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A comparative study of health and wellbeing measures in Ireland using EQ-HWB, EQ-5D-5L, and ICECAP-A

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ABSTRACT

Objectives: The EQ-HWB is a new experimental measure of health and wellbeing, having been validated in an increasing number of countries and languages. This study aimed to examine the psychometric properties of the EQ-HWB and EQ-HWB-S in Ireland and compare them to the EQ-5D-5L and ICECAP-A.

Methods: We conducted a secondary analysis of data from a cross-sectional general population survey in Ireland (2023). The survey included the 25-item EQ-HWB (from which EQ-HWB-S responses were derived), EQ-5D-5L, ICECAP-A, socioeconomic and health-related questions. For the EQ-HWB, we computed Level Sum Scores (LSS), while the EQ-HWB-S was scored with the UK pilot value set. Multiple EQ-5D-5L value sets were used for the comparisons, including (1) the Irish 5L value set, (2) the English 5L and (3) the UK crosswalk. The ICECAP-A was scored with its UK general public values. Ceiling was determined for all instruments. Convergent and divergent validity were assessed through Spearman/Pearson correlation coefficients. Known-group validity was evaluated based on self-perceived health (5-point scale), history of chronic condition(s) and EQ VAS groups (cut-point=80). Effect sizes were calculated from Kruskal–Wallis H or Mann–Whitney U statistic. Exploratory factor analysis was conducted to identify the underlying constructs of these instruments.

Results: Data of 1220 respondents were analysed (69% with ongoing medical conditions). Mean EQ-HWB LSS was 51.9 (transformed 26.9), and index values were 0.755, 0.760-0.830

(depending on values set) and 0.807 for the EQ-HWB-S, EQ-5D-5L and ICECAP-A, respectively. The ceilings for the four measures in corresponding order were 3%, 7%, 23% and 15%. For the EQ-HWB items, the most problems were reported for 'feeling good about oneself' (85%) and 'exhaustion' (83%). Among corresponding items, the EQ-HWB 'unsupported' and 'loneliness' items correlated moderately with ICECAP-A attachment (0.440 and 0.430). The EQ-HWB 'control' correlated weakly with ICECAP-A autonomy (0.374), EQ-HWB 'feeling unsafe' with ICECAP-A stability (0.246), EQ-HWB 'do the things wanted to' with ICECAP-A enjoyment (0.196) and EQ-HWB 'feeling good about oneself' with ICECAP-A achievement. Both the EQ-HWB LSSs and EQ-HWB-S index values correlated strongly with EQ-5D-5L index (-0.705-0.719 and 0.740-0.759) and ICECAP-A index (-0.648 and 0.604), while moderately with EQ VAS (-0.505 and 0.489). All instruments demonstrated good known-group validity for health-related variables with moderate to strong effect sizes with the EQ-5D-5L's best overall performance. The exploratory factor analysis has identified five factors: 1) psychosocial health, 2) pain and discomfort, 3) sensory and physical functioning, 4) capability wellbeing, 5) positive psychological states. Only the stability ICECAP-A item loaded on the same factor (1st) as any EQ-5D-5L or EQ-HWB items. The three positively framed EQ-HWB items alone constituted factor 5.

Conclusion: This is the first study to validate the EQ-HWB in Ireland and the first to compare the psychometric properties of EQ-HWB and ICECAP-A. Our findings show the good psychometric performance of the EQ-HWB and EQ-HWB-S in a general Irish population sample. The EQ-5D-5L is more sensitive to capture health problems than the EQ-HWB, EQ-HWB-S or ICECAP-A. There appears to be only limited overlap in the wellbeing concepts captured by the EQ-HWB and ICECAP-A. Future studies should replicate these findings using the recently proposed modified wordings for the EQ-HWB, particularly for the positively framed items.

Keywords: 5-level EQ-5D, EQ Health and Wellbeing, EuroQol, ICECAP-A, health-related quality of life, capability wellbeing

INTRODUCTION

In recent years, there has been a growing recognition that traditional health-related measures alone may not capture the full spectrum of human wellbeing. This has led to an increased interest in developing more comprehensive assessment tools that extend beyond health-related quality of life (HRQoL) to encompass broader aspects of wellbeing. Existing measures such as the WHO Quality of Life (WHOQOL), Psychological Well-Being Scale (PWB), General Well-Being Schedule (GWBS) and the Satisfaction with Life Scale (SWLS) have paved the way for more holistic approaches to measuring wellbeing [1-3]. Building on this trend, the EQ-HWB is a new measure designed to assess interventions in healthcare, public health, and social care, with the intention that it can be used to estimate quality-adjusted life-years to inform decision-making both within and between these sectors [4].

The EQ-HWB differs from preference-based HRQoL instruments, such as the EQ-5D, by incorporating a broader range of health and wellbeing domains, including psychological and social wellbeing, in addition to physical and mental health [5]. The EQ-HWB has a long-form (25 items) and a short-form representing a subset of items (9 items; EQ-HWB-S), each serving different purposes. The long form is a profile measure, while the short form functions as a health classifier with a preference-based scoring (i.e. value set) [6]. The EQ-HWB-S has been officially recognized in Dutch guidelines as a recommended tool for evaluating non-curative interventions [7].

The capability approach and associated ICECAP measures [ICECAP-A (ICEpop CAPability measure for Adults 18+), ICECAP-O (ICEpop CAPability measure for Older people 65+), ICECAP-SCM (ICEpop CAPability Supportive Care Measure for use in economic evaluation conducted in an end of life setting)] provide an alternative framework for conceptualizing and measuring wellbeing, which differ from the EQ-HWB in several ways [8-10]. The capability approach emphasizes the importance of individual agency and freedom to pursue life goals and the ICECAP measures focus on capability and broader domains of wellbeing, such as autonomy, social participation, and security [11]. The ICECAP-A and ICECAP-O demonstrated good measurement performance in multiple populations [12, 13]. In some countries, including the UK [14] and the Netherlands [7], the ICECAP measures are on the list of recommended instruments to measure outcomes of health interventions with potential effects beyond health, e.g., social or long-term care [9].

While both the EQ-HWB-S and ICECAP measures employ preference-based scoring, there are important methodological distinctions in their approach. EQ-HWB-S values are anchored on the traditional utility scale, with 0 representing 'dead' and 1 representing 'full health'. Utilities can be multiplied with life years (i.e. survival time) to compute QALYs for cost-utility analysis. Conversely, ICECAP values are anchored on a 'no capability' (0) to 'full capability' (1) scale. In cost-effectiveness analyses, ICECAP values can be combined with time to generate years of full capability (YFCs), representing the total available capability over time [15, 16].

The current evidence on how well the EQ-HWB performs compared to other wellbeing or social care-related measures is limited. Existing qualitative and quantitative validation studies included the short Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS), personal-wellbeing (PWI-A), CarerQol-7D, Quality of Life - Aged Care Consumers (QOL-ACC) and Adult Social Care Outcomes Toolkit (ASCOT) [17-19]. However, no studies have compared the measurement performance of the EQ-HWB with any ICECAP measure. Several of the existing comparison studies used a preliminary version of the EQ-HWB [5, 20]. Furthermore, previously conducted comparative studies were concentrated in a limited number of countries, including the Argentina, Australia, China, Germany, United Kingdom, and the United States. Our study therefore aims to contribute to the existing evidence pool and assess the measurement performance of the English versions of the EQ-HWB and EQ-HWB-S in a sample of the adult general population in Ireland, and compare it with EQ-5D-5L and ICECAP-A.

