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Focusing on positive outcomes in frailty research:

Development of a Short Well-being Instrument for Older adults (SWIO)

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Abstract

Objective: Studies of frailty have tended to focus on adverse outcomes. This study aims to develop a short instrument that identifies a positive outcome; namely, the level of well-being in older adults at risk of frailty.

Method: 871 older adults (49.4% women; mean age 75.72 years; SD = 8.05) with a frailty risk profile participated in the first wave of the D-SCOPE study. The possible domains of well-being were identified using a bottom-up approach. Exploratory Structural Equation Modeling (ESEM) and multidimensional IRT analysis of 17 items in 4 domains measuring well-being was performed on a calibration sample (n= 435) to develop the instrument. The instrument was subsequently corroborated by confirmatory factor analysis and convergent/divergent relations with relevant external measures in a validation sample (n = 436).

Results: The ESEM 3-factor solution, with the subdimensions of sense of mastery, meaning in life, and life satisfaction, displayed good fit to the data (RMSEA=0.070). For each dimension, the three best discriminating items were retained for the instrument following IRT analysis. Internal consistency of these dimensions was good in the validation sample (sense of mastery α=.864, meaning in life α=.715, and life satisfaction α=.782). The CFA 3-factor model also showed good fit to the data (RMSEA=0.064). Small to large zero-order correlations with the external measures were as expected.

Conclusions: Using a bottom-up approach, this study developed a short instrument to identify levels of well-being in vulnerable or frail older adults. The instrument can be applied in primary care and prevention programs.

Keywords: frailty; Item Response Theory; well-being; health outcomes; short form

Introduction

Frailty is a concept that is frequently used in aging research and in the care of older adults. While the majority of research focuses mainly on physical frailty, increasing attention is being paid to a more holistic and multidimensional concept of frailty (e.g., Gobbens et al., 2010). Multidimensional frailty has been defined as "a dynamic state affecting an individual who experiences losses in one or more domains of human functioning …, which is caused by the influence of a range of variables and which increases the risk of adverse outcomes'' (Gobbens et al., 2010: p. 342). Within this holistic view, domains such as social, cognitive, psychological, and environmental frailty are included, as well as the physical domain (De Roeck et al., 2018). To date, however, there is no consensus on a conceptual definition of frailty in later life (Bergman et al., 2007; Junius-Walker et al., 2018).

The vast majority of frailty research on outcomes for older persons focuses on adverse medical outcomes, such as mortality, functional decline, hospitalization, institutionalization, and other issues (Vermeiren et al., 2016), often in order to investigate the cost-effectiveness of interventions (e.g., Metzelthin et al., 2015). Research on more positive outcomes such as the quality of life is scarce (Kojima et al., 2016). However, the outcome of being frail does not have to be situated solely in adversities or negativities. The inclusion of more positive outcomes in frailty research has been proven to be an interesting avenue of research, but until now these positive outcomes are, to the best of our knowledge, rarely studied. They include: the quality of life and/or psychological well-being (e.g., Clegg et al., 2014; Dury et al., 2017; Landi et al., 2017; van der Vorst et al., 2017; Walters et al., 2017); meaning in life (Duppen et al., accepted); and a sense of mastery (Dury et al., 2018; van der Vorst et al., 2017). The few pioneering studies cited above have demonstrated that frail older adults can still experience a sense of well-being. The current study aims to further describe the importance of positive outcomes in frailty research, and presents the development and validation of a brief instrument to measure positive outcomes by means of aspects of well-being in older adults at risk of frailty. This instrument could be used both in research as well

as in primary care and prevention programs to identify persons/groups at risk of lower levels of well-being.

