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Brief Report

Quality-Adjusted Life Expectancy Norms for the English Population

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ABSTRACT

Objectives: The National Institute for Health and Care Excellence in England has implemented severity-of-disease modifiers that give greater weight to health benefits accruing to patients who experience a larger shortfall in quality-adjusted life-years (QALYs) under current standard of care than healthy individuals. This requires an estimate of quality-adjusted life expectancy (QALE) of the general population based on age and sex. Previous QALE population norms are based on nearly 30-year-old assessments of health-related quality of life in the general population. This study provides updated QALE estimates for the English population based on age and sex.

Methods: 5-level version of EQ-5D data for 14 412 participants from the Health Survey for England (waves 2017 and 2018) were pooled, and health-related quality of life population norms were calculated. These norms were combined with official life tables from the Office for National Statistics for 2017 to 2019 using the Sullivan method to derive QALE estimates based on age and sex. Values were discounted using 0%, 1.5%, and 3.5% discount rates.

Results: QALE at birth is 68.24 QALYs for men and 68.21 QALYs for women. These values are significantly lower than previously published QALE population norms based on the older 3-level version of EQ-5D data.

Conclusion: This study provides new QALE population norms for England that serve to establish absolute and relative QALY shortfalls for the purpose of health technology assessments.

Keywords: absolute shortfall, EQ-5D, National Institute for Health and Care Excellence, population health, proportional shortfall, quality-adjusted life expectancy, quality-adjusted life-year shortfall.

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Introduction

The National Institute for Health and Care Excellence (NICE) published revised methods for health technology evaluation in January 2022.[1] As part of these revisions, NICE has introduced a new severity-of-disease modifier: a mechanism designed to enable their advisory committees to formally, quantitatively, and transparently grant additional weight to incremental quality-adjusted life-years (QALYs) provided to people with more severe health conditions. This mechanism furthers the development introduced through the end-of-life criterion in 2009, in which NICE moved away from the long-held view that QALY gains are equally valuable independent of who they accrue to.[2]

For the purpose of this modifier, NICE defines the severity of a health condition using 2 metrics: absolute QALY shortfall and proportional QALY shortfall. Absolute shortfall is quantified as the absolute number of future QALYs an individual can expect to lose as a result of that condition, given currently available interventions.[3] In contrast, proportional shortfall is quantified as the proportion of future QALYs a person can expect to lose as a result of their condition.[4] If the magnitude of these shortfall metrics is sufficiently large, any incremental gains in QALYs achieved by a new health technology are assigned weights greater than one, thus increasing the effective cost-effectiveness threshold for these interventions. Outside of England, absolute shortfall is used as severity modifier in Norway,[5,6] whereas proportional shortfall is applied in The Netherlands.[7,8]

Both shortfall metrics require 2 pieces of information: (1) an estimate of the number of future QALYs people who receive current standard of care can expect to experience in their lifetime and (2) an estimate of the number of future QALYs that individuals with the condition would have experienced had they been healthy. The first of these is a standard output of a cost-utility analysis and so is already available as part of a NICE appraisal conducted using current methods. The second is not routinely calculated as part of a current NICE assessment. In practical terms, this information could be estimated independently by each of the stakeholders making submissions to NICE or appraising evidence on behalf of NICE. Alternatively, reference values ("population norms") could be established outside the review process to improve consistency across appraisals, reduce the burden on stakeholders, and provide a basis for appraisal-specific modification if warranted.

Table 1. Mean EQ-5D-5L utility scores based on age group and sex and 95% confidence intervals (based on bootstrapping with 10 000 iterations and Hernandez Alava et al[21] crosswalk).