METHODS

Study design and sample

This study was a secondary analysis of data collected from a cross-sectional online survey that aimed to derive a value set for the ICECAP Supportive Care Measure (ICECAP-SCM) based on preferences from the general Irish population [21]. The 25-item long format EQ-HWB along with EQ-5D-5L and ICECAP-A were included in the survey. The survey was open on 20 February 2023 and closed on 05 April 2023.

A reputable survey company recruited a sample of the adult general population in Ireland with nationally representative quotas on gender and age using their panel members. After removing 181 entries which were speeders (below 1/3 of the median duration), IP duplicates, and

'flatliners', i.e. respondents who always chose the same answer in one of the BWS/DCE tasks, the survey company supplied a final database with a sample of 1,220 completed entries.

Survey

The survey was in English, self-administered online and included sections on socio-demographic characteristics (age group, gender, partnership status, caregiving status, dependent children, general health status on excellent-to-poor scale with reasons in open text box, ongoing medical conditions, country of birth and current county, the importance of religion and spiritual beliefs, ethnicity, education and work status, experience of a life-limiting illness); 16 DCE and 16 BWS choice tasks based on ICECAP-SCM; the EQ-5D-5L, the ICECAP-A and the EQ-HWB 25-item long format. Ongoing medical conditions was assessed with the following question: *Do you have any of the following medical conditions? Select all that apply*. Caregiving status was assessed with the following two questions: *Are you currently providing help or support to a family member, friend, or neighbour (adult or child) who has a disability, mental health difficulty, chronic condition, dementia, terminal illness, drug or alcohol dependency, who needs care due to aging? If yes, how many hours did you spend on helping or supporting this person in the last 7 days*. The order of EQ-5D-5L, the ICECAP-A and the EQ-HWB was fixed. All questions in the survey were mandatory; and for some questions there was a 'prefer not to answer' option, therefore there were no missing data.

Outcome measures

The survey collected data on participant health and wellbeing using experimental English version for the UK of the EQ-HWB (version 1.2), English digital version of the EQ-5D-5L for the UK (version 1.0) and English version of the ICECAP-A.

EQ-HBW: The 25-item EQ-HWB captures health and well-being across domains of (1) activity, (2) autonomy, (3) cognition, (4) feelings and emotions, (5) relationships, (6) physical sensations, and (7) self-identity [4]. Except for the self-identity domain, the EQ-HWB-S captures the same domains as the full EQ-HWB. The timeframe of the instrument is the past seven days. In our study, participant responses for the 9-item EQ-HWB-S were extracted from the EQ-HWB.

Responses to items in the EQ-HWB are captured on a 5-point frequency scale ("None of the time," "Only occasionally," "Sometimes," "Often," "Most or all of the time"), difficulty scale

("No difficulty," "Slight," "Some," "A lot of," "Unable"), or severity scale ("no physical pain," "mild physical pain," "moderate physical pain," "severe physical pain," "very severe physical pain"). We computed level sum scores for the long version. Responses to the three framed items in the EQ-HWB ("Felt accepted," "Felt good about myself," and "I could do the things I wanted to do") were reverse scored before computing level sum scores, which were transformed to 0-100 range. We also used recently developed UK pilot value set for the EQ-HWB-S to obtain index values [6]. Potential values range from -0.384 (extreme problems on all dimensions) to 1 (full health).

EQ-5D-5L: The EQ-5D-5L is a generic measure of HRQoL that comprises of two parts: a descriptive system and the EQ VAS [22]. The descriptive system captures five dimensions of health, these are (1) mobility, (2) self-care, (3) usual activities, (4) pain/discomfort, and (5) anxiety/depression. Each dimension uses a severity scale with participants' responses ranging from 'no problems' (1) to 'unable to'/'extreme problems' (5). The EQ VAS records self-rated health on a vertical health thermometer anchored at 0 ('the worst health you can imagine') to 100 ('the best health you can imagine'). The timeframe for both the descriptive system and EQ VAS is the day of the completion. Multiple EQ-5D-5L value sets were used for the comparisons conducted in this study, including the Irish EQ-5D-5L index value set (values ranging from -0.974 (extreme problems on all dimensions) to 1 (full health)) [23], the English value set (values ranging from -0.285 (extreme problems on all dimensions) to 1 (full health)) [24], and the UK values derived using crosswalk from the EQ-5D-3L (values ranging from -0.594 (extreme problems on all dimensions) to 1 (full health)) [25].

ICECAP-A: The ICECAP-A is a measure of capability wellbeing for all adults (18+) consisting of the following five single-item dimensions: stability (an ability to feel settled and secure), attachment (an ability to have love, friendship and support), autonomy (an ability to be independent), achievement (an ability to achieve and progress in life) and enjoyment (an ability to experience enjoyment and pleasure)[10]. In each dimension, participants' responses may range from 'no capability' (1) to 'full capability' (4). The timeframe of the instrument is 'at the moment'. The UK value set was used to generate ICECAP-A scores [26]. Potential values range from 0 to 1, where 0 is the worst (i.e. no capability on any dimension) and 1 the best (full capability on all dimensions).

Statistical analyses

Participant characteristics

Descriptive statistics were used to describe key characteristics of the surveyed sample. Continuous variables were expressed as mean and SD or median and mode where relevant, whereas categorical variables were expressed as frequencies and percentages.

Floor and ceiling effect

We examined, both the item-level and instrument-level, floor, and ceiling effects of the EQ-HWB and EQ-HWB-S, and also in comparison to the EQ-5D-5L and ICECAP-A. We considered ceiling or floor effect to be present if either >70% responded in the top or bottom category [5]. However, given the general population sample, a skewed distribution was expected for several items. We used the threshold of 15% for the instrument level effect [27]. We hypothesized the highest ceiling for the EQ-5D-5L, which showed an average ceiling of 49% in earlier general population samples [28], and the lowest for the EQ-HWB, which has the highest number of items.

Convergent and divergent validity

Spearman's and Pearson's correlations were used to assess convergent and divergent validity. Correlations were interpreted according to Cohen's guidelines, i.e., "strong" (≥0.50), "moderate" (0.30-0.49), "weak" (0.10-0.29), and "none" (0-0.09) [29]. We expected moderate or strong correlations between items of different instruments covering the same health or wellbeing area, for example, between the EQ-HWB 'getting around inside and outside' and EQ-5D-5L 'mobility', EQ-HWB 'personal care' and EQ-5D-5L 'self-care', EQ-HWB 'unsupported' and 'loneliness' and ICECAP-A 'attachment'; the EQ-HWB 'control' and ICECAP-A 'autonomy'; EQ-HWB 'feeling unsafe' and ICECAP-A 'stability'; EQ-HWB 'do the things wanted to' and ICECAP-A 'enjoyment'; and EQ-HWB 'feeling good about oneself' and ICECAP-A 'achievement', among others. Otherwise, we expected weak or no correlation between items of different instruments.

Known-group validity

Known-groups validity was examined by comparing groups defined by age, sex, employment, education, caregiving (yes/ not currently, in the past/ no), general health status on excellent-to-

poor scale, EQ VAS (with a cutoff at 80) [5], and ongoing medical condition (none/any). Better HRQoL and wellbeing were anticipated with being employed, more educated, not being a caregiver, good or excellent general health status, an EQ VAS > 80 [30-33]. No hypotheses were set regarding age due to the mixed evidence about the association between age and wellbeing [34], nor sex as a prior study in Ireland found no sex differences in EQ-5D [33].

