 2	-2.619**	0.449
	AQoL close relationships (including sexual) 3	-7.399**	0.570
	AQoL close relationships (including sexual) 4	-7.383**	0.920
	AQoL close relationships (including sexual) 5	-11.277**	1.365
Hearing	AQoL hearing 1	(omitted)	(omitted)
	AQoL hearing 2	-1.936**	0.443
	AQoL hearing 3	-2.576**	0.512
	AQoL hearing 4	-4.927**	1.126
	AQoL hearing 5	1.584	3.571
	AQoL hearing 1	8.191	5.420
Hearing	15 D hearing 1	(omitted)	(omitted)
	15 D hearing 2	-1.227*	0.49
	15 D hearing 3	-1.360	0.754
	15 D hearing 4	-0.047	2.090
	15 D hearing 5	1.965	4.522
Hearing	HUI 3 hearing 1	(omitted)	(omitted)
	HUI 3 hearing 2	-0.216	0.654
	HUI 3 hearing 3	-0.025	0.943
	HUI 3 hearing 4	-1.665	1.086
	HUI 3 hearing 5	-4.335*	1.478
	HUI 3 hearing 6	9.290	5.761
Speech / Cognition	AQoL communication 1	(omitted)	(omitted)
	AQoL communication 2	-0.842	0.606
	AQoL communication 3	-1.707	1.243
	AQoL communication 4	-1.457	2.042
Speech / Cognition	HUI 3 speech 1	(omitted)	(omitted)
	HUI 3 speech 2	-1.445	0.749
	HUI 3 speech 3	0.804	1.299
	HUI 3 speech 4	-2.176	2.655
	HUI 3 speech 5	-6.090	6.177
Speech / Cognition	15 D speech 1	(omitted)	(omitted)
	15 D speech 2	-3.441	0.702
	15 D speech 3	0.381	1.833
	15 D speech 4	3.228	3.752
	15 D speech 5	-9.872	8.141
Speech / Cognition	15 D mental function 1	(omitted)	(omitted)
	15 D mental function 2	-3.557**	0.471
	15 D mental function 3	-3.438*	1.215
	15 D mental function 4	-5.656	2.338
	15 D mental function 5	-1.006	6.211
Speech / Cognition	HUI 3 cognition 1	(omitted)	(omitted)
	HUI 3 cognition 2	-3.022**	0.674
	HUI 3 cognition 3	-3.674**	0.560
	HUI 3 cognition 4	-4.940**	1.056
	HUI 3 cognition 5	-7.719**	1.993
	HUI 3 cognition 6	5.787	4.269
Vision	AQoL vision 1	(omitted)	(omitted)
	AQoL vision 2	-2.390**	0.494
	AQoL vision 3	-4.070**	0.548
	AQoL vision 4	-8.383**	1.513
	AQoL vision 5	-33.079*	11.450
	AQoL vision 6	14.274	8.131
Vision	HUI 3 vision 1	(omitted)	(omitted)
	HUI 3 vision 2	-1.489**	0.420
	HUI 3 vision 3	-2.187	1.046
	HUI 3 vision 4	-1.321	1.049
	HUI 3 vision 5	-9.856**	2.178
	HUI 3 vision 6	-2.377	6.165
Vision	15D vision 1	(omitted)	(omitted)
	15D vision 2	-2.286**	0.458