	Female		Male	
Age, years	Mean (95% CI)	n	Mean (95% CI)	n
16-17	0.878 (0.870-0.896)	151	0.918 (0.910-0.935)	146
18-19	0.856 (0.846-0.895)	122	0.930 (0.925-0.945)	110
20-24	0.859 (0.853-0.875)	370	0.894 (0.889-0.910)	298
25-29	0.869 (0.864-0.881)	515	0.895 (0.890-0.907)	366
30-34	0.869 (0.867-0.883)	669	0.915 (0.911-0.925)	450
35-39	0.854 (0.850-0.869)	722	0.863 (0.853-0.887)	465
40-44	0.846 (0.842-0.861)	668	0.872 (0.868-0.887)	498
45-49	0.806 (0.801-0.820)	693	0.822 (0.815-0.844)	527
50-54	0.798 (0.793-0.815)	729	0.836 (0.831-0.852)	529
55-59	0.791 (0.787-0.809)	730	0.809 (0.803-0.826)	582
60-64	0.776 (0.769-0.797)	608	0.803 (0.798-0.822)	532
65-69	0.775 (0.770-0.795)	619	0.797 (0.792-0.818)	568
70-74	0.784 (0.779-0.801)	619	0.801 (0.794-0.818)	505
75-79	0.730 (0.724-0.755)	399	0.788 (0.781-0.806)	335
80-84	0.710 (0.699-0.733)	268	0.767 (0.760-0.801)	233
85-89	0.666 (0.657-0.707)	145	0.727 (0.704-0.764)	126
90+	0.666 (0.651-0.721)	67	0.656 (0.635-0.730)	49

CI indicates confidence interval; EQ-5D-5L, 5-level version of EQ-5D.

Quality-adjusted life expectancy (QALE) population norms for several countries including England have been published by Heijink et al.[9] The authors combined mortality data from the Human Mortality Database 2013[10] and 3-level version of EQ-5D (EQ-5D-3L) data from the 1993 Measuring and Valuing Health (MVH) study[11] via a life table approach to derive estimates of QALE stratified based on age and sex. In 2020, Briggs et al[12] derived QALE estimates for the UK population by combining ONS mortality data for 2016 to 2018 with utility data from Kind et al[13] reported in Szende et al.[14] More recently, Palmer et al[15] used a 2-state Markov model to provide updated QALE estimates based on UK population life tables for the period 2017 to 2019. Each of these studies relies on the rather dated EQ-5D population norms from the 1993 MVH study and focuses on the -3L version of the instrument despite the 5-level version of EQ-5D (EQ-5D-5L) instrument—a newer version of the instrument with a more detailed descriptive system[16]—being rapidly adopted in clinical trials and observational studies. Furthermore, the EQ-5D-3L population norms were based on relatively small samples of individuals, which induces considerable sampling uncertainty in any assessment of severity of disease.[11] This limits the usefulness of existing QALE population norms for NICE decision making.

In this article, we report more recent (2017/2018) estimates of the QALE of the English population, drawing on a large data set of quality-of-life measurements collected using the EQ-5D-5L instrument. In parallel, we publish an R-Shiny online tool (https://shiny.york.ac.uk/shortfall) inspired by the iDBC platform of Versteegh et al (https://imta.shinyapps.io/iDBC/). Our tool enables users to combine QALE population norms with the outputs of an economic model to estimate the absolute and proportional QALY shortfall associated with a condition.

Methods

To derive QALE population norms, we combined age- and sex-specific EQ-5D-5L utility scores with national life tables of the English population.

National life tables (pooled for 2017-2019) were taken from the Office for National Statistics.[17] We used the Chiang II method to derive crude age- and sex-specific life expectancies (LEs).[18] The LE at the start of age interval i is accordingly estimated by dividing the number of years lived in that and all successive intervals by the number of people alive at the beginning of interval i.

Information on self-reported EQ-5D-5L health state profiles were retrieved from the 2017 and 2018 waves of the Health Survey for England (HSE), which is a long-running survey of the English population.[19,20] We used the individual sampling weights to adjust the sample for nonresponders and to make it nationally representative in terms of age, sex, and geography. The HSE is a survey of the noninstitutionalized general population. People in care homes or hospitals, prisoners, and asylum seekers are not included. Thus, the obtained health state profiles likely overestimate the health-related quality of life (HRQoL) of the population. Moreover, the HSE only provides a cross-sectional snapshot of the health of the population in the present. Future health trajectories may differ significantly from the trajectories observed in the HSE data.