Differences were assessed using the nonparametric Mann–Whitney U test (2 groups) and Kruskal–Wallis H test (multiple groups). Effect sizes were calculated and interpreted as follows: eta squared based on the Kruskal–Wallis H-statistic "small" 0.01-0.059, "moderate" 0.06-0.139, "large" ≥0.14; Cohen's r based on the *z* value for the Mann–Whitney U "small" 0.11-0.30, "moderate" 0.31-0.49, "large" ≥0.5 [35].

Dimensionality and the dimension structure

Building on previous work on dimensionality of EQ-5D-5L and bolt-ons [36], we conducted an exploratory factor analysis (EFA) to better understand the dimensionality of the EQ-HWB and EQ-HBW-S instruments. In addition to the 25 EQ-HWB items, we also included items from the EQ-5D-5L and ICECAP-A instruments to see if the EQ-HWB measures capture similar or distinct underlying constructs related to health and wellbeing (i.e. loading on the same factor or not). The positively framed items of the EQ-HWB were appropriately recoded prior to analysis to ensure consistent interpretation of the factor loadings.

Initially, we performed Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy to assess the suitability of our data for factor analysis. The number of factors to retain was guided by examination of the scree plot and the application of the Kaiser criterion (eigenvalues > 1). Following this initial analysis, we conducted a Maximum Likelihood Factor Analysis, specifying a five-factor solution based on our preliminary findings. We applied a *promax* rotation to allow for potential correlations between factors, with a minimum loading criterion of 0.32 to determine item retention on factors (goodness of factor loadings: 0.33 to 0.44 (poor), 0.45 to 0.54 (fair), 0.55 to 0.62 (good), 0.63 to 0.70 (very good), and 0.71 (excellent)) [37]. All the statistics were two-sided, and $p < 0.05$ was considered statistically significant. Data were analysed with using Stata version 17.0 (StataCorp, 2021).

Ethics

This study has been approved by the Health Policy and Management and Centre for Global Health Research Ethics Committee [02/2022/02] at Trinity College Dublin.

RESULTS

Participant characteristics

Table 1 presents the demographic and health characteristics of the study sample (*n*=1220). The sample comprised predominantly younger adults. When compared to national representation, the age distribution of the sample was skewed towards younger age groups, with 51% of participants aged 18-34 years, compared to 22% nationally. Conversely, older age groups were underrepresented, with only 3% of the sample aged 65 or older, compared to 13% nationally. The gender distribution in the sample also differed from national figures, with females overrepresented at 67%.

In terms of socioeconomic characteristics, 52% of participants were married, in a civil partnership, or living together. The majority (61%) were employed or self-employed, and educational attainment was relatively high, with 32% holding a bachelor's degree or higher. The sample showed a diverse distribution across regions, with Dublin (36%) being the most represented area. Regarding health status, 84% of participants reported their health as good or excellent, with 39% scoring above 80 on the EQ VAS. However, 69% reported having at least one ongoing medical condition, with anxiety (38%) and depression (19%) being the most prevalent. The sample also captured aspects of caregiving and family responsibilities, with 37% of participants providing help or support to others, and 53% having dependent children.

Table 1: Participant characteristics (*n* = 1220)

Demographic characteristics	Frequency (%)	National statistics
Age		
18-24years	302 (24.75)	8.2%
25-34years	325 (26.64)	13.8%
35-44years	278 (22.79)	15.7%
45-54years	198 (16.23)	13.1%
55-64years	80 (6.56)	10.7%
65 or older	36 (2.95)	13.3%
Prefer not to answer	1 (0.08)	
Gender		
Female	815 (66.80)	50.6%
Male	395 (32.38)	49.2%
Non-binary	6 (0.49)	
Prefer not to answer	4 (0.33)	
Partnership status		

Married / Civil Partnered / Living together	635 (52.05)
Single	511 (41.89)
Divorced / Separated	47 (3.85)
Widowed	11 (0.90)
Other	3 (0.25)
Prefer not to answer	13 (1.07)
Employment status	
Employed or self-employed	748 (61.31)
Retired	40 (3.28)
Student	132 (10.82)
Looking after home or family	193 (15.82)
Long-term sick or disabled	59 (4.84)
Prefer not to answer	48 (3.93)
Highest level of education	
Some post-primary education or less	69 (5.66)
Leaving certificate	292 (23.93)
Post-Leaving certificate vocational training	148 (12.13)
Completed some third-level education	177 (14.51)
Higher certificate	129 (10.57)
Bachelor/ MSc/ PhD	391 (32.05)
None of the above	1 (0.08)
Prefer not to answer	13 (1.07)
Ethnicity	
White Irish	951 (77.95)
White Irish traveller	25 (2.05)
Any other white background	129 (10.57)
Black or Black Irish - African	30 (2.46)
Black or Black Irish - any other Black	12 (0.98)
Asian or Asian Irish - Chinese	7 (0.57)
Asian or Asian Irish - any other Asian	26 (2.13)
Other (incl. mixed background)	24 (1.97)
Prefer not to answer	16 (1.31)
Importance of religion, spirituality, or faith in your life	
Very important	245 (20.08)
Moderately important	314 (25.74)
Slightly Important	263 (21.56)
Not important	379 (31.07)
Prefer not to answer	19 (1.56)
How often do you engage in religious or spiritual activities	
Everyday	150 (12.30)
A few times a week	143 (11.72)
Once a week	133 (10.90)
A few times a month	142 (11.64)
A few times a year	257 (21.07)
Never or practically never	362 (29.67)
Prefer not to answer	33 (2.70)
Country of birth	
Ireland	942 (77.21)
Other	278 (22.79)
Region	
Dublin	441 (36.15)
South East	152 (12.46)
South West	140 (11.48)
Mid East	134 (10.98)
Border	108 (8.85)
Midlands	98 (8.03)
West	76 (6.23)
Mid West	71 (5.82)
Are you currently providing help or support?	
Yes	450 (36.89)
Not currently, but I have in the past	261 (21.39)
No	496 (40.66)
Prefer not to answer	13 (1.07)
In total, how many hours did you spend on helping or supporting this person (out of *n*=450)	
1 to 19	218 (48.44)
20 to 49	127 (28.22)

50 or more	87 (19.33)
Don't know	18 (4.00)
Do you have dependent children of any age?	
Yes	648 (53.11)
No	555 (45.49)
Prefer not to answer	17 (1.39)
General health status	
Excellent	166 (13.61)
Very good	472 (38.69)
Good	389 (31.89)
Fair	162 (13.28)
Poor	31 (2.54)
EQ VAS	
EQ VAS =< 80	749 (61.39)
EQ VAS > 80	471 (38.61)
Medical condition	
Anxiety	464 (38.03)
Arthritis	85 (6.97)
Asthma	152 (12.46)
Back problem	211 (17.30)
Cancer	16 (1.31)
Chronic obstructive pulmonary disease (COPD)	21 (1.72)
Chronic pain	69 (5.66)
Depression	227 (18.61)
Diabetes	46 (3.77)
Heart, stroke, and vascular disease	13 (1.07)
Hypertension	95 (7.79)
High cholesterol	103 (8.44)
Osteoporosis	26 (2.13)
Kidney disease	11 (0.90)
Other mental health and behavioural condition	95 (7.79)
Other	68 (5.57)
No ongoing medical conditions	383 (31.39)
Any	837 (68.61)

Note: *Central Statistics Office. Census of Population 2016 - Profile 3 An Age Profile of Ireland. 2016; https://www.cso.ie/en/releasesandpublications/ep/p-cp3oy/cp3/assr/. Accessed 15 June, 2023 [38].

