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Exploring the measurement of health related quality of life and broader instruments: A dimensionality analysis

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ABSTRACT

Background: Comprehensively measuring the outcomes of interventions and policy programmes impacting both health and broader areas of quality of life (QoL) is important for decision-making within and across sectors. Increasingly, broad QoL measures are being developed to capture outcomes beyond health-related quality of life (HRQoL). Jointly exploring the dimensionality of diverse instruments can improve our understanding about their evaluative space and how they conceptually build on each other. This study explored the measurement relationship between five broader QoL measures and the most widely used HRQoL measure, the EQ-5D.

Methods: Participants from the Dutch general population (n = 1002) completed six instruments (n = 126 items) in December of 2020. The measurement relationship was explored using qualitative and quantitative dimensionality assessment methods. This included a content analysis and exploratory factor analyses which were used to develop a confirmatory factor model of the broader QoL dimensions. Correlations between the identified dimensions and self-reported overall health and wellbeing were also explored.

Results: The final CFA model exhibited acceptable/good fit and described 12 QoL dimensions: 'psychological symptoms', 'social relations', 'physical functioning', 'emotional resilience', 'pain', 'cognition', 'financial needs', 'discrimination', 'outlook on life/growth', 'access to public services', 'living environment', and 'control over life'. All dimensions were positively correlated to self-reported health and wellbeing, but the magnitudes in associations varied considerably (e.g., 'pain' had the strongest correlation with overall health but a weak correlation with wellbeing).

Conclusions: This study contributes to a broader understanding of QoL by exploring the dimensionality and relationships among various QoL measures. A number of the dimensions identified are HRQoL-focused, with others covering broader constructs. Our findings offer insights for the development of comprehensive instruments, or use of instrument suites that capture multidimensional aspects of QoL. Further research should explore the relevance and feasibility/appropriateness of measuring the identified dimensions in different settings and populations.

1. Introduction

Government budgets worldwide face increasing constraints due to demand-side factors such as population aging, the prevalence of chronic diseases, and a shift from cure to care. To develop interventions and policy programmes with impact, and to inform decision-making within and across sectors, it is crucial to have extensive knowledge about the quality of life (QoL) outcomes that matter to people.

A number of QoL measures have been developed to measure outcomes in diverse settings. Health-related quality of life (HRQoL) measures, such as the EQ-5D, are widely used in the health sector and primarily focus on QoL dimensions that are influenced by health status, such as physical and psychological symptoms (Herdman et al., 2011). Social care-related QoL (SCrQoL) instruments, such as the ASCOT, measure those aspects that can be affected by social care interventions (e.g., personal safety, social participation) (Netten et al., 2012). Broader

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instruments also exist and are often referred to as wellbeing (WB) measures, health and wellbeing (HWB) measures, and/or 'broader QoL' measures. Examples of such broader instruments include the ICECAP (Al-Janabi et al., 2012) and the recently developed EuroQol Health and Well-being (EQ-HWB) instrument (Brazier et al., 2022), among many others (e.g., Benson et al., 2019; Bom et al., 2023; De Vries et al., 2016; Tennant et al., 2007).

The existence of multiple measures underscores the diverse ways in which QoL can be conceptualized and operationalized in different contexts (i.e., target populations, intended intervention outcomes, study design). Indeed, the question of 'which QoL domains are relevant' to measure calls for normative (re)considerations by various stakeholders and is highly context dependent (Brazier and Tsuchiya, 2015; Crocker et al., 2021; Peasgood et al., 2019, 2021). Moreover, there is often overlap in the dimensions covered by HRQoL and broader QoL instruments, making it challenging to differentiate their unique contributions towards measuring and defining these constructs (Finch and Mulhern, 2022). Understanding the measurement relationship within broader QoL measures, and between these measures and those assessing HRQoL such as the EQ-5D, can provide insights into which key constructs are being covered. This source of evidence can valuably complement findings from theoretical and user-centered studies to inform further discussions about 'what QoL dimensions should be measured', support the choice of instruments to use in different contexts and study types, and inform conceptual frameworks for the development of new instruments (De Vries et al., 2016; Finch and Mulhern, 2022). Dimensionality analyses can also reveal gaps and overlaps in the evaluative space of existing measures, informing theoretical distinctions between health and broader wellbeing. However, such dimensionality analyses require single study populations to complete several questionnaires, which occurs rarely.

Two previous research efforts—the Outcome Measurement Study (OMS) (Mulhern, 2020) and the Multi Instrument Comparison (MIC) survey (Richardson et al., 2012) – collected data on various HRQoL, wellbeing, and SCrQoL measures from patients and the general population. Dimensionality analyses of these datasets identified several latent constructs covered by the included instruments, such as 'physical functioning', 'psychological symptoms', energy/sleep, 'pain', 'social functioning', 'needs', 'relationships', 'hearing', 'cognition', and 'satisfaction' (Finch et al., 2017; Finch and Mulhern, 2022). The results of these dimensionality analyses were useful for expanding the evaluative space of the EQ-5D and revealed overlaps in the QoL aspects covered by the included measures (Finch et al., 2019; Finch and Mulhern, 2022). At the same time, a limitation inherent to all dimensionality analyses is that their results depend on the set of included items (Brown, 2015; Watkins, 2020). For instance, the instruments included in previous studies did not cover certain dimensions that may also be relevant to consider within a broader QoL assessment framework (e.g. socioeconomic dimensions), reflecting our need to explore additional/diverse item pools in order to achieve a comprehensive overview about which QoL domains are being covered.

Building on this previous work, in this study we investigate a larger pool of items included in a diverse set of broader QoL measures whose dimensionality has not yet been explored. Given the lack of (quantitative) evidence about the relationship and distinction between health and wellbeing, we also explore how the different identified dimensions relate to participants' self-perceived overall health and wellbeing.