Health states were valued in terms of utilities using Hernandez Alava et al[21] crosswalk method, which is the approach recommended by NICE.[1] This method maps the EQ-5D-5L health states to the EQ-5D-3L value set for the UK. To derive QALEs, mean utility scores based on age and sex were calculated and then combined with LE estimates, using the Sullivan method.[22] Age- and sex-specific QALE estimates for the English population are reported for a 1.5% and a 3.5% annual discount rate and undiscounted.

Table 2. LE and QALE based on age and sex with 0%, 1.5%, and 3.5% discount rates (based on Hernandez Alava et al[21] crosswalk utilities and 2017-2019 life tables).

	Female				Male			
	LE, years	QALE, quality adjusted life years			LE, years	QALE, quality adjusted life years		
Age, years		0%	1.5%	3.5%		0%	1.5%	3.5%
0	83.33	68.24	39.92	23.61	79.67	68.21	40.62	24.36
1	82.63	67.60	39.78	23.62	79.02	67.59	40.47	24.37
2	81.65	66.74	39.49	23.54	78.04	66.68	40.16	24.28
3	80.66	65.87	39.20	23.46	77.05	65.77	39.83	24.18
4	79.67	65.00	38.90	23.37	76.06	64.86	39.50	24.08
5	78.67	64.13	38.59	23.28	75.06	63.95	39.17	23.98
6	77.68	63.25	38.28	23.19	74.07	63.04	38.83	23.87
7	76.68	62.38	37.97	23.10	73.08	62.13	38.48	23.75
8	75.69	61.51	37.65	23.00	72.08	61.21	38.13	23.64
9	74.69	60.63	37.33	22.90	71.09	60.30	37.77	23.52
10	73.70	59.76	37.00	22.79	70.09	59.38	37.41	23.39
11	72.70	58.89	36.66	22.68	69.09	58.47	37.04	23.26
12	71.71	58.01	36.33	22.57	68.10	57.56	36.67	23.13
13	70.71	57.14	35.98	22.45	67.11	56.65	36.29	22.99
14	69.72	56.26	35.63	22.33	66.12	55.73	35.91	22.85
15	68.72	55.39	35.28	22.21	65.12	54.82	35.52	22.70
16	67.73	54.52	34.92	22.08	64.13	53.91	35.13	22.55
17	66.74	53.65	34.56	21.94	63.15	53.01	34.73	22.39
18	65.75	52.78	34.19	21.81	62.17	52.11	34.33	22.23
19	64.76	51.94	33.85	21.69	61.19	51.20	33.91	22.05
20	63.78	51.09	33.49	21.57	60.22	50.29	33.49	21.87
21	62.79	50.24	33.13	21.44	59.25	49.42	33.10	21.72
22	61.80	49.39	32.76	21.30	58.28	48.55	32.71	21.57
23	60.81	48.54	32.39	21.16	57.30	47.68	32.31	21.41
24	59.82	47.69	32.01	21.02	56.33	46.81	31.90	21.24
25	58.84	46.85	31.62	20.87	55.36	45.93	31.49	21.07
26	57.85	45.99	31.22	20.71	54.39	45.06	31.07	20.90
27	56.87	45.13	30.82	20.54	53.42	44.19	30.64	20.71
28	55.88	44.27	30.41	20.36	52.45	43.32	30.21	20.52
29	54.90	43.42	29.99	20.18	51.48	42.46	29.78	20.33
30	53.92	42.56	29.56	20.00	50.51	41.59	29.34	20.13
31	52.93	41.71	29.14	19.80	49.55	40.70	28.87	19.90
32	51.95	40.85	28.70	19.60	48.59	39.82	28.39	19.67
33	50.98	40.00	28.26	19.40	47.62	38.94	27.91	19.42
34	50.00	39.15	27.82	19.19	46.66	38.05	27.43	19.17
35	49.03	38.30	27.37	18.97	45.71	37.17	26.94	18.91
36	48.05	37.47	26.92	18.76	44.75	36.35	26.49	18.70
37	47.08	36.63	26.48	18.54	43.80	35.52	26.04	18.48
38	46.11	35.81	26.03	18.32	42.85	34.70	25.59	18.26
39	45.15	34.98	25.57	18.09	41.90	33.88	25.12	18.03
40	44.18	34.15	25.11	17.86	40.95	33.06	24.66	17.79
41	43.22	33.33	24.64	17.62	40.01	32.23	24.18	17.54
42	42.26	32.52	24.18	17.38	39.07	31.41	23.69	17.27
43	41.30	31.70	23.71	17.13	38.14	30.59	23.20	17.00