Floor and ceiling effects

Across the various indices, respondents reported high levels of HRQoL and wellbeing, as indicated by modes consistently at the highest possible value (**Table 2**). The median values were generally higher than the means, suggesting left-skewed distributions for most measures. The standard deviations varied, with the Irish EQ-5D-5L index showing the highest variability in responses. The majority of the respondents reported no or only slight problems across various aspects of HRQoL and wellbeing.

Table 2: Descriptive statistics of the survey instruments' indices

Health and wellbeing	Mean (SD)	Min-Max (observed)	Min-Max (theoretical)	Median	Mode
EQ-5D-5L Index (England; Devlin et al)	0.830 (0.179)	-0.175 to 1	-0.285 to 1	0.872	1
EQ-5D-5L Index (UK crosswalk; van Hout et al)	0.760 (0.224)	-0.414 to 1	-0.594 to 1	0.791	1
EQ-5D-5L Index (Ireland; Hobbins et al)	0.770 (0.269)	-0.754 to 1	-0.974 to 1	0.852	1
EQ VAS	71.60 (19.63)	0 to 100	0 to 100	77	80
EQ-HWB-LSS	51.9 (16.04)	25 to 103	25 to 125	50	63
EQ-HWB-LSS transformed	26.9 (16.04)	0 to 78	0 to 100	25	12

EQ-HWB-S Index (UK pilot; Mukuria et al)	0.755 (0.211)	-0.204 to 1	-0.384 to 1	0.819	1
ICECAP-A Index (UK)	0.807 (0.178)	0.077 to 1	0 to 1	0.861	1

Note: Higher scores represent better HRQoL or wellbeing except for EQ-HWB LSS.

Table 3 presents the floor and ceiling effects of the study instruments. None of the measures demonstrated a significant floor effect, with 0% of respondents scoring the minimum possible value across all domains for the EQ-5D-5L, EQ-HWB, EQ-HWB-S, and ICECAP-A. There were two respondents that scored 0 on the EQ VAS. The EQ-5D-5L exhibited ceiling effect, with 22.54% of respondents scoring the maximum possible value across all five domains. Neither the EQ-HWB (2.62%) nor the EQ-HWB-S (6.64%) demonstrated any ceiling effect. The ICECAP-A demonstrated borderline ceiling effect with 14.59% of respondents scoring the maximum value. The EQ VAS did not show ceiling effect, with only 3.61% of respondents scoring 100.

Table 3: Floor and ceiling effect of the instruments

Instrument	Number of items	Minimum (floor) n (%)	Maximum (ceiling) n (%)
EQ-5D-5L	5	0	275 (22.54)
EQ VAS	-	2 (0.16)	44 (3.61)
EQ-HWB	25	0	32 (2.62)
EQ-HWB-S	9	0	81 (6.64)
ICECAP-A	5	0	178 (14.59)

Ceiling effects (>70% responses in the top category) were observed in several EQ-5D-5L (i.e., mobility, self-care, usual activities) and EQ-HWB items (i.e., hearing, mobility, personal care) (**Table 4**). The ICECAP-A did not demonstrate ceiling effects in any items. Floor effects were not observed in any of the instruments' items. The three positively framed EQ-HWB items showed the highest floor (10.57-14.10%).

Table 4: Distribution of item response for EQ-5D-5L, EQ-HWB, EQ-HWB-S, and ICECAP-A

Instrument	Item	Ceiling, %				Floor†, %
		1	2	3	4	5
EQ-5D-5L[a]	Mobility	**78.85**	13.61	5.49	1.48	0.57
	Self-care	**85.98**	7.54	4.43	1.64	0.41
	Usual activities	**70.41**	18.28	8.28	2.46	0.57
	Pain/discomfort	44.92	37.30	12.46	4.02	1.31
	Anxiety/depression	38.20	34.10	17.54	7.62	2.54
EQ-HWB[b]	Difficulty w/seeing	57.21	25.41	12.13	4.84	0.41
	Difficulty w/hearing	**73.52**	14.92	7.87	3.28	0.41
	Difficulty w/getting around inside and outside (mobility)*	**79.18**	9.59	7.79	2.54	0.90
	Difficulty w/day-to-day (daily activities)*	66.15	20.66	8.52	4.10	0.57
	Difficulty w/ washing, using the toilet, getting dressed,	**78.93**	9.75	7.05	3.52	0.74

	eating, or caring for your appearance (personal care)					
	Frequency (problems w/sleep)	26.23	34.02	22.21	11.89	5.66
	Frequency (exhausted) *	16.64	29.59	27.62	18.85	7.30
	Frequency (lonely) *	35.98	25.98	21.56	11.64	4.84
	Frequency (feel that people did not support)	36.89	27.62	22.54	9.34	3.61
	Frequency (trouble remembering)	46.97	27.54	15.82	7.30	2.38
	Frequency (trouble concentrating/thinking clearly) *	35.08	31.15	21.80	9.18	2.79
	Frequency (feel anxious) *	27.54	27.54	24.59	14.67	5.66
	Frequency (feel unsafe)	63.28	18.69	11.89	3.69	2.46
	Frequency (feel frustrated)	24.02	32.38	26.48	13.36	3.77
	Frequency (feel sad/depressed)*	30.41	30.41	22.21	12.30	4.67
	Frequency (feel nothing to look forward to)	40.41	25.41	18.69	9.84	5.66
	Frequency (feel no control over day-to-day life) *	44.51	24.34	18.03	9.59	3.52
	Frequency (feel unable to cope with day-to-day life)	48.20	24.18	15.74	7.87	4.02
	Frequency (feel accepted)[d]	25.16	21.80	21.80	17.13	14.10
	Frequency (feet good)[d]	15.08	22.62	29.18	20.49	12.62
	Frequency (could do things wanted)[d]	20.82	22.46	27.62	18.52	10.57
	Frequency (physical pain)	35.41	32.87	19.02	9.26	3.44
	Severity (physical pain)*	38.20	37.87	17.05	5.57	1.31
	Frequency (physical discomfort)	47.70	29.18	16.72	5.16	1.23
	Severity (physical discomfort)	41.39	39.34	14.26	4.02	0.98
ICECAP-A[c,d]	Stability (feeling settled and secure)	30.98	42.95	20.25	5.82	na
	Attachment (love, friendship and support)	44.34	34.59	19.10	1.97	na
	Autonomy (being independent)	51.31	35.25	11.72	1.72	na
	Achievement (achievement and progress)	31.48	44.59	20.16	3.77	na
	Enjoyment (enjoyment and pleasure)	38.03	38.69	20.82	2.46	na

Note: EQ-HWB = EuroQol Health and Wellbeing; w/ = with; ICECAP-A - ICEpop CAPability measure for Adults; na = not applicable

[a] EQ-5D-5L response scale: 1 = no problems, 2 = slight problems, 3 = moderate problems, 4 = severe problems, 5 = unable/extreme problems.