1.1. Aim

This study aimed to examine the measurement relationship between five broader QoL measures and the most widely used HRQoL measure internationally (i.e., the EQ-5D). Specifically, we sought to identify the dimensions of QoL covered by these measures using qualitative content exploration, and quantitative exploratory and confirmatory methods. We also examined the relationship between the identified dimensions and proxy measures of overall health and overall wellbeing.

2. Methods

2.1. Data and measures

This was a secondary analysis of data which was initially collected for the development and validation of a new positive health instrument (Doornenbal et al., 2022). Data was obtained from 1002 participants older than 18 years recruited via a Dutch independent internet panel. The study population was representative of the general population in the Netherlands in terms of sex, age, education level, and geographical distribution (see Appendix A Table S1). Data collection took place in December 2020. An independent medical ethics committee evaluated the study and confirmed it did not fall within the Dutch Medical Research Act, waiving the need for ethical approval as the study did not involve an intervention and the questionnaires were not regarded as invasive (METC-LDD 19–035). After providing informed consent, participants completed six questionnaires in Dutch, in the order listed below. Our selection of instruments includes prominent measures (e.g., ICECAP-A and EQ-5D-5L) but also less commonly used/studied measures which were considered of interest due to their particularly diverse coverage of QoL dimensions. All translated question wordings and response categories are presented in Appendix A Table S2.

2.1.1. PHDT (positive health dialogue tool)

A 52-item questionnaire based on the My Positive Health (MPH) dialogue tool (see www.iph.nl). The MPH tool was developed in the Netherlands as a tool to stimulate self-reflection and communication about individuals' situation/needs in a wide range of settings. The latest MPH tool includes 44 items covering 6 dimensions: bodily functions, mental functions and perception, spiritual or existential dimension, quality of life, social and societal participation and daily functioning (Institute for Positive Health, 2022). The PHDT questionnaire used in this study contained the 44 items from the latest version plus 8 items that were included exploratively. All items consisted of statements for which participants reported their agreement on a 5-level scale (i.e., 'completely disagree' to 'completely agree').

2.1.2. BRS (brief resilience scale)

The BRS is a widely used instrument designed to assess an individual's ability to cope with stress and adversity (Smith et al., 2008). Participants reported their level of agreement with five statements/items on a 5-point scale, with higher scores indicating greater resilience. The validity and psychometric properties of the BRS have been extensively studied (Smith et al., 2023).

2.1.3. CAP-AWB (capabilities for adult wellbeing)

A 54-item questionnaire developed based on Nussbaum's 10 core capabilities for adult-wellbeing. It includes 16 items on personal context, 24 items on social context and 14 items on environmental context. Items consist of statements for which participants report their level of agreement on a 5-level scale.

2.1.4. HR-SWB (health-related subjective well-being)

This measure comprises five items covering five dimensions: bodily independence, happiness, loneliness, autonomy, and personal growth (De Vries et al., 2016). Items consist of statements for which participants report their level of agreement on a 5-level scale. In a Dutch general population sample, the HR-SWB demonstrated reasonable/good concurrent and convergent validity (Haspels et al., 2023).

2.1.5. EQ-5D-5L

The most widely-used HRQoL measure in the healthcare sector, the EQ-5D-5L consists of 5 dimensions i.e., mobility, selfcare, usual activities, pain/discomfort and anxiety/depression, described in terms of five

severity levels (i.e., no problems to extreme problems/unable to) (Herdman et al., 2011). The validity and psychometric properties of the EQ-5D-5L have been studied extensively (Feng et al., 2021; Longworth et al., 2014).

2.1.6. ICECAP-A

Originally designed as a broader alternative to traditional HRQoL measures, the ICECAP-A covers five broad attributes of capability wellbeing, i.e., stability, attachment, autonomy, achievement, and enjoyment (Al-Janabi et al., 2012). Respondents complete one item per domain on a 4-level scale (e.g., cannot/unable to completely/a lot). The validity and psychometric properties of the ICECAP-A have been studied extensively (Afentou and Kinghorn, 2020).

Together, these measures comprised a pool of 126 items. Of those items, three items which directly asked about perceived general health or wellbeing status were excluded *a priori* to enable the identification of specific health and wellbeing-*related* constructs. Appendix A Table S3 describes each instrument's level sum score range, reported minimum/maximum/median scores, and the percentage of floor and ceiling effects. Participants' self-reported overall health and happiness were also measured using two visual analogue scales (VAS): the VAS-Health (score of 0 = worst imaginable health and 100 = best imaginable health) and a VAS-Happiness (0 = completely unhappy and 100 = completely happy). These two measurements were used as proxies of health and wellbeing in subsequent analyses.

2.2. Data analysis

Several qualitative and quantitative methodologies were applied to achieve the research aim. First, a content analysis was conducted to generate theory-driven hypotheses about the dimensions covered within the item pool. Second, exploratory factor analysis (EFA) was used to identify latent factors without making *a priori* hypotheses about the underlying factor structure. Third, a confirmatory factor analysis (CFA) model was developed using information from the content analysis and the EFAs. Finally, we estimated the associations between the factors identified in the CFA model (as independent variables) and the VAS-health and VAS-Happiness. We elaborate on each of these steps in turn below.