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Table 2. Continued

	Female				Male			
	LE, years	QALE, quality adjusted life years			LE, years	QALE, quality adjusted life years		
44	40.34	30.89	23.23	16.87	37.21	29.77	22.71	16.73
45	39.39	30.08	22.75	16.61	36.28	28.96	22.21	16.45
46	38.45	29.32	22.30	16.38	35.36	28.20	21.76	16.21
47	37.50	28.55	21.85	16.14	34.44	27.44	21.30	15.96
48	36.56	27.79	21.40	15.90	33.53	26.69	20.84	15.71
49	35.63	27.04	20.94	15.65	32.62	25.94	20.37	15.45
50	34.69	26.28	20.47	15.39	31.71	25.20	19.91	15.19
51	33.77	25.54	20.01	15.14	30.81	24.44	19.42	14.91
52	32.84	24.80	19.55	14.87	29.92	23.69	18.93	14.61
53	31.92	24.06	19.08	14.61	29.03	22.94	18.44	14.32
54	31.00	23.32	18.60	14.33	28.15	22.20	17.94	14.01
55	30.09	22.59	18.12	14.04	27.27	21.45	17.44	13.70
56	29.18	21.86	17.65	13.76	26.39	20.74	16.96	13.40
57	28.28	21.15	17.17	13.47	25.53	20.04	16.48	13.10
58	27.38	20.43	16.69	13.17	24.67	19.34	16.00	12.80
59	26.49	19.72	16.20	12.87	23.82	18.65	15.52	12.49
60	25.61	19.02	15.71	12.56	22.98	17.97	15.03	12.18
61	24.73	18.33	15.24	12.26	22.14	17.30	14.55	11.86
62	23.86	17.65	14.76	11.95	21.32	16.63	14.07	11.54
63	23.00	16.98	14.28	11.64	20.51	15.97	13.59	11.22
64	22.15	16.31	13.80	11.32	19.71	15.32	13.11	10.89
65	21.30	15.65	13.31	10.99	18.91	14.68	12.63	10.56
66	20.46	14.99	12.83	10.66	18.13	14.05	12.16	10.23
67	19.62	14.34	12.34	10.32	17.36	13.44	11.69	9.90
68	18.80	13.69	11.85	9.97	16.60	12.82	11.22	9.56
69	17.98	13.05	11.36	9.62	15.86	12.22	10.75	9.21
70	17.17	12.42	10.86	9.25	15.12	11.63	10.28	8.87
71	16.38	11.78	10.36	8.88	14.38	11.03	9.81	8.51
72	15.58	11.14	9.85	8.49	13.66	10.44	9.33	8.15
73	14.81	10.52	9.35	8.10	12.96	9.86	8.86	7.78
74	14.06	9.91	8.85	7.71	12.27	9.31	8.40	7.42
75	13.31	9.31	8.35	7.32	11.60	8.75	7.94	7.05
76	12.58	8.77	7.90	6.97	10.95	8.23	7.50	6.70
77	11.87	8.24	7.46	6.62	10.32	7.72	7.07	6.35
78	11.18	7.72	7.03	6.27	9.71	7.22	6.64	6.00
79	10.51	7.22	6.60	5.92	9.12	6.73	6.23	5.65
80	9.86	6.73	6.18	5.58	8.55	6.26	5.81	5.30
81	9.22	6.26	5.79	5.25	8.00	5.82	5.43	4.98
82	8.61	5.82	5.40	4.92	7.46	5.39	5.05	4.66
83	8.02	5.38	5.02	4.60	6.95	4.98	4.68	4.33
84	7.46	4.97	4.65	4.28	6.46	4.57	4.32	4.02
85	6.92	4.56	4.29	3.97	6.00	4.19	3.97	3.71
86	6.41	4.22	3.98	3.70	5.57	3.85	3.66	3.44
87	5.94	3.90	3.70	3.46	5.17	3.54	3.38	3.18
88	5.49	3.60	3.42	3.21	4.79	3.23	3.09	2.93