[b] EQ-HWB response scale: difficulty scale (1 = no difficulty, 2 = slight difficulty, 3 = some difficulty, 4 = a lot of difficulty, 5, unable); frequency scale (1 = none of the time, 2 = only occasionally, 3 = sometimes, 4 = often, 5 = most or all of the time); severity scale (1 = no pain, 2 = mild pain, 3 = moderate pain, 4 = severe pain, 5 = very severe pain)

[c] ICECAP-A response scale: 1 = full capability (can have, able) to 4 = no capability (cannot have/achieve, unable)

[d] Rescaled to ensure consistency across the response characteristics

* EQ-HWB-S items

┼ Level 4 was considered the floor for the ICECAP-A

Bolded ceiling effects >70% responses in the top category

Convergent and divergent validity

Correlations between EQ-5D-5L and EQ-HWB items

Analysis of the EQ-5D-5L and EQ-HWB items revealed strong correlations between conceptually similar domains, supporting convergent validity (**Table 5**). For example, the EQ-

HWB item 'getting around inside and outside' showed strong correlations with the EQ-5D-5L mobility (r = 0.579). Similarly, the EQ-HWB item ‘day-to-day’ correlated strongly with the EQ-5D-5L usual activities (r = 0.677). The EQ-HWB item ‘feel anxious’ and ‘feel sad/depressed’ items demonstrated strong correlations with the EQ-5D-5L anxiety/depression (r = 0.707 and 0.648).

Table 5: Correlation coefficients (Spearman) between EQ-5D-5L and EQ-HWB items (n=1220)

Instrument	Item	EQ-5D-5L[a]				
		Mobility	Self-care	Usual activities	Pain/ discomfort	Anxiety/ depression
EQ-HWB[b]	Difficulty w/seeing	0.195	0.211	0.213	0.205	0.213
	Difficulty w/hearing	0.271	0.376	0.345	0.226	0.180
	Difficulty w/getting around inside and outside (mobility)*	**0.579**	**0.528**	**0.536**	0.355	0.196
	Difficulty w/day-to-day (daily activities)*	**0.534**	**0.522**	**0.677**	0.487	0.329
	Difficulty w/ washing, using the toilet, getting dressed, eating, or caring for your appearance (personal care)	0.443	**0.620**	**0.551**	0.346	0.271
	Frequency (problems w/sleep)	0.251	0.226	0.346	0.374	0.401
	Frequency (exhausted) *	0.226	0.191	0.331	0.404	0.444
	Frequency (lonely) *	0.224	0.255	0.364	0.308	**0.541**
	Frequency (feel that people did not support)	0.187	0.224	0.346	0.299	0.465
	Frequency (trouble remembering)	0.181	0.226	0.295	0.248	0.297
	Frequency (trouble concentrating/thinking clearly) *	0.218	0.267	0.366	0.324	0.449
	Frequency (feel anxious) *	0.139	0.196	0.312	0.280	**0.707**
	Frequency (feel unsafe)	0.273	0.387	0.381	0.285	0.424
	Frequency (feel frustrated)	0.189	0.224	0.338	0.302	**0.502**
	Frequency (feel sad/depressed)*	0.193	0.250	0.329	0.284	**0.648**
	Frequency (feel nothing to look forward to)	0.246	0.259	0.363	0.315	**0.526**
	Frequency (feel no control over day-to-day life) *	0.214	0.294	0.361	0.300	0.487
	Frequency (feel unable to cope with day-to-day life)	0.248	0.334	0.406	0.330	**0.542**
	Frequency (feel accepted)[c]	0.113	0.150	0.152	0.031[1]	0.159
	Frequency (feet good)[c]	0.098	0.121	0.158	0.088[2]	0.281
	Frequency (could do things wanted)[c]	0.160	0.176	0.182	0.074[3]	0.188
	Frequency (physical pain)	0.377	0.267	0.408	**0.644**	0.288
	Severity (physical pain)*	0.397	0.329	0.436	**0.670**	0.305
	Frequency (physical discomfort)	0.254	0.285	0.369	0.404	0.368
	Severity (physical discomfort)	0.435	0.346	0.443	**0.594**	0.340

Note: EQ-HWB = EuroQol Health and Wellbeing; w/ = with; ICECAP-A - ICEpop CAPability measure for Adults; na = not applicable

[a] EQ-5D-5L response scale: 1 = no problems, 2 = slight problems, 3 = moderate problems, 4 = severe problems, 5 = unable/extreme problems.

[b] EQ-HWB response scale: difficulty scale (1 = no difficulty, 2 = slight difficulty, 3 = some difficulty, 4 = a lot of difficulty, 5, unable); frequency scale (1 = none of the time, 2 = only occasionally, 3 = sometimes, 4 = often, 5 = most or all of the time); severity scale (1 = no pain, 2 = mild pain, 3 = moderate pain, 4 = severe pain, 5 = very severe pain)

[c] Rescaled to ensure consistency across the response characteristics

* EQ-HWB-S items

All Spearmen's correlation coefficient were statistically significant (p <0.001), unless specified otherwise, i.e. [1] p = 0.282, [2] p < 0.01, [3] p < 0.05. Correlations were interpreted according to Cohen's guidelines, i.e., "strong" (≥0.50), "moderate" (0.30-0.49), "weak" (0.10-0.29), and "none" (0-0.09). **Bolded** results indicate a strong correlation.

Correlations between EQ-HWB and ICECAP-A items

We observed moderate correlations between conceptually similar items across the EQ-HWB and ICECAP-A instruments, indicating convergent validity (**Table 6**). Notably, the EQ-HWB 'unsupported' and 'loneliness' items showed moderate correlations with the ICECAP-A attachment domain (r = 0.440 and 0.430, respectively).

However, some expected relationships showed weaker correlations than anticipated. For instance, the EQ-HWB 'control' item correlated only weakly with ICECAP-A autonomy (r = 0.374), despite both concepts relating to independence and self-determination. Similarly, EQ-HWB 'feeling unsafe' showed a weak correlation with ICECAP-A stability (r = 0.246), and EQ-HWB 'do the things wanted to' correlated weakly with ICECAP-A enjoyment (r = 0.196). The EQ-HWB 'feeling good about oneself' item also demonstrated a weak correlation with ICECAP-A achievement.

Table 6: Correlation coefficients (Spearman) between EQ-5D-5L, EQ-HWB and ICECAP-A items (n=1220)

Instrument	Item	ICECAP-A[c]				
		Stability	Attachment	Autonomy	Achievement	Enjoyment
EQ-5D-5L[a]	Mobility	0.178	0.155	**0.316**	0.207	0.207
	Self-care	0.110	0.186	0.281	0.263	0.224
	Usual activities	0.269	0.228	**0.374**	**0.363**	**0.329**
	Pain/discomfort	0.295	0.230	**0.311**	**0.316**	**0.312**
	Anxiety/depression	**0.462**	0.290	0.289	**0.376**	**0.395**
EQ-HWB[b]	Difficulty w/seeing	0.166	0.152	0.205	0.181	0.173
	Difficulty w/hearing	0.064[2]	0.145	0.172	0.164	0.147
	Difficulty w/getting around inside and outside (mobility)*	0.085	0.176	**0.315**	0.228	0.208
	Difficulty w/day-to-day (daily activities)*	0.225	0.209	**0.365**	**0.320**	0.293
	Difficulty w/ washing, using the toilet, getting dressed, eating, or caring for your appearance (personal care)	0.125	0.203	**0.317**	0.249	0.246
	Frequency (problems w/sleep)	**0.376**	0.230	0.272	**0.323**	**0.322**
	Frequency (exhausted) *	**0.425**	0.263	0.256	**0.321**	**0.378**
	Frequency (lonely) *	**0.445**	**0.429**	**0.326**	**0.388**	**0.452**
	Frequency (feel that people did not support)	**0.389**	**0.440**	0.295	**0.349**	**0.425**
	Frequency (trouble remembering)	0.276	0.253	0.274	**0.312**	**0.322**
	Frequency (trouble concentrating/thinking clearly) *	**0.367**	0.273	**0.304**	**0.316**	**0.366**
	Frequency (feel anxious) *	**0.472**	0.297	0.288	**0.380**	**0.409**
	Frequency (feel unsafe)	0.246	0.271	**0.310**	0.279	**0.300**
	Frequency (feel frustrated)	**0.415**	**0.302**	0.296	**0.359**	**0.403**
	Frequency (feel sad/depressed)*	**0.459**	**0.337**	**0.313**	**0.375**	**0.438**