2.2.1. Content analysis

The Wilson and Cleary model was used as the conceptual starting point for the content analysis of the item pool (Wilson and Cleary, 1995). The Wilson and Cleary model is rather clinically-focused, covering five principal categories of HRQoL, i.e., physiological factors, symptom status, functioning status, general health, and overall QoL (Wilson and Cleary, 1995). To better align the Wilson and Cleary model with our broader (beyond health) focus, we sub-divided the symptom category into psychological, social, and physical symptoms, and the functioning category into physical, social, psychological, and role functioning (Fig. 1). A similar adaptation of the Wilson and Cleary model has been useful in previous studies (Finch and Mulhern, 2022; Peasgood et al., 2021). We also included the 'Characteristics of the environment' category to ensure sufficient coverage of such aspects which are relevant in the context of social care. Finally, for the content analysis, the 'Quality of life' category (rightmost in Fig. 1) was understood as any remaining aspects that further affect QoL (including non-health related aspects).

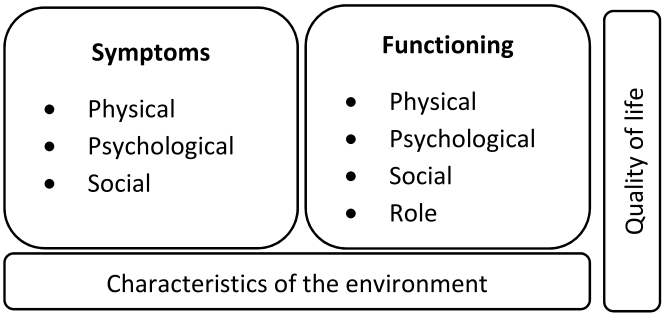

Fig. 1. Adapted Wilson and Cleary conceptual model, based on (Finch and Mulhern, 2022).

An iterative and collaborative process was followed to conduct the content analysis. First, each co-author conducted an independent content analysis which involved (inductively) generating themes that described the items based on their interpretation (e.g. assigning questions about social interactions to a 'relationships' theme) and then (deductively) linking each theme to one of the Wilson and Cleary model categories (e.g. Social Functioning, Fig. 1). In these independent analyses, co-authors were free to generate as many themes as necessary to interpret the item pool and/or propose further adaptations of the Wilson and Cleary model. Thereafter, all co-authors participated in two rounds of joint discussions and adaptations to achieve consensus about which themes to include in the final content analysis. In the first round, the independent analyses were discussed and items were ranked by level of interpretation disagreement, i.e., assigning a score of 1 if all co-authors assigned an item to the same theme and a score of 5 if clearly different themes were proposed. Discordant interpretations were prioritized for discussion to achieve agreement. During the second round, a first draft of the joint content analysis was proposed by the first author, modifications/re-interpretations were jointly discussed, and the final version was drafted.

2.2.2. Exploratory factor analysis (EFA)

The content analysis was as a purely theory-driven and qualitative approach to inform hypotheses about the dimensionality of the item pool. A separate methodology that may produce complementary quantitative insights about dimensionality is EFA. In EFA, latent factors are identified through the common/shared variance between item responses while allowing all items load on all factors (Watkins, 2020).

Data from a random draw of 80% of participants (n = 800 out of 1002) was used for the EFA. To accommodate the items' ordered categorical response levels, polychoric correlations were used to conduct the EFAs (Watkins, 2020). As most items in the item pool were positively worded, the response categories of negatively-worded questions were re-coded to avoid negative loadings and ensure that higher scores always indicated better quality of life (Brown, 2015). The R software package 'psych' was used for the EFAs (Watkins, 2020).

Since the EFA results were only used to inform model (re)specification in subsequent CFA analyses, various EFA solutions were interpreted. Parallel analysis, scree plots, the Kaiser rule, and the minimum average partial method (MAP) were used to inform how many factors to extract (Watkins, 2020). For completeness, orthogonally (varimax) and obliquely (promax) rotated factor solutions were interpreted.

2.2.3. Confirmatory factor analysis (CFA)

CFA is a statistical technique used to test the validity of a pre-specified factor structure by examining the relationships between observed variables and hypothesized latent factors (Brown, 2015). In this study, CFA was conducted to develop and test a measurement model of the QoL dimensions (i.e. factors) covered by the included instruments.

The content analysis was used as the starting point in the development of a CFA model, whereby the (adapted) Wilson and Cleary categories were specified as factors in the first CFA iteration. This was done because CFA analyses should ideally be based on theory (Brown, 2015), and the Wilson and Cleary model has been used extensively in previous studies about QoL constructs (Bakas et al., 2012).

An iterative model-building process was followed to arrive at the final CFA model. Several outputs were used to inform model adaptations between CFA iterations, primarily: standardized factor loadings, the content analysis themes, model residuals, the EFA results, modification indices, and tests of uni-dimensionality. For example, the themes that

made up the categories in the (adapted) Wilson and Cleary model were specified as factors when appropriate and consistent with findings from the EFA. Items with low standardized loadings (i.e., between 0.32 and 0.4) were assigned to alternative factors based on information from the content analysis and EFA. Items were only dropped from the item pool if alternative specifications for the item had been explored and the item still exhibited poor loadings. Modification indices were only considered when the modification was theoretically sound (e.g., allowing residual correlations between two similarly-phrased or clearly related items). Tests of uni-dimensionality were performed by specifying a bi-factor model, where methods factors and a global factor model were imposed with no strain between factor solutions (i.e., no correlation between methods-factors and global factor), and comparing the common variance accounted for by the three (Reise et al., 2013). If at least 50% of the common variance was explained by the global factor, this was taken as a demonstration of sufficient uni-dimensionality (Reise et al., 2013).