	15D vision 3	-3.653**	1.062
	15D vision 4	-1.448	1.595
	15D vision 5	-1.779	5.148
Energy / Sleep	15D vitality 1	(omitted)	(omitted)
	15D vitality 2	-9.071**	0.456
	15D vitality 3	-17.609**	0.665
	15D vitality 4	-22.761**	0.862
	15D vitality 5	-29.180**	1.279
Energy / Sleep	AQoL energy 1	(omitted)	(omitted)
	AQoL energy 2	-5.036**	0.844
	AQoL energy 3	-12.392**	0.885
	AQoL energy 4	-19.350**	0.947
	AQoL energy 5	-25.957**	1.194
Energy / Sleep	SF-6D vitality 1	(omitted)	(omitted)
	SF-6D vitality 2	-3.228**	0.879
	SF-6D vitality 3	-8.685**	0.898
	SF-6D vitality 4	-14.132**	0.961
	SF-6D vitality 5	-19.493**	1.014
Energy / Sleep	AQoL enthusiasm 1	(omitted)	(omitted)
	AQoL enthusiasm 2	-1.937*	0.627
	AQoL enthusiasm 3	-7.473**	0.662
	AQoL enthusiasm 4	-14.735**	0.826
	AQoL enthusiasm 5	-19.979**	1.358
Energy / Sleep	AQoL sleeping 1	(omitted)	(omitted)
	AQoL sleeping 2	-2.119**	0.620
	AQoL sleeping 3	-4.776**	0.633
	AQoL sleeping 4	-7.722**	0.735
	AQoL sleeping 5	-9.646**	0.893
Energy / Sleep	15 D sleeping 1	(omitted)	(omitted)
	15 D sleeping 2	-2.452**	0.461
	15 D sleeping 3	-5.180**	0.580
	15 D sleeping 4	-7.396**	0.781
	15 D sleeping 5	-10.056**	1.673

Note: * $P \leq 0.05$; ** $P \leq 0.01$

Table 4. Changes in chronic condition β coefficients after factor were included individually

Chronic conditions	Base model coefficients	Factors – change in coefficients					
		Energy/ Sleep	Relationships	Satisfaction	Speech/ Cognition	Vision	Hearing
Cancer	-14.008	0.005	0.067	0.045	-0.070	-0.397	-0.069
Asthma	-9.587	-0.003	0.048	0.019	-0.042	-0.206	-0.040
COPD	-15.570	0.638	0.294	-0.617	-0.115	-0.436	-0.093
Depression	-11.123	-0.022	0.053	0.037	-0.055	-0.863	-0.055
Diabetes	-12.565	-0.050	0.053	0.062	-0.071	-0.503	-0.074
Hearing Problems	-6.890	0.027	0.031	-0.014	-0.014	-0.274	-0.009
Arthritis	-7.731	0.010	0.039	0.003	-0.029	-0.060	0.026
Heart diseases	-13.323	-0.030	0.063	0.047	-0.069	-0.322	-0.069
Stroke	-20.651	-1.561	0.010	1.735	-0.580	-2.623	-0.589

Note: **Bold** indicates reduction in b coefficients ≥ 0.5 . All coefficients were statistically significant at $p \leq 0.05$.

Table 5. Changes in chronic condition coefficients after items were included individually

		Factors on which items loaded									
		Energy / Sleep					Relationships				
		Items (change in coefficients)									
Chronic condition	Base model coefficients	15D vitality	AQoL8 enthusiasm	15D sleep	AQoL energy	SF6D vitality	AQoL sleeping	ICECAP love, friendship support	AQoL close rel (family friends)	AQoL close rel (sexual)	AQoL enjoyment close relationships
Cancer	-14.008	-1.733	-0.383	-0.263	-1.802	-1.048	-0.434	0.107	0.174	-0.066	0.07
Asthma	-9.587	-1.709	-0.377	-0.455	-1.618	-1.02	-0.439	0.008	-0.089	0.073	-0.062
COPD	-15.570	-2.162	-0.36	-0.590	-3.059	-2.187	-0.451	0.179	0.213	0.062	0.605
Depression	-11.123	-2.707	-1.763	-0.649	-2.836	-1.975	-0.807	-0.138	-0.677	-0.537	-0.696
Diabetes	-12.565	-1.835	-0.544	-0.279	-1.914	-1.160	-0.459	0.070	-0.118	-0.139	-0.111
Hearing Problems	-6.890	-1.13	-0.448	-0.111	-1.194	-0.561	-0.296	-0.074	-0.231	-0.106	-0.275
Arthritis	-7.731	-0.786	-0.403	-0.340	-0.907	-0.427	-0.477	0.097	-0.020	0.248	-0.013
Heart	-13.323	-2.031	-0.635	-0.355	-2.284	-1.363	-0.444	0.020	0.027	0.111	0.143
Stroke	-20.651	-2.959	-1.136	-0.561	-2.401	-0.265	-0.484	-1.010	0.009	-0.473	-0.28