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Table 2. Continued

	Female				Male			
	LE, years	QALE, quality adjusted life years			LE, years	QALE, quality adjusted life years		
89	5.08	3.32	3.17	2.99	4.44	2.94	2.82	2.68
90	4.68	3.05	2.92	2.77	4.12	2.66	2.56	2.44
91	4.32	2.79	2.69	2.56	3.80	2.45	2.36	2.26
92	3.98	2.56	2.47	2.36	3.51	2.25	2.18	2.09
93	3.67	2.33	2.26	2.17	3.23	2.05	1.99	1.92
94	3.38	2.11	2.05	1.98	2.98	1.87	1.82	1.76
95	3.11	1.90	1.85	1.80	2.75	1.69	1.65	1.60
96	2.88	1.69	1.66	1.61	2.55	1.51	1.49	1.45
97	2.67	1.48	1.46	1.43	2.38	1.34	1.32	1.30
98	2.47	1.23	1.22	1.20	2.21	1.13	1.12	1.11
99	2.28	0.94	0.93	0.92	2.04	0.88	0.87	0.87

LE indicates life expectancy; QALE, quality-adjusted life expectancy.

In secondary analysis, we also construct QALE population norms using the crosswalk method proposed by van Hout et al[23] applied to the HSE data and using the EQ-5D-3L population norms reported by Kind et al.[11] We then compare the resulting estimates of QALE at different ages to gauge the effect of the HRQoL weights, holding mortality risks constant.

For the analysis, we had to make several assumptions. First, although life tables are reported based on single year of age, EQ-5D-5L data were only available according to the grouped age variable in the HSE (16-17 years, 18-19 years, followed by 5-year bands, up until 90+ years). We assumed that HRQoL was constant within each age band. Second, the HSE does not contain any EQ-5D-5L data for children under the age of 16 years. It was assumed that children aged 0 to 15 years had the same HRQoL as those aged 16 to 17 years. Third, the calculation of LEs was based on the assumption that individuals dying at a given year of age had an average survival of 6 months (half-cycle correction). The life table was closed at a maximum age of 100 years.

To help stakeholders estimate the absolute and proportional QALY shortfall, we developed an interactive web application: the "QALY Shortfall Calculator" is available at https://shiny.york.ac.uk/shortfall. It can be used to compute the difference between the QALE of individuals without and with a particular disease (the estimate for the latter obviously needs to be supplied by the user). The application allows the user to adjust the age and male/female distribution of the patient group and the discount rate that is applied.

The R source code of the web application, as well as the code used to generate the results reported in this article, is available online at https://github.com/bitowaqr/shortfall.

Results

A total of 16 175 individuals participated in the HSE in 2017 (n = 7997) and 2018 (n = 8178). Of these, 1762 respondents (10.9%) did not report their EQ-5D-5L health state and were excluded from the analysis. This left 14 413 individuals for the estimation of utility scores based on age and sex.