The R package lavaan was used for the CFA (Rosseel, 2012). To accommodate the categorical nature of the data, the parameter estimator used was diagonally weighted least squares with robust standard errors (lavaan estimator 'WLSMV') (Li, 2016). The root mean square error of approximation (RMSEA) and the comparative fit index (CFI) were used to assess model fit at each iteration (Bentler, 1990; Kenny and McCoach, 2003; Steiger, 1990). An RMSEA of around 0.08 was considered acceptable and 0.05 or less was considered good. A CFI of around 0.90 was considered acceptable and 0.95 or more was considered good (Hu and Bentler, 1999). That said, rather than adopting specific cut-offs for the RMSEA or CFI, these statistics were primarily used to monitor and guide improvements in model fit throughout iterations (Kenny and McCoach, 2003; Marsh et al., 2004).

The same subsample used for the EFAs was used for the development of the CFA model. The final CFA model was then tested on a different random draw of 80% of participants (n = 800 out of 1002). Sample splitting for testing, although not strictly required in exploratory studies such as this, was considered useful to build confidence in the replicability of the identified factor structure. The decision was made to use two different random draws of 80% of participants (as opposed to two distinct 50% subsamples, which is ideal) to both apply sample splitting and to achieve a sufficient sample size during the exploratory/development and confirmatory stages.

2.2.4. Correlation analysis

To explore how the identified CFA dimensions relate to constructs of 'overall health' and 'overall wellbeing', we measured the correlations between the identified factors and participants' self-reported health and wellbeing. Individual factor scores were estimated for each participant in the 'testing' sample using the regression scoring method (Distefano et al., 2009; Skrondal and Laake, 2001). Thereafter, Pearson correlations between the factor scores and the VAS-Health and VAS-Happiness (i.e., as proxy measures of overall health and wellbeing, respectively) were estimated.

We note that the exploratory rationale for the correlation analysis

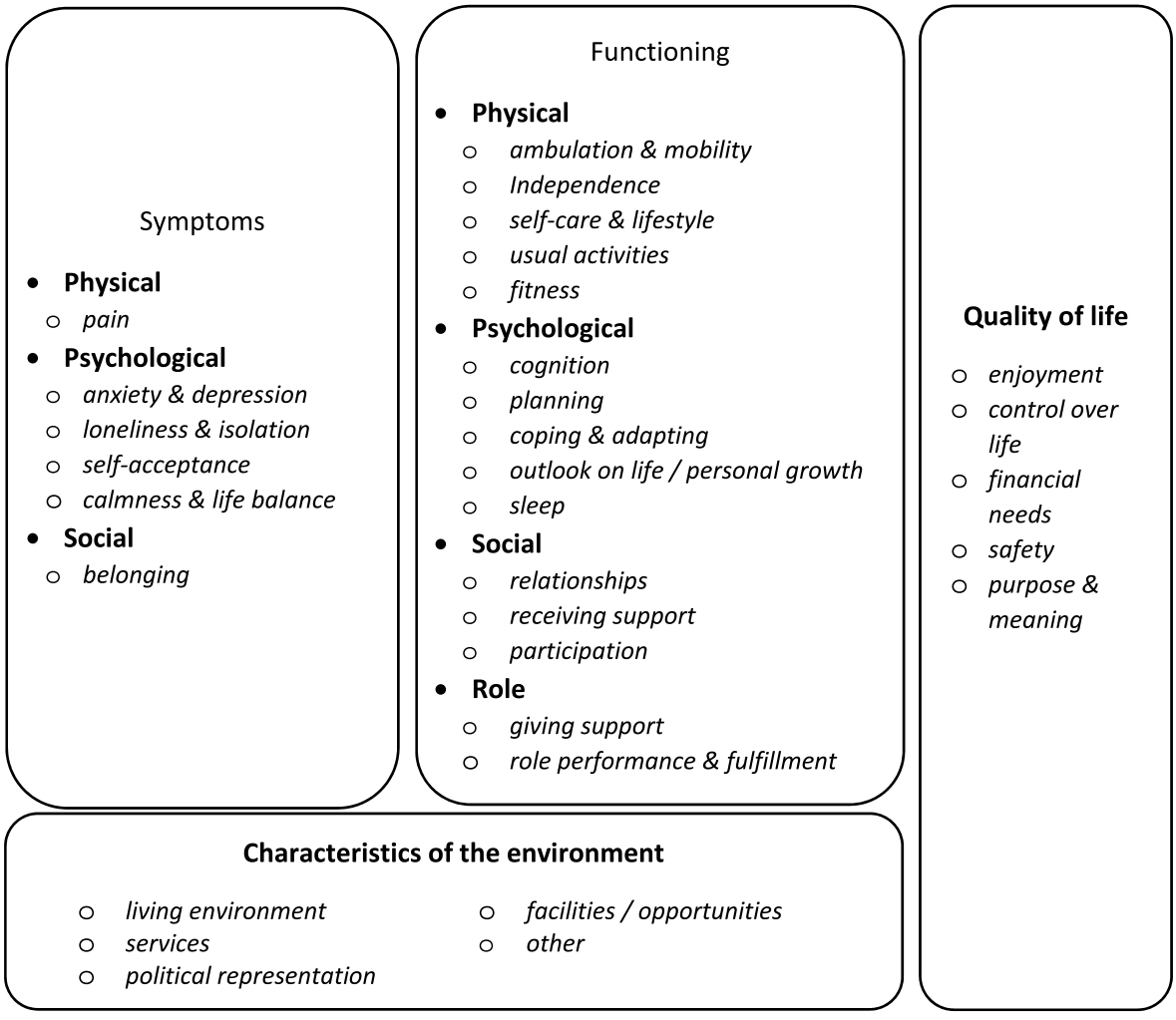

Fig. 2. Summary of content analysis results including categories (in bold) and sub-themes (in italics). See Appendix A Table S4 for the detailed results with all items.

was to aid further interpretations about the relative relevance of the identified dimensions in the context of comprehensively measuring health and wellbeing; not necessarily to obtain precise estimates of the relationships between the dependent and independent variables.