Note: Bold indicates reduction in b coefficients ≥ 0.5 . All coefficients remained statistically significant at $p \leq 0.05$.

		Factors on which items loaded														
		Satisfaction														
		Items (change in coefficients)														
Chronic conditions	Base model coefficients	ONS life	SWLS condition life	SWLS live life over	PWI standard living	PWI achievement	PWI life as whole	SWLS life as whole	SWLS life close ideal	SWLS got important things	ONS things worthwhile	ONS happiness	PWI personal rel	PWI part community	PWI future security	PWI spirituality
Cancer	-14.008	-0.841	-0.943	0.138	0.023	-0.446	-0.397	-0.782	-0.573	-0.062	-0.408	-0.627	0.019	-0.282	-0.102	-0.252
Asthma	-9.587	-0.259	-0.513	0.065	-0.212	-0.254	-0.206	-0.252	-0.339	-0.195	-0.169	-0.381	-0.064	-0.059	-0.094	0.084
COPD	-15.570	-0.537	0.036	0.176	0.155	-0.168	-0.436	0.155	0.472	-0.725	-0.103	-0.276	0.200	-0.132	-0.138	-0.174
Depression	-11.123	-0.598	-0.883	-0.591	-0.232	-0.911	-0.863	-0.981	-0.65	-0.556	-0.802	-0.517	-0.314	-0.592	-0.256	-0.127
Diabetes	-12.565	-0.888	-0.832	-0.170	-0.453	-0.810	-0.503	-0.900	-0.674	-0.616	-0.832	-0.393	-0.166	-0.376	-0.28	-0.078
Hearing Problems	-6.890	-0.284	0.045	0.155	0.149	-0.167	-0.274	-0.228	0.040	0.119	-0.204	-0.193	-0.087	-0.199	0.003	0.034
Arthritis	-7.731	-0.223	-0.177	-0.165	0.156	-0.111	-0.060	-0.329	-0.238	-0.251	-0.097	0.114	-0.087	-0.008	0.048	0.051
Heart	-13.323	-0.537	-0.512	0.085	-0.153	-0.593	-0.322	-0.342	-0.316	0.074	-0.372	-0.25	0.028	-0.18	-0.169	0.022
Stroke	-20.651	-2.582	-3.519	-1.648	-1.293	-0.904	-2.623	-2.290	-1.263	-2.258	-0.828	-0.734	-0.532	-1.596	-1.732	-0.746

Note: **Bold** indicates reduction in b coefficients ≥ 0.5 . All coefficients remained statistically significant at $p \leq 0.05$.

Table 5. (continued)