Average EQ-5D-5L utility scores based on age for male and female respondents are presented in Table 1.[21]

The age- and sex-specific period LE and QALE, undiscounted and with a 1.5% and 3.5% discount rate applied, are presented in Table 2.[21] At birth, women are expected to live considerably longer lives (+3.7 years) but have similar undiscounted QALE as men (+0.03 QALYs). Over time, the discrepancy in QALE between men and women increases: for example, at age 60 years, women can expect 1.07 more undiscounted QALYs than men.

Appendix Tables 1 and 2 in Supplemental Materials found at https://dx.doi.org/10.1016/j.jval.2022.07.005 provide QALE norms based on the same 2017 to 2019 life tables but using the van Hout et al[23] crosswalk from -5L to -3L and the original MVH EQ-5D-3L population norms,[11] respectively. Appendix Table 3 in Supplemental Materials found at https://dx.doi.org/10.1016/j.jval.2022.07.005 shows QALE estimates at selected ages (undiscounted) for all 3 valuation approaches. The 2 crosswalk methods generate very similar QALE estimates. In contrast, using the MVH population norms results in higher estimated QALE for women and, to a lesser degree, for men. For example, QALE at birth for females is estimated to be 71.9 QALYs or nearly 3.7 QALYs more than those estimated using the EQ-5D-5L crosswalk by Hernandez Alava et al[21] preferred by NICE. A similar albeit smaller gap of 1.0 QALYs is observed for men.

Discussion

NICE has introduced severity-of-disease modifiers that assign greater value to QALY gains for patients with greater absolute or relative expected shortfall in QALE under the current standard of care. This short note provides updated QALE population norms for England based on the EQ-5D-5L instrument that serve to establish the benchmark against which shortfalls can be assessed, thereby complementing recent work by Briggs et al[12] and Palmer et al.[15] The population norms presented here combine official, full population life tables with HRQoL data obtained from a large, representative sample of the English population and valued using NICE's newly preferred valuation method. Additional data tables and figures are made available through an interactive website (https://shiny.york.ac.uk/shortfall).

Existing QALE population norms for England[9,12,15] are based on population norms derived as part of the MVH study.[11] Our analysis

shows that this results in significantly higher QALE population norms and, ceteris paribus, larger estimates of QALY shortfall. This discrepancy may arise for a number of reasons such as changes in population health over the last 3 decades or noise introduced by the crosswalk from the EQ-5D-5L health states to EQ-5D-3L utility scores. Our analysis cannot disentangle these issues, and therefore, we call on NICE to take a position on which QALE population norm should be used in health technology assessments.

There are 3 main limitations to our study: First, both life tables and HRQoL data reflect the health of current populations, and as a result, our estimates should be interpreted as period QALEs. Medical and societal progress are likely to change both LE and HRQoL for future cohorts of patients, thus creating a need for regular updates of these QALE population norms. Second, approximately 10% of the participants in the HSE did not report their EQ-5D-5L health profiles and were therefore not included in the study. This might have introduced selection bias in our estimates of average HRQoL based on age and sex. Nevertheless, previous work by Love-Koh et al[24] found that imputing missing HRQoL data changed QALE estimates by less than 0.01 QALYs. Therefore, we believe that missing data are unlikely to introduce significant bias. Finally, our analysis is based on EQ-5D-5L data being mapped to and valued using the EQ-5D-3L value set (ie, cross-walking), which is consistent with NICE's current reference case. A new valuation study for the EQ-5D-5L is underway,[25] which will provide health state valuations without the need for crosswalks and associated loss of information. Once published, we plan to update the interactive website to give stakeholders access to QALE estimates based on this new value set.

Conclusion

This study provides new QALE population norms for England. These norms serve as an input for the calculation of absolute and relative QALY shortfalls to inform health technology assessment with severity of condition adjustment as applied in England.

Supplemental Material

Supplementary data associated with this article can be found in the online version at https://dx.doi.org/10.1016/j.jval.2022.07.005.

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Analysis and interpretation of data: McNamara, Schneider, Love-Koh, Doran, Gutacker
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