3. Results

3.1. Content analysis

The results of the content analysis are summarized in Fig. 2, and Table S4 in Appendix A contains the detailed categorizations with all items. The adapted Wilson and Cleary model was able to accommodate all the included items, although several items were potentially related to multiple categories (e.g. some items in the 'psychological functioning' category could also fit in the 'psychological symptom' category). There was little disagreement between co-authors' independent content analyses (i.e., 25 out of the 123 items had a disagreement score of 4 or 5, all of which were resolved during the first and second joint rounds) and no modifications to the adapted Wilson and Cleary model were required. Finally, one item was considered uninformative in the context of this study and was excluded (i.e. "I experience problems in my life due to an epidemic/pandemic and/or measures taken for it").

3.2. Exploratory factor analysis

Appendix B (Excel file) contains the EFA factor solutions that were considered informative for the development of a CFA model. Results from parallel analysis, scree-plots, and MAP suggested 9–15 as a reasonable range of factors to extract. Both factor rotation methods (oblique and orthogonal) produced consistent results in terms of the identified factors but, as expected, orthogonal solutions contained considerably more cross loadings. Regardless of the rotation method or number of factors extracted, the most differentiable factors were related to psychological functioning (≈25 loading items) physical/daily functioning (≈15 loading items) and relationships/social functioning (≈15 loading items). The EFAs with 14–15 factors and oblique rotations (Appendix B, Excel) produced the most interpretable factor solutions and as such were considered most informative for the subsequent CFA analyses.

3.3. Confirmatory factor analysis

The final CFA model results are presented in Table 1. The confirmatory model included 12 factors: 'psychological symptoms', 'social relationships', 'physical functioning', 'emotional resilience', 'pain', 'cognition', 'financial needs', 'discrimination', 'outlook on life/growth', 'access to public services', 'living environment', and 'control over life'. These factors were broadly consistent with the hypothesized categories and themes identified during content analysis. The final model exhibited acceptable/good fit when applied to the testing sample (RMSEA = 0.046 and CFI = 0.901).

Few noteworthy decisions were made during the iterative model building process. Some content analysis categories (e.g., 'psychological functioning') were split into their component themes, some of which were further modified and renamed during later iterations (see Table 1). Nine items were excluded throughout the model-building process for the theoretical and statistical reasons detailed in Appendix A Table S5. Finally, sufficient uni-dimensionality between highly correlated (i.e., >0.90) factors was detected in two instances: the factor 'social relationships' demonstrated uni-dimensionality over the two separate factors 'social participation' and 'relationships', and the 'physical functioning' factor demonstrated uni-dimensionality over the separate factors 'daily functioning' and 'physical mobility'.

Some instruments exhibited a wide coverage of dimensions and others loaded on fewer factors. Except for the BRS, all instruments had at least one item loading on 'psychological symptoms' and 'physical functioning'. The two largest instruments, i.e., PHDT and the CAP-AWB, exhibited the widest coverage with item loadings on 10 and 9 factors respectively. Three factors were represented by single instruments: 'emotional resilience' had only BRS items, 'cognition' only PHDT items, and 'discrimination' had only CAP-AWB items. As the only HRQoL measure in the item pool, the EQ5D covered three factors: 'psychological symptoms' (1 item), 'pain' (1 item), and 'physical functioning' (3 items). For further interpretation, Appendix A Table S6 presents the factor coverage per instrument in percentages and number of items per factor, and Tables S7a–S7f describe which factors each instrument's items mapped to.

3.4. Correlation analysis

Table 2 presents the correlations between participants' standardized factor scores and the VAS-Health and VAS-Happiness, sorted by strength of association.

All factors were positively and significantly correlated to the VAS-Health and the VAS-Happiness, although the magnitudes and relative differences in the associations varied considerably. For example, the 'pain' factor had the strongest correlation with the VAS-Health and among the weakest correlations with the VAS-Happiness.

The 'psychological symptoms' factor had the strongest correlation with the VAS-Happiness. Moreover, the factors 'social relationships', 'living environment', 'psychological symptoms', 'outlook on life', and 'emotional resilience' were more strongly associated with the VAS-Happiness than the VAS-Health, while the opposite was true for 'pain' and 'physical functioning'. Finally, the factors 'cognition', 'financial needs', 'access to public services', and 'discrimination' were more or less equally related to the VAS-Happiness and the VAS-Health, and 'access to public services' and 'discrimination' had among the lowest correlations with both VAS's.

4. Discussion

This study utilized theory-driven and empirical methods to explore the dimensionality of five broad QoL measures alongside an established HRQoL measure (i.e., the EQ-5D). Our findings contribute to a better understanding of the broad QoL constructs covered in existing instruments and may inform the development of measures that capture the multidimensionality of QoL within a broader measurement framework. Key strengths of this study lie in its methodological approach, the large pool of included items, and the set of measures explored.

The results of the confirmatory factor analysis (CFA) shed light on the underlying dimensional structure and relationships among the included measures. In line with the hypotheses generated during the content analysis, the CFA revealed distinct factors representing various QoL domains, namely 'psychological symptoms', 'social relations', 'physical functioning', 'emotional resilience', 'pain', 'cognition', 'financial needs', 'discrimination, 'outlook on life/growth', 'access to public services', 'living environment', and 'control over life'. These factors provide a broad framework for understanding aspects that may be relevant for the QoL of responders, capturing both subjective and objective aspects of individuals' experiences. The results from the correlation analyses further completement the CFA results by enabling interpretations about the relationships between the identified dimensions and participant's self-reported overall health and wellbeing.