Chronic condition	Base model coefficients	Factors on which items loaded										
		Vision			Hearing			Speech / cognition				
		Items (change in coefficients)										
		AQoL Vision	HUI3 Vision	15D Vision	AQoL Hearing	15D Hearing	HUI 3 Hearing	HUI 3 speech	15D mental function	AQoL communication	15D speech	HUI3 cognition
Cancer	-14.008	-0.194	-0.023	-0.052	-0.322	-0.112	-0.062	0.001	-0.296	-0.027	-0.019	-0.273
Asthma	-9.587	-0.218	-0.043	-0.038	-0.165	-0.073	-0.007	0.017	-0.070	0.002	-0.059	-0.101
COPD	-15.570	-0.284	-0.043	0.058	-0.441	-0.226	-0.221	-0.017	0.080	0.019	0.148	0.281
Depression	-11.123	-0.098	-0.101	0.052	-0.153	-0.055	-0.037	0.005	-0.456	-0.048	-0.100	-0.440
Diabetes	-12.565	-0.323	-0.139	-0.149	-0.181	-0.089	-0.067	0.016	-0.136	0.008	-0.008	-0.087
Hearing Problems	-6.890	-0.364	-0.184	-0.208	-1.663	-0.974	-0.706	-0.022	-0.327	-0.224	-0.171	-0.376
Arthritis	-7.731	-0.187	-0.055	-0.004	-0.182	-0.059	-0.023	0.032	-0.01	0.020	-0.017	0.013
Heart	-13.323	-0.208	-0.063	-0.057	-0.305	-0.108	-0.083	0.010	-0.08	-0.003	-0.057	-0.154
Stroke	-20.651	-0.832	-0.751	-0.477	-0.650	-0.153	-0.147	-0.139	-1.137	-0.202	-0.916	-1.293

Note: **Bold** indicates reduction in b coefficients ≥ 0.5 . All coefficients remained statistically significant at $p \leq 0.05$.

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Appendix Table 1. Items wording

Measure	Items	Wording of the first level of the item
EQ-5D-5L	EQ-5D-5L mobility	I have no problems in walking about
	EQ-5D-5L self care	I have no problems washing or dressing myself
	EQ-5D-5L usual activities	I have no problems doing my usual activities
	EQ-5D-5L pain/discomfort	I have no pain or discomfort
	EQ-5D-5L anxiety/depression	I am not anxious or depressed
SF-6D	SF-6D vitality	I have a lot of energy all of the time
HUI 3	HUI 3 vision	Able to see well enough to read ordinary newsprint and recognize a friend on the other side of the street, without glass
	HUI 3 hearing	Able to hear what is said in a group conversation with at least three other people, without a hearing aid
	HUI 3 speech	Able to be understood completely when speaking with strangers or people who know me well
	HUI 3 cognition	Able to remember most things, think clearly and solve day to day problems
AQoL 8D	AQoL energy	[Thinking about how much energy you have to do the things you want to do: I am] Always full of energy
	AQoL close relationships (family and friends)	[Your close relationships (family and friends) are:] Very satisfying
	AQoL communication	[How well can you communicate with others? (e.g., by talking, listening, writing or signing)] I have no trouble speaking to them or understanding what they are saying
	AQoL sleeping	[How often do you have trouble sleeping?] Never
	AQoL enthusiasm	[How enthusiastic do you feel?] Extremely
	AQoL enjoyment close relationships	[How much do you enjoy your close relationships (family and friends)?] Immensely
	AQoL vision	[How is your vision (while using any visual aids you need)?] I have excellent sight
	AQoL hearing	[How is your hearing (while using any hearing aids you need)?] I have excellent hearing
	AQoL close relationships (including sexual)	[Your close and intimate relationships (including any sexual relationships) make you:] Very happy
	15D	15D vision
15 D hearing		I can hear normally, i.e. normal speech (with or without a hearing aid)
15 D sleeping		I am able to sleep normally, i.e. I have no problems with sleeping
15 D speaking		I am able to speak normally, i.e. clearly, audibly and fluently