The studies that recognize these positive outcomes use different dimensions or concepts to operationalize "positive outcomes", including the umbrella concept of well-being. Well-being is conceptualized in different ways, although two forms occur repeatedly in the scientific literature: psychological well-being and subjective well-being. First, psychological well-being is frequently assessed using the Ryff scales, according to which well-being is founded theoretically in six dimensions: namely, autonomy; environmental mastery; personal growth; positive relations with others; purpose in life; and self-acceptance (Ryff, 2014). Second, subjective well-being is a broad construct that includes subjective appraisals of a person's whole life and from their own perspective. Although some researchers measure subjective well-being using only one item (Diener et al., 2018), including multiple dimensions is more common. These include: eudemonic well-being (i.e., meaning in life); evaluative well-being (i.e., life satisfaction); and hedonic well-being (i.e., happiness) (Steptoe et al., 2015); or, alternatively, positive/negative affect and life satisfaction (Chen et al., 2013). Both subjective well-being and psychological well-being are concerned with the positive aspects of psychological functioning. However, although they are strongly related, there is a distinction between the two at the individual component level (Chen et al., 2013).

This study aims to evaluate the subjective well-being of older adults at risk of frailty by beginning with the inclusion of four domains of well-being. The four domains are based on previous qualitative studies of the Detection-Support and Care for Older people, Prevention and Empowerment project (D-SCOPE) (Dury et al., 2018; van der Vorst et al., 2017, Duppen et al., 2018). They are: meaning in life; life satisfaction; autonomy/sense of mastery; and community inclusion. The project adopted a strong bottom-up approach and identified the dimensions of well-being for frail older adults through the narratives of elderly adults

themselves. In these narratives, frail older adults denoted the above-mentioned domains of well-being as being relevant in their lives.

Meaning in life, life satisfaction, and sense of mastery are domains of well-being that are widely acknowledged in ageing research. Eudemonic well-being (or meaning in life) has received increasing attention in the fields of psychology and medicine (e.g., Brandstaetter et al., 2012; Van der Heyden et al., 2015), and studies have demonstrated its particular relevance in old age (Battersby and Phillips, 2016). Life satisfaction, or evaluative well-being, is a valuable domain to include given the positive effect that greater life satisfaction has on survival, even when people are ill (Chida and Steptoe, 2008). A sense of mastery (or having a sense of control over your life) has multiple positive effects in later life and can counteract the negative effects of frailty on functional decline (Lee et al., 2016). Community inclusion is a domain of well-being that was derived from the qualitative D-SCOPE interviews (Dury et al., 2018; van der Vorst et al., 2017, Duppen et al., 2018). This was expressed in the interviews by the older adults themselves as they strove to maintain the feeling of inclusion and the ability to participate in the community. A further aspect of well-being, also derived from the qualitative D-SCOPE interviews, was labeled 'future perspective 'and incorporated into the 'meaning in life' domain, given the strong overlap with 'purpose in life' (an item in the 'meaning in life' domain).

In order to be able to intervene and to improve the sense of well-being in vulnerable groups, it is vitally important to identify well-being or a lack thereof in the early stages. To measure each of these domains separately, several instruments are available. For meaning in life, there is the Valuation of Life scale (Lawton et al., 2001) or the Meaning in Life questionnaire (Steger et al., 2006). For life satisfaction, there is the Satisfaction with Life Scale (Diener et al., 1985); and for sense of mastery, there is the Sense of Mastery scale (Pearlin et al., 2007). Combining all these relevant questionnaires of well-being would lead to a very long questionnaire. Questionnaire designs in gerontological research should take into account the

potential needs of the older target group in terms of accessibility, usability, and the length (i.e., brevity) of the questionnaire (Converse and Presser, 1986; Fowler, 2002). Moreover, given the vulnerable target group of older adults at risk of frailty and the risk of fatigue when intensive questionnaires are used, the respondent burden is a considerable issue (Rolstad et al., 2011). Several shorter instruments do exist to evaluate well-being, such as the short form of the Ryff scale (Andrew et al., 2012). However, a short well-being instrument with domains designated by older adults themselves is nonexistent.

This study aims therefore to design a brief and user-friendly instrument, capturing the important domains of well-being, and using already existing and validated scales. In search of an instrument that is both short but sufficiently discriminative, our approach will utilize both confirmatory factor analysis and item response theory to ensure that the items used in the subscales do discriminate sufficiently. The aim is to develop a short scale measuring the important aspects of well-being, as expressed by older adults at risk of frailty. Such an instrument will make it possible to evaluate the effectiveness of interventions by measuring changes in levels of well-being over time.