Frequency (feel nothing to look forward to)	**0.415**	**0.379**	**0.333**	**0.405**	**0.451**
Frequency (feel no control over day-to-day life) *	**0.419**	**0.301**	**0.374**	**0.407**	**0.441**
Frequency (feel unable to cope with day-to-day life)	**0.390**	**0.324**	**0.339**	**0.392**	**0.439**
Frequency (feel accepted)[d]	0.033[3]	0.181	0.114	0.095	0.132
Frequency (feet good)[d]	0.181	0.217	0.144	0.174	0.252
Frequency (could do things wanted)[d]	0.141	0.159	0.208	0.172	0.197
Frequency (physical pain)	0.249	0.169	**0.315**	0.265	0.290
Severity (physical pain) *	0.265	0.190	0.298	0.287	**0.313**
Frequency (physical discomfort)	0.284	0.202	0.297	0.264	0.275
Severity (physical discomfort)	**0.309**	0.207	**0.327**	**0.308**	**0.335**

Note: EQ-HWB = EuroQol Health and Wellbeing; w/ = with; ICECAP-A - ICEpop CAPability measure for Adults; na = not applicable

[a] EQ-5D-5L response scale: 1 = no problems, 2 = slight problems, 3 = moderate problems, 4 = severe problems, 5 = unable/extreme problems.

[b] EQ-HWB response scale: difficulty scale (1 = no difficulty, 2 = slight difficulty, 3 = some difficulty, 4 = a lot of difficulty, 5, unable); frequency scale (1 = none of the time, 2 = only occasionally, 3 = sometimes, 4 = often, 5 = most or all of the time); severity scale (1 = no pain, 2 = mild pain, 3 = moderate pain, 4 = severe pain, 5 = very severe pain)

[c] ICECAP-A response scale: 1 = full capability (can have, able) to 4 = no capability (cannot have/achieve, unable)

[d] Rescaled to ensure consistency across the response characteristics

* EQ-HWB-S items

All Spearmen's correlation coefficient were statistically significant (p <0.001), unless specified otherwise, i.e. [1] $p = 0.282$, [2] $p < 0.01$, [3] $p < 0.05$. Correlations were interpreted according to Cohen's guidelines, i.e., "strong" (≥0.50), "moderate" (0.30-0.49), "weak" (0.10-0.29), and "none" (0-0.09). **Bolded** results indicate a moderate correlation.

The ICECAP-A demonstrated a strong correlation with the EQ-HWB-S (r = 0.604) and EQ-5D-5L (English value set) (r = 0.525) and moderate correlation with the EQ VAS (r = 0.461) (**Table 7**). It is worth noting that the choice of EQ-5D-5L value set had a negligible impact on the results. The EQ-HWB-LSS showed strong negative correlations with other outcomes (r ranging from -0.505 (EQ VAS) to -0.922 (EQ-HWB-S). This inverse relationship was expected given the scoring direction of the EQ-HWB LSS.

Table 7: Correlation coefficients (Pearson) between EQ-5D-5L, EQ-HWB, ICECAP-A indices (n=1220)

Instrument	EQ-5D-5L Index (van Hout et al)	EQ-5D-5L Index (Hobbins et al)	EQ VAS	EQ-HWB LSS	EQ-HWB-S Index (Mukuria et al)	ICECAP-A Index
EQ-5D-5L Index (Devlin et al)	**0.970**	**0.977**	0.474	**-0.719**	**0.759**	**0.525**
EQ-5D-5L Index (van Hout et al)	-	**0.957**	0.467	**-0.705**	**0.740**	**0.514**
EQ-5D-5L Index (Hobbins et al)		-	0.466	**-0.710**	**0.746**	**0.520**
EQ VAS			-	**-0.505**	0.489	0.461
EQ-HWB LSS				-	**-0.922**	**-0.648**
EQ-HWB-S Index (Mukuria et al)					-	**0.604**

Note: Higher scores represent better HRQoL/wellbeing for all measures except for EQ-HWB LSS. All Pearson's correlation coefficient were statistically significant (P <0.001). Correlations were interpreted according to Cohen's guidelines, i.e., "strong" (≥0.50), "moderate" (0.30-0.49), "weak" (0.10-0.29), and "none" (0-0.09). (+) indicates positive direction; (-) negative direction. Strong correlations are **bolded**.

Known-group validity

Table 8 presents results of the known-group validity analyses. In line with our hypotheses, individuals who were employed, more educated, not caregivers, or in better general health reported better HRQoL or wellbeing on all instruments. The EQ-5D-5L indices (Ireland, UK crosswalk, and England) and EQ-HWB-S index consistently showed comparable or better performance than the ICECAP-A across most known-group comparisons. Overall, the ability of the EQ-HWB and EQ-HWB-S to differentiate between known groups was very similar. In contrast to our hypothesis, all instruments showed a significant improving trend in HRQoL or wellbeing with increasing age. For age groups, only the EQ-HWB demonstrated a moderate effect size (ES = 0.06), whereas all other instruments showed small effect size. For employment status, both the EQ-5D-5L (ES = 0.08) indices and EQ-HWB-S (ES = 0.06) exhibited moderate effect sizes outperforming the ICECAP-A with its small effect size (ES = 0.05). Although all instruments were able to detect significant differences between respondents based on their level of education, with more educated individuals having higher HRQoL or well-being, the effect sizes were very small (ES = 0.01-0.02). Similarly, all instruments differentiated between respondents based on caregiver roles, with small effect sizes (ES = 0.01-0.04).

The instruments demonstrated the strongest differentiation for health-related characteristics. For general health status, the EQ-5D-5L showed moderate-to-large effect sizes (ES = 0.13-0.14), slightly outperforming the EQ-HWB-S and ICECAP-A, which showed only moderate effect sizes (0.10 and 0.12, respectively). For EQ VAS groups, all instruments exhibited large effect sizes (ES = 0.43-0.47), indicating comparable performance. The presence of ongoing medical conditions was well-differentiated by all instruments, with the EQ-5D-5L indices showing the largest effect sizes (ES = 0.54-0.59), followed by the EQ-HWB-S index (ES = 0.47), and the ICECAP-A index (ES = 0.36).