The range of dimensions identified in this study mirrors the changing paradigm in the field of outcome measurement for the evaluation and assessment of interventions and policy programmes, increasingly moving beyond health-related QoL (Brazier et al., 2019). As such, our findings may support the choice of instruments to use in different contexts (i.e., study types, target populations) and inform frameworks for the development of new measures. Furthermore, findings from our correlation analysis may inform the selection/prioritization of dimensions of interest for broader descriptive profiles. For instance, in the

Table 1
Final CFA model standardized factor loadings.

	Psychological symptoms	Social relationships	Physical functioning	Emotional resilience	Pain	Cognition	Financial needs	Discrimi-nation	Outlook on life/growth	Access to Public Services	Living enviro-nment	Control over life
PHDT - Experience balance in life	0.897											
PHDT - Can enjoy life	0.883											
PHDT - Comfortable with self	0.88											
PHDT - Daily self-confidence sufficient	0.877											
PHDT - Feeling happy	0.804											
PHDT - Self-acceptance	0.781											
PHDT - Able to relax	0.762											
PHDT - Experience inner peace	0.755											
ICECAP - Enjoyment	0.74											
CAP-AWB - Enough peace of mind	0.708											
CAP-AWB - Can relax when necessary	0.702											
EQ5D – anxiety and depression	0.701											
HR-SWB - Feels lonely.	0.694											
CAP-AWB - Often feel alone	0.647											
PHDT - Taken seriously by others		0.818										
PHDT - Fulfills life roles		0.81										
PHDT - 'Fits in' in environment		0.773										
PHDT - Good social connections		0.766										
PHDT - Fun activities with people		0.755										
PHDT - Can give support		0.754										
PHDT - Supportive people available		0.752										
PHDT - Feels socially involved		0.68										
PHDT - Communication ability		0.663										
ICECAP - Attachment		0.626										
CAP-AWB - Hides emotions/ problems		0.554										
CAP-AWB - Has faith in others		0.552										
CAP-AWB - Is perceived as supportive		0.533										
CAP-AWB - Feels supported by neighborhood contacts		0.529										
CAP-AWB - Feels connected to environment.		0.497										
CAP-AWB - Loved ones' problems burden		0.423										
CAP-AWB - Feels involved in community		0.389										
CAP-AWB - People are available to help.		0.371										
PHDT - Independent daily living			0.887									
PHDT - Can move outdoors			0.878									
PHDT - Self-care managed well			0.805									
PHDT - Can work/volunteer			0.771									
CAP-AWB - Physical/mental health causes limitations			0.754									
PHDT - Easy movement possible			0.749									
PHDT - recovery after exercise			0.749									
EQ5D – Usual activities			0.733									
EQ5D - Self-care			0.681									
PHDT - Adequate sleep achievable			0.657									

(*continued on next page*)

Table 1 (*continued*)

	Psychological symptoms	Social relationships	Physical functioning	Emotional resilience	Pain	Cognition	Financial needs	Discrimi-nation	Outlook on life/growth	Access to Public Services	Living enviro-nment	Control over life
EQ5D - Mobility			0.602									
ICECAP - Autonomy			0.591									
HR-SWB - No physical activity problems.			0.541									
PHDT - Preforms tasks/activities adequately			0.472									0.444
BRS - Quick stress recovery				0.772								
BRS - Easily overcome difficult times				0.731								
BRS - Hard to recover from setbacks				0.645								
BRS - Hard time handling stress				0.643								
BRS - Quickly overcome hard times				0.508								
PHDT - Pain-free movement possible					0.973							
EQ5D - pain					0.818							
PHDT - Good concentration						0.949						
PHDT - Good memory						0.820						
PHDT - Affordable healthy lifestyle							0.921					
CAP-AWB - Healthy lifestyle affordable							0.896					
CAP-AWB - Financial freedom present							0.830					
PHDT - monthly budget managed							0.770					
CAP-AWB - Medical care unaffordable							0.694					
CAP-AWB - Burdened by debt							0.600					
CAP-AWB - Feels appearance-based discrimination								0.879				
CAP-AWB - Feels cultural background disadvantage								0.858				
CAP-AWB - Feels gender/sexuality-based discrimination								0.849				
CAP-AWB - Feels religious disadvantage								0.794				
CAP-AWB - Upbringing causes limitations								0.654				
CAP-AWB - Is ashamed of situation	0.34							0.499				
PHDT - Optimistic about future									0.834			
PHDT - Grateful for life									0.816			
PHDT - Acceptance of life									0.805			
PHDT - Achieves own ideals									0.782			
ICECAP - Achievement									0.670			
CAP-AWB - Has purpose in life									0.629			
ICECAP - Stability									0.615			
PHDT - Lifelong learner									0.516			
CAP-AWB - Thinks healthy lifestyle is important									0.476			
CAP-AWB - Can access medical help										0.793		
CAP-AWB - Feels taken seriously by healthcare providers.										0.726		
CAP-AWB - Effective communication with healthcare workers										0.685		

(*continued on next page*)

Table 1 (*continued*)