Methods

Sample

Data were gathered from 871 older adults (49.4% women) who completed the survey in the first wave of the D-SCOPE study in 2017. Participants were selected from the census records of the Belgian municipalities Knokke-Heist, Gent and Tienen, with a stratified sample based on risk profiles for frailty (Dury et al., 2016). Questionnaires were completed at the home of older adults by a researcher or a trained volunteer and lasted on average 67 minutes. More information on the study design and the eligibility criteria of the participants can be found in Lambotte et al. (2018). All participants were 60 years or older. The mean age was 75.72 (SD = 8.05). Of the total, 38.5% were married or lived together with a partner, 6.6% were never married,19.2% were divorced, and 35.5% were widowed. The latter two are

higher than population averages as these marital statuses were purposefully sampled as risk profiles for frailty. Of the total, 37.7% had a lower level of education (i.e., until the age of 14). Although all respondents had a risk profile for frailty, not all of them were frail in one or more domains. Table 1 presents the characteristics of the respondents with respect to their frailty level for each domain separately. In general, severe physical frailty and cognitive frailty was more prevalent for female older adults, older adults above 75 year, older adults with a poor educational level or when they were unmarried or not living together. Psychological frailty was more prevalent for female older adults, older adults above 75 year or when they were unmarried or not living together. Social frailty was more prevalent for older adults who were unmarried or not living together.

- insert Table 1 here -

Measures of well-being

Sense of Mastery (SOM) – 4 items that measure current mastery were derived from the Sense of Mastery scale (Pearlin et al., 2007). Based on qualitative interviews prior to this study (Dury et al., 2018), a supplemental item was added to assess mastery in relation to others: "I can determine how I want things in my life".

Meaning in Life (MIL) –The Dutch version of the 'presence' subscale (5 items) of the Meaning in Life Questionnaire (Steger et al., 2006) was used for the evaluation of meaning in life. Additionally, a supplemental item was added to the questionnaire to assess their desire for future events, using the statement: "I am looking forward to events in the future."

Life Satisfaction (LS) – The Dutch version of the complete Satisfaction with Life Scale (5 items) was used in the questionnaire (Diener et al., 1985).

Community Inclusion (CI) – One item from the Community Integration Measure (CIM) was used to assess the extent to which participants felt they were part of the community (McColl et al., 2001).

For all measures, responses were given on a 5-point Likert scale ranging from 1 ("totally disagree") to 5 ("totally agree). If no Dutch version was available for an instrument, we adopted a team translation approach called 'Translation, Review, Adjudication, Pre-Testing, and Documentation' (TRAPD) to translate the English questions into Dutch. The survey was screened by the organization "Wablieft", who checked the accessibility and clarity of language considering the vulnerability of the target group.

External validation measures

Comprehensive Frailty Assessment Instrument plus (CFAI+) – Multidimensional frailty was assessed according to the CFAI+ (De Roeck et al., 2018; De Witte et al., 2013). This self-assessment instrument includes five domains of frailty. The physical domain is captured by assessing the respondent's general physical health and consists of four items; e.g., walking up a hill or stairs. The psychological domain includes measurements of mood disorders and emotional loneliness and consists of eight items; e.g., losing self-confidence. The social domain was evaluated based on social loneliness (three items: e.g., feeling close to other people) and potential social support networks (ten items: e.g., partner, children, and neighbors). Environmental frailty was assessed based on factors related to the suitability of the physical housing environment (five items: e.g., insufficient comfort in the house). Finally, subjective cognitive frailty was assessed based on factors related to cognitive functioning (four items: e.g. memory problems). Scores for each domain, which theoretically range from 0 to 100, were calculated by adding the scores for the specific items (De Roeck et al., 2018). The total scores were used in our analyses, but specific cut-offs if needed can be found elsewhere (De Witte et al., 2018).