Table 8: Known-group validity of the EQ-5D-5L, EQ-HWB, EQ-HWB-S and ICECAP-A

Characteristic	Sample (N=1220)	Instrument EQ-5D-5L Index (Ireland)	EQ-5D-5L Index (UK crosswalk)	EQ-5D-5L Index (England)	EQ-HWB-LSS[a]	EQ-HWB-S Index (UK)	ICECAP-A Index (UK)
	n	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Employment[1]							
Employed/ Self-employed	748	0.810 (0.238)	0.793 (0.198)	0.857 (0.157)	24.93 (15.220)	0.781 (0.199)	0.828 (0.164)
Retired	40	0.751 (0.368)	0.739 (0.310)	0.807 (0.253)	22.50 (19.060)	0.789 (0.250)	0.798 (0.188)
Student	132	0.734 (0.258)	0.739 (0.211)	0.816 (0.165)	29.89 (15.410)	0.721 (0.201)	0.807 (0.166)
Looking after home, family	193	0.740 (0.267)	0.733 (0.218)	0.810 (0.175)	29.19 (16.420)	0.728 (0.205)	0.782 (0.190)
Long-term sick or disabled	59	0.438 (0.355)	0.459 (0.271)	0.581 (0.238)	40.05 (16.790)	0.546 (0.265)	0.639 (0.196)
		KW 92.42* **ES 0.08**	KW 97.02* **ES 0.08**	KW 97.44* **ES 0.08**	KW 57.00* ES 0.05	KW 69.16* **ES 0.06**	KW 56.07* ES 0.05
Education[2]							
Bachelor/ MSc/ PhD	391	0.808 (0.255)	0.798 (0.206)	0.857 (0.169)	24.02 (15.580)	0.788 (0.199)	0.823 (0.170)
Third-level education	177	0.766 (0.275)	0.756 (0.227)	0.829 (0.185)	26.88 (15.720)	0.750 (0.213)	0.810 (0.168)
Higher certificate	129	0.778 (0.242)	0.764 (0.205)	0.835 (0.157)	27.86 (15.990)	0.746 (0.204)	0.806 (0.188)
Leaving certificate	292	0.745 (0.274)	0.739 (0.228)	0.815 (0.180)	28.34 (16.250)	0.740 (0.219)	0.800 (0.184)
Post-leaving cert training	148	0.729 (0.299)	0.717 (0.250)	0.798 (0.200)	30.30 (16.510)	0.713 (0.226)	0.770 (0.179)
Post-primary education	69	0.749 (0.262)	0.731 (0.234)	0.808 (0.181)	27.61 (15.270)	0.749 (0.203)	0.814 (0.176)
		KW 21.25* ES 0.02	KW 25.30* ES 0.02	KW 23.63* ES 0.02	KW 24.36* ES 0.02	KW19.80* ES 0.01	KW 11.22‡ ES 0.01
Caregiving role[3]							
Yes	450	0.728 (0.289)	0.720 (0.234)	0.798 (0.192)	30.52 (16.260)	0.709 (0.224)	0.793 (0.185)
Not currently, in the past	261	0.758 (0.264)	0.751 (0.213)	0.825 (0.167)	27.14 (16.350)	0.755 (0.207)	0.800 (0.171)
No	496	0.819 (0.232)	0.805 (0.199)	0.865 (0.159)	23.33 (14.850)	0.800 (0.189)	0.825 (0.174)
	1207	KW 37.65* ES 0.03	KW 43.73* ES 0.04	KW 42.35* ES 0.03	KW 48.46* ES 0.04	KW 45.95* ES 0.04	KW 11.00† ES 0.01
General health status							
Excellent	166	0.858 (0.229)	0.839 (0.205)	0.893 (0.154)	21.01 (14.080)	0.824 (0.182)	0.877 (0.139)
Very good	472	0.817 (0.230)	0.803 (0.201)	0.863 (0.156)	24.15 (14.990)	0.794 (0.180)	0.840 (0.163)
Good	389	0.778 (0.235)	0.759 (0.198)	0.836 (0.148)	27.49 (15.390)	0.753 (0.199)	0.802 (0.165)
Fair/ Poor	193	0.561 (0.344)	0.586 (0.250)	0.682 (0.227)	37.50 (16.470)	0.602 (0.254)	0.674 (0.198)
		KW 165.60* **ES 0.13**	KW 174.85* **ES 0.14**	KW 172.73* **ES 0.14**	KW 110.51* **ES 0.09**	KW 122.45* **ES 0.10**	KW 143.93* **ES 0.12**
EQ VAS							
=< 80	749	0.700 (0.294)	0.699 (0.233)	0.782 (0.193)	31.75 (15.870)	0.697 (0.222)	0.758 (0.187)
> 80	471	0.881 (0.175)	0.856 (0.169)	0.906 (0.122)	19.18 (13.020)	0.847 (0.153)	0.884 (0.128)
		Z -13.91* **ES 0.47**	Z -13.62* **ES 0.46**	Z -13.95* **ES 0.47**	Z -13.59* **ES 0.46**	Z -13.15* **ES 0.45**	Z -12.63* **ES 0.43**
Ongoing medical condition							
None	383	0.914 (0.144)	0.884 (0.159)	0.926 (0.114)	18.68 (13.070)	0.859 (0.151)	0.878 (0.135)
Any	837	0.704 (0.287)	0.702 (0.226)	0.786 (0.187)	30.66 (15.880)	0.707 (0.218)	0.774 (0.185)
		Z 16.69* **ES 0.59**	Z 15.39* **ES 0.54**	Z 16.06* **ES 0.57**	Z 12.51* **ES 0.45**	Z 13.22* **ES 0.47**	Z 10.00* **ES 0.36**

Note: [a] Transformed on a scale 0-100. Higher scores represent better HRQoL/wellbeing for all measures except for EQ-HWB LSS.
[1] Excluded Prefer not to answer (*n*=48)
[2] Excluded Prefer not to answer (*n*=13) and none of the above (*n*=1)
[3] Excluded Prefer not to answer (*n*=13)
*p < 0.001
†p < 0.01
‡p < 0.05
Kruskal–Wallis H effect size (ES): "small" 0.01-0.059, "moderate" 0.06-0.139, "large" ≥0.14; Mann–Whitney U effect size (ES): "small" 0.11-0.30, "moderate" 0.31-0.50, "large" ≥0.5. **Bolded** results indicate a large-moderate effect size.

Dimensionality and the dimension structure

The EFA revealed a five-factor structure (**Table 9**):

- Factor 1. Psychosocial health (15 items): EQ-5D-5L anxiety/depression, 13 EQ-HWB items related to mental and social well-being and ICECAP-A stability.
- Factor 2. Pain and discomfort (5 items): EQ-5D-5L pain/discomfort item and EQ-HWB pain- and discomfort-related items.
- Factor 3. Sensory and physical functioning (8 items): EQ-5D-5L mobility, self-care, and usual activities items, along with corresponding three EQ-HWB items and EQ-HWB hearing and unsafe.
- Factor 4. Capability wellbeing (5 items): All ICECAP-A items.
- Factor 5. Positive psychological states (3 items): Positively framed EQ-HWB items.

EQ-5D-5L items loaded on three factors: anxiety/depression on Factor 1, pain/discomfort on Factor 2, and the remaining items on Factor 3. EQ-HWB items loaded on Factors 1, 2, 3, and 5. All ICECAP-A items loaded exclusively on Factor 4. Most factor loadings were good (>0.55), with a few exceptions in the EQ-5D-5L and ICECAP-A showing poor-fair loadings (0.33-0.54). The EQ-HWB 'seeing' item did not sufficiently load on any of the factors and exhibited high uniqueness (0.8752). Some items demonstrated cross-loadings, for example, the EQ-HWB item 'unsafe' loading on both Factors 1 and 3, and the ICECAP-A 'stability' item loading on Factors 1 and 4.