	15 D mental function	I am able to think clearly and logically, and my memory functions well
	15 D vitality	I feel healthy and energetic
ICECAP	ICECAP Love and support	I can have a lot of love, friendship, and support
ONS	ONS satisfaction with life	[Overall, how satisfied are you with your life nowadays?] Completely satisfied
	ONS life is worthwhile	[Overall, to what extent do you feel that the things you do in your life are worthwhile?] Completely worthwhile
	ONS happiness yesterday	[Overall, how happy did you feel yesterday?] Completely happy
PWI	PWI satisfaction with life as a whole	[Thinking about your own life and personal circumstances, how satisfied are you with your life as a whole?] Completely satisfied
	PWI satisfaction standard of living	[How satisfied are you with your standard of living?] Completely satisfied
	PWI satisfaction achievement	[How satisfied are you with what you are achieving in life?] Completely satisfied
	PWI satisfaction personal relationships	[How satisfied are you with your personal relationships?] Completely satisfied
	PWI satisfaction safety	[How satisfied are you with how safe you feel?] Completely satisfied
	PWI satisfaction part of the community	[How satisfied are you with feeling part of your community?] Completely satisfied
	PWI satisfaction future security	[How satisfied are you with your future security?] Completely satisfied
	PWI satisfaction spirituality	[How satisfied are you with your spirituality or religion?] Completely satisfied
SWLS	SWLS life close ideal	[In most ways my life is close to my ideal] How content are you with your life. Strongly agree
	SWLS condition of life are excellent	[The conditions of my life are excellent] How content are you with your life. Strongly agree
	SWLS satisfaction with life	[I am satisfied with my life] How content are you with your life. Strongly agree
	SWLS gotten important things in life	[So far I have gotten the important things I want in life] How content are you with your life. Strongly agree
	SWLS if I could live life over	[If I could live my life over, I would change almost nothing] How content are you with your life. Strongly agree

Appendix Table 2. β coefficients, statistical significance and standard errors of the base model assessing the impact on chronic health conditions HRQoL (Health VAS dependent variable)

Variables	β coefficients	Standard error
Constant	80.449**	0.830
High school education	(Omitted)	(Omitted)
Diploma education	0.121	0.422
University education	1.746**	0.465
Age 18-24	(Omitted)	(Omitted)
Age 25-34	1.196	0.877
Age 35-44	0.312	0.855
Age 45-54	0.409	0.829
Age 55-64	-1446	0.830
Age >65	3.551**	0.855
Male	(Omitted)	(Omitted)
Female	2.365**	0.368
EQ5D-5L mobility level 1	(Omitted)	(Omitted)
EQ5D-5L mobility level 2	-2.718**	0.553
EQ5D-5L mobility level 3	-5.272**	0.823
EQ5D-5L mobility level 4	-9.427**	1.256
EQ5D-5L mobility level 5	-9.955**	3.126
EQ5D-5L self care level 1	(Omitted)	(Omitted)
EQ5D-5L self care level 2	-2.381**	0.734
EQ5D-5L self care level 3	0.043	1.168
EQ5D-5L self care level 4	-1.955	2.225
EQ5D-5L self care level 5	1.183	5.697
EQ5D-5L usual activities level 1	(Omitted)	(Omitted)
EQ5D-5L usual activities level 2	-6.296**	0.543
EQ5D-5L usual activities level 3	-10.466**	0.870
EQ5D-5L usual activities level 4	-15.217**	1.379
EQ5D-5L usual activities level 5	-15.299**	2.488
EQ5D-5L pain discomfort level 1	(Omitted)	(Omitted)
EQ5D-5L pain discomfort level 2	-2.917**	0.462
EQ5D-5L pain discomfort level 3	-6.388**	0.634
EQ5D-5L pain discomfort level 4	-9.293**	0.889
EQ5D-5L pain discomfort level 5	-12.988**	1.713
EQ5D-5L anxiety depression level 1	(Omitted)	(Omitted)
EQ5D-5L anxiety depression level 2	-5.074**	0.435
EQ5D-5L anxiety depression level 3	-10.437**	0.614
EQ5D-5L anxiety depression level 4	-18.642**	0.945
EQ5D-5L anxiety depression level 5	-23.198**	1.380
Cancer	-14.008**	0.729
Asthma	-9.587**	0.680
COPD	-15.570**	2.008
Depression	-11.123**	0.753
Diabetes	-12.565**	0.682
Hearing problems	-6.890**	0.688
Arthritis	-7.731**	0.714
Heart diseases	-13.323**	0.686
Stroke	-20.651**	3.304
R ²	0.483	

Note: * $P \leq 0.05$; ** $P \leq 0.01$