	Psychological symptoms	Social relationships	Physical functioning	Emotional resilience	Pain	Cognition	Financial needs	Discrimi-nation	Outlook on life/growth	Access to Public Services	Living enviro-nment	Control over life
PHDT - Can ask authorities for help										0.658		
CAP-AWB - Independent administration handled										0.610		
CAP-AWB - Can understand presented information										0.591		
CAP-AWB - Wait times for mental healthcare are problematic.										0.561		
CAP-AWB - Mediation needed for finances										0.548		
CAP-AWB - Short-notice medical help available										0.539		
CAP-AWB - Feels safe in neighborhood											0.786	
CAP-AWB - Feels at home in environment											0.784	
CAP-AWB - Good access to transportation.											0.774	
PHDT - Satisfied with living situation											0.718	
CAP-AWB - Safe environment with activities.											0.668	
CAP-AWB - Easy access to in-home facilities.											0.624	
CAP-AWB - Environment hinders healthy lifestyle											0.541	
CAP-AWB - Enough schools in area.											0.497	
CAP-AWB - Activities in area match own interests.											0.456	
PHDT - Feeling safe	0.388										0.370	
PHDT - Can be productive												0.826
PHDT - can have meaningful pursuits												0.825
PHDT - Choose meaningful life												0.806
CAP-AWB - Knows how to organize life												0.784
PHDT - Can organize life												0.781
CAP-AWB - Can make own choices												0.777
PHDT - Freedom to choose												0.766
PHDT - Aware about abilities/limits												0.715
PHDT - Can influence own health												0.710
PHDT - Hobbies and interests pursued												0.706
PHDT - Finding solutions												0.704
PHDT - Can plan daily activities												0.668
CAP-AWB - Can adapt to life changes												0.660
PHDT - Choose healthy food												0.617
HR-SWB - Lives life in 'own way'												0.534
CAP-AWB - Healthy lifestyle education received												0.440
PHDT - Important activities fulfilled			0.456									0.437
CAP-AWB - Upfront about abilities												0.408

Table 2
Correlations between identified factors and proxy measures of health and wellbeing, sorted by strength of association.

Dependent variable	Independent variable (i.e. factor)	Pearson Correlation (95% CI)[a]	P-value
VAS-Health			
	Pain	0.664 (0.624, 0.701)	<0.001
	Physical functioning	0.629 (0.585, 0.669)	<0.001
	Outlook on life/growth	0.542 (0.491, 0.589)	<0.001
	Psychological symptoms	0.536 (0.485, 0.584)	<0.001
	Control over life	0.490 (0.435, 0.541)	<0.001
	Cognition	0.449 (0.392, 0.502)	<0.001
	Emotional resilience	0.433 (0.375, 0.488)	<0.001
	Social relationships	0.416 (0.357, 0.471)	<0.001
	Financial needs	0.373 (0.312, 0.431)	<0.001
	Living environment	0.363 (0.301, 0.422)	<0.001
	Access to public services	0.285 (0.220, 0.347)	<0.001
	Discrimination	0.237 (0.170, 0.301)	<0.001
VAS-Happiness			
	Psychological symptoms	0.668 (0.628, 0.705)	<0.001
	Outlook on life/growth	0.611 (0.566, 0.653)	<0.001
	Social relationships	0.545 (0.495, 0.592)	<0.001
	Emotional resilience	0.532 (0.481, 0.580)	<0.001
	Control over life	0.531 (0.480, 0.579)	<0.001
	Cognition	0.483 (0.428, 0.534)	<0.001
	Physical functioning	0.456 (0.399, 0.509)	<0.001
	Living environment	0.415 (0.356, 0.471)	<0.001
	Pain	0.384 (0.323, 0.442)	<0.001
	Financial needs	0.354 (0.292, 0.413)	<0.001
	Access to public services	0.290 (0.225, 0.352)	<0.001
	Discrimination	0.282 (0.217, 0.344)	<0.001

[a] asymptotic confidence interval based on Fisher's Z transform.

context of capturing outcomes beyond those normally covered by HRQoL, the dimensions 'outlook on life', 'social relationships', and 'control over life' may be relevant additions as they were all strongly related to overall health and wellbeing.

When considering 'which QoL dimensions should be measured', it is important to note the distinction between comprehensiveness (i.e., 'how many dimensions are covered?') and relevance (i.e., 'which dimensions are most important?'), both of which are highly context-dependent. For example, asking about wait times for mental health services (an item in the 'public services' factor in this study) would not be appropriate in a generic measure targeted towards the general public. Instrument brevity is another important element which may be difficult to balance with comprehensiveness. Longer instruments may be more challenging to complete, especially for vulnerable populations who are also more likely to be users of health and social care services. We note that this study, which focused primarily on the joint dimensionality of instruments, did not aim to propose specific items for inclusion in future or existing measures. It is for future studies to investigate the adequacy/relevance the identified dimensions and develop items that accurately operationalize those dimensions of interest in a particular context. The development process of the EQ-HWB aptly illustrates such considerations, highlighting the challenges in developing a generic yet comprehensive QoL measure that can be widely used (Peasgood et al., 2021).

Our results share similarities and differences with findings from previous dimensionality studies (Finch et al., 2017; Finch and Mulhern, 2022). The dimensions 'physical functioning', 'psychological symptoms', and 'social relations/functioning' identified in this study were also identified in the OMS and MIC datasets (Finch et al., 2017; Finch and Mulhern, 2022). This is reasonable given that these aspects of QoL closely resonate with the World Health Organization definition of health and are often included in QoL measures. In contrast, new/additional factors identified in this study compared to the MIC and OMS datasets included 'financial needs', 'discrimination', 'outlook on life/growth', 'access to public services', 'living environment', and 'control over life'. These more context-related factors, some of which were strongly correlated with participants' perceived health and wellbeing, represent potentially relevant dimensions to account for in future instruments or broaden the evaluative space of existing instruments (Finch et al., 2017, 2019).