Table 9: Results of exploratory factor analysis (5-factor-model)

Instrument	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	U
EQ-5D-5L[a]	Mobility			0.4465			0.6153
	Self-care			0.6890			0.5229
	Usual activities			0.5411			0.4492
	Pain/discomfort		0.7057				0.4040
	Anxiety/depression	0.6617					0.4961
EQ-HWB[b]	Difficulty w/seeing						0.8752
	Difficulty w/hearing			0.5790			0.6840

	Difficulty w/getting around inside and outside (mobility)*			0.8255		0.3745
	Difficulty w/day-to-day (daily activities)*			0.7170		0.3157
	Difficulty w/washing, using the toilet, getting dressed, eating, or caring for your appearance (personal care)			0.8299		0.3420
	Frequency (problems w/sleep)	0.4526				0.6230
	Frequency (exhausted) *	0.5454				0.5237
	Frequency (lonely) *	0.7040				0.3968
	Frequency (feel that people did not support)	0.6509				0.4867
	Frequency (trouble remembering)	0.4796				0.6799
	Frequency (trouble concentrating/thinking clearly) *	0.6796				0.4786
	Frequency (feel anxious) *	0.8397				0.3687
	Frequency (feel unsafe)	0.5328		0.4023		0.4965
	Frequency (feel frustrated)	0.7787				0.4154
	Frequency (feel sad/depressed)*	0.9342				0.2408
	Frequency (feel nothing to look forward to)	0.7931				0.3423
	Frequency (feel no control over day-to-day life) *	0.6295				0.4608
	Frequency (feel unable to cope with day-to-day life)	0.7176				0.3812
	Frequency (feel accepted)[d]				0.7560	0.4127
	Frequency (feet good)[d]				0.8318	0.2753
	Frequency (could do things wanted)[d]				0.7749	0.3867
	Frequency (physical pain)		0.8552			0.3312
	Severity (physical pain)*		0.8975			0.2649
	Frequency (physical discomfort)		0.4904			0.5801
	Severity (physical discomfort)		0.7602			0.3387
ICECAP-A[c]	Stability	0.3285		0.5149		0.4922
	Attachment			0.5609		0.6155
	Autonomy			0.4434		0.6482
	Achievement			0.7288		0.4308
	Enjoyment			0.6704		0.4042

Note: EQ-HWB = EuroQol Health and Wellbeing; w/ = with; ICECAP-A - ICEpop CAPability measure for Adults; na = not applicable; U = Uniqueness

[a] EQ-5D-5L response scale: 1 = no problems, 2 = slight problems, 3 = moderate problems, 4 = severe problems, 5 = unable/extreme problems.

[b] EQ-HWB response scale: difficulty scale (1 = no difficulty, 2 = slight difficulty, 3 = some difficulty, 4 = a lot of difficulty, 5, unable); frequency scale (1 = none of the time, 2 = only occasionally, 3 = sometimes, 4 = often, 5 = most or all of the time); severity scale (1 = no pain, 2 = mild pain, 3 = moderate pain, 4 = severe pain, 5 = very severe pain)

[c] ICECAP-A response scale: 1 = full capability (can have, able) to 4 = no capability (cannot have/achieve, unable)

[d] Rescaled to ensure consistency across the response characteristics

* EQ-HWB-S items

Blanks represent abs(loading)<.32

DISCUSSION

This study validated the English versions of the EQ-HWB and EQ-HWB-S instruments in Ireland, providing the first comparison in the literature with the ICECAP-A capability wellbeing measure. The EQ-HWB and EQ-HWB-S showed no ceiling effects at the instrument level, indicating their suitability for capturing a wide range of health and wellbeing aspects in a general population sample. They demonstrated good convergent validity with corresponding items of the EQ-5D-5L and exhibited good known-groups validity for self-reported health status, EQ VAS scores, and the presence of ‘ongoing medical conditions’.

Our study provides the first empirical evidence of the considerable differences between the content and measurement performance of the EQ-HWB and ICECAP-A instruments. Both the EQ-HWB and EQ-HWB-S demonstrated substantially lower ceiling compared to the ICECAP-A. This is likely attributable to the EQ-HWB's broader content coverage (both health and well-being) and the higher number of items, even in the EQ-HWB-S. While the known-groups validity was relatively similar across measures, both the EQ-HWB and EQ-HWB-S were more sensitive to health-related factors such as presence of 'ongoing medical conditions' than ICECAP-A, potentially making them a valuable tool in clinical settings. However, it is important to highlight that the EQ-5D-5L outperformed the EQ-HWB, EQ-HWB-S as well as ICECAP-A in many aspects. One of the most interesting findings was the unexpected weak to moderate correlations between similar items of the EQ-HWB and ICECAP-A. This suggests that while both instruments aim to assess aspects of wellbeing, they capture different dimensions. The factor analysis further supported this distinction, with all ICECAP-A items loading predominantly on a separate factor from any EQ-HWB items.

Comparing our results with existing psychometric testing of the EQ-HWB and ICECAP-A alone [31, 39-44], we found largely consistent patterns in terms of validity. However, our study provides novel insights into the relationship between these instruments, particularly in terms of their factor structure and the distinct aspects of wellbeing they capture. These findings have important implications for the selection and use of health and wellbeing measures in various contexts. The EQ-HWB instruments appear to offer a broader coverage of health-related aspects, while the ICECAP-A captures unique dimensions of capability wellbeing. This suggests that the choice between these instruments should be guided by the specific goals of the assessment and the population being studied. However, it is important to note that further research is needed before making definitive recommendations on when to use which measure. Future studies should explore the performance of these instruments in various patient populations and contexts (e.g., social care, older adults) to better understand their relative strengths and limitations. Additionally, comparing these measures in the context of economic evaluations is an important future research direction, as it will help determine their utility in health technology assessment and policy decision-making.

While this study provides valuable insights, several limitations should be noted. The sample was skewed towards younger age groups and females, which may limit generalizability to the broader Irish population and other populations or contexts. The reverse age gradient, contrary

to our expectations (i.e. lower HRQoL and wellbeing in younger adults), may also be related to the somewhat limited representativeness of the sample. All 'ongoing medical conditions' were self-reported and not verified by a physician. Furthermore, no information on disease severity was available for the known-groups validity tests. This limited the ability to assess how the instruments performed across different levels of health impairment. There were relatively few items even after pooling all instruments' items. This constraint may have affected the factor analysis results, for example, the EQ-HWB sight item did not fit on any factor. The fixed order of completion of the instruments might have caused some ordering effect. While this study provides evidence for multiple aspects of validity, further research is needed to assess test-retest reliability, responsiveness to change over time and performance in specific demographic and clinical populations.

CONCLUSION

In conclusion, this study found that the EQ-HWB and EQ-HWB-S demonstrated good psychometric properties, also comparatively to the EQ-5D-5L and ICECAP-A in an Irish context. The results suggest that the EQ-HWB and ICECAP instruments offer complementary approaches to measuring health and wellbeing, with the EQ-HWB instruments showing lower ceiling and a particular strength in discriminating across a wide range of health-related characteristics. As research in this area continues to evolve, these findings will contribute to more informed selection and use of health and wellbeing measures in both clinical and policy contexts.

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