Our inclusion of diverse instruments also enabled us to observe how some measures that were included in previous dimensionality studies, namely the EQ-5D and the ICECAP, behaved differently when included within our different and larger item pool. Most ICECAP items loaded on a single 'Needs' factor in the OMS dataset (Finch and Mulhern, 2022), and two ICECAP items were omitted from the CFA model on the MIC dataset due to poor performance (i.e., low or incoherent loadings) (Finch et al., 2017). In the current study, all ICECAP items loaded saliently on four distinct factors (i.e. 'psychological symptoms', 'social relations', 'physical functioning', and 'outlook on life'). In contrast, the items of the EQ-5D consistently loaded on the same three factors (i.e., 'psychological symptoms', 'pain', and 'physical functioning') in this study and the OMS and MIC datasets. The varying performance of the ICECAP across studies is informative and highlights the influential role of the specific item pool (i.e., enabling or preventing factor identification) on conclusions drawn from dimensionality results. At the same time, the consistent performance of the EQ-5D across studies confirms its ability to capture those specific QoL dimensions.

Finally, our 12-factor CFA model is broadly in line with two recently developed instruments that were not included in this analysis but were developed with broader frameworks in mind and are intended for use across sectors. The EQ-HWB, intended for use in evaluations of health and social care interventions covers the domains 'activity', 'autonomy', 'cognition', 'feelings/emotions', 'physical sensation', 'relationships', and 'self-identity' (Brazier et al., 2022; Peasgood et al., 2022). Most of EQ-HWB's domains overlap with the dimensional structure identified in this study. Similarly, the new Capabilities-Adjusted Life-Year Sweden (CALY-SWE) instrument (Meili et al., 2022), designed following a broad capabilities framework with embedded equity/distributional considerations, covers six dimensions: 'financial situation & housing', 'health', 'social relations', 'occupations', 'security', and 'political & civil rights'. Again, most of these dimensions are in line with our CFA model structure. As two innovative measures whose uptake will likely increase in the coming years, it would be of interest to explore the dimensionality of the EQ-HWB and the CALY-SWE alongside other broad measures in future studies.

5. Limitations

This study's findings should be interpreted in view of its limitations. First, the sample is representative of the Dutch general population and not the users of health/social care services, whose outcomes are usually of interest. While representativeness at the population level is desirable, it is also possible that this relatively healthy sample reduced the variability in responses and, consequently, influenced which dimensions were identified. Second, in all factor analytic studies, results are largely dependent on the specific item pool. Of the included measures, only the EQ-5D-5L, ICECAP, and BRS are commonly used internationally. The less commonly used PHDT, CAP-AWB, and HR-SWB do not have as much supporting evidence with regards to their validity and psychometric performance in different contexts and populations. Nonetheless, these instruments' coverage of broader constructs that are not usually included in commonly used measures (e.g., environmental contexts and spiritual dimensions) was of interest in this study. Third, our analyses do not account for the conceptual models or theoretical frameworks of the included instruments (e.g., the capability framework for the ICECAP and the CAP-AWB). This may have limited our ability to identify all relevant QoL domains and sub-domains during the content analysis and subsequent CFA. However, this limitation was likely minimized by our use of our adapted Wilson and Cleary model as a conceptual starting point, as well as our iterative and flexible (i.e., using inductive and deductive features) approach to content analysis which enabled us to hypothesize a wide range of potentially relevant QoL domains. Fourth, our inclusion

of the EQ-5D as the only HRQoL measure may explain why we did not identify more physical-health related factors (e.g. vision, hearing, and speech) which were identified in other analyses where more HRQoL measures were included (Finch et al., 2017; Finch and Mulhern, 2022). The fact that our CFA model misses certain aspects of QoL illustrates the need for more/several dimensionality analyses (using diverse item pools) to be conducted and their findings interpreted jointly. Fifth, with so many items to complete, participant fatigue may have influenced the quality of the data. We explored this limitation by comparing the correlation between two similarly phrased items placed around the start and end of the questionnaire (i.e., "I feel healthy" with 5 response options from "completely agree" to "completely disagree", and "how is your health in general?" with 5 response options from "very good" to "very bad"); the correlation was 0.75, indicating that consistency in responses was maintained. Sixth, the observation that some factors consist solely of items from a single instrument may suggest that factor identification was influenced by the characteristics of the included instruments (e.g., item proximity and similarity in phrasing). The non-random order in which questions were completed also contributes to this limitation. Seventh, our choice to use two random draws of 80% of participants for the exploratory and testing subsamples attempted to strike a balance between what was methodologically ideal (i.e., splitting into two non-overlapping samples) and what was acceptable given the constraints of the data. From one side, this splitting approach enabled us to achieve a large enough sample size at each stage of the analysis (i.e., model development and testing), while from the other side, it induced some re-cycling of participants and consequently a limitation. As split-sample cross-validation is not strictly required (but useful) for exploratory studies such as ours, we consider this a minor limitation. Finally, our correlation analyses were explorative and their results should be interpreted carefully for several reasons: a) it was not feasible account for the complex relationships between factors, which would require separate multivariate interaction models and causality assumptions; b) the VAS-happiness is a limited (strongly welfarist) indicator of overall wellbeing; and c) a potential source of non-comparability is that the VAS-Health was anchored at 'best/worst imaginable health' while the VAS-happiness was anchored at 'completely happy/unhappy'.

6. Conclusion

In conclusion, this study contributes to a broader understanding of QoL by exploring dimensionality and relationships among various QoL measures. Jointly, our findings from the CFA and correlation analyses offer valuable insights for the development of comprehensive instruments that capture multidimensional aspects of QoL. Future research should seek to address key limitations of our analysis (e.g., use population of patients/service users), investigate the relevance and validity of the identified dimensions within a wider measurement framework, and more thoroughly investigate the relationships between the identified dimensions and their influence on overall health and wellbeing.

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CRediT authorship contribution statement

Jan M. Heijdra Suasnabar: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Aureliano Paolo Finch:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Brendan Mulhern:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **M. Elske van den Akker-van Marle:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Conceptualization.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2024.116720.

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