Numeric Rating Scales – Five single-item questions on a numeric rating scale (NRS) from 0 to 10 were developed as part of the D-SCOPE project to assess quality of life (QOL), MIL, CI, SOM, and subjective frailty; e.g., "On a scale from 0 to 10, to what extent do you feel part of the community?" The scores ranged from 0 (bad) to 10 (excellent) on an NRS. These single-item questions were related to earlier D-SCOPE research (Dury et al., 2018; van der Vorst et al., 2017) and were used to gain insight into the older adult's feelings of frailty and overall experience regarding QOL, MIL, CI, and SOM. The subjective frailty NRS was reversed to align with the frailty dimensions of the CFAI. See supplementary material Appendix A1.

Analyses

The sample was randomly divided into a calibration (*n* = 435) and a validation sample (*n* = 436). The *calibration* sample was used to develop a short well-being **i**nstrument for older adults (SWIO). Firstly, the underlying structure of well-being was evaluated for all potential items by using Mplus to perform exploratory structural equation modeling analyses (ESEM; see Marsh et al., 2014). The fit of the successive factor solutions was evaluated using the following goodness-of-fit criteria: the Tucker-Lewis Index (TLI); the comparative fit index (CFI); the standardized root mean square residual (SRMR); and the root mean square error of approximation (RMSEA). For an acceptable fit, the rules of thumb are: TLI ≥ .90; CFI ≥ .90; RMSEA ≤ .08 (RMSEA interval ≤ .10); and SRMR ≤ .08 (Chen et al., 2008; Hu and Bentler, 1999). To decide on the number of factors, these goodness-of-fit criteria were used in combination with interpretability of the factors. Items were considered to load on a factor substantially if the factor loading was significant and at least .32 (Tabachnick and Fidell, 2013). Next, the SWIO was developed. A prior decision was made to shorten the scales by confining the measures of the underlying factors to 3 items, which would optimize the brevity of the instrument while still allowing the use of the dimensions in structural analyses. For the SWIO, items were selected only if they had substantial factor loadings. To further shorten the scale, IRT modeling was used to include the most discriminating parameters. In IRT, the *a*

parameter is the discrimination parameter which indicates the extent to which the item is related to the construct; the higher the parameter, the more discriminating is the item. IRT analyses were conducted using IRTpro (Cai et al., 2011). Since all items have five response categories with increasing valence, a graded response model was applied (Samejima, 1997).

The *validation* sample was used to cross-validate the instrument in an independent sample. First, using Mplus, confirmatory factor analysis was applied to statistically test whether the factor structure deduced in the calibration sample, based on the reduced number of items, showed acceptable fit in the independent validation sample by specifying patterns of relations a priori. Next, zero-order correlations of the subscales of the SWIO were calculated with all external validity measures and interpreted according to Cohen's (1988) *r* effect sizes (.10 small, .30 medium, and .50 large).

Results

Factor structure of all potential well-being items

ESEM (geomin rotation) was performed on the calibration sample. Factors were interpretable up to three factors. However, the 1-factor CFA model ($\chi^2_{(119)}$ = 983.842, CFI = 0.735, TLI = 0.697, RMSEA = 0.129 (90% CI 0.122-0.137), SRMR= .089), as well as the 2-factor model ($\chi^2_{(103)}$ = 546.402, CFI = 0.864, TLI = 0.821, RMSEA = 0.099 (90% CI 0.122-0.108), SRMR = 0.058), did not have acceptable fit to the data. The 3-factor model had good fit to the data: $\chi^2_{(88)}$ = 274.769, CFI = 0.943, TLI = 0.912, RMSEA = 0.070 (90% CI 0.061-0.079), SRMR = 0.032). Geomin rotated factor loadings are reported in Table 2. We labeled the three factors 'meaning in life', 'life satisfaction', and 'sense of mastery'. The SWIO includes these factors as 3 different subscales. However, since the pattern of the convergent correlations between each factor are very close to each other (SOM-LS: *r*=.556; SOM-MIL: *r*=.585; LS-MIL: *r*=.565), one total well-being score can be applied.

- insert Table 2 here -

IRT modeling in the calibration sample

Since the ESEM analyses indicated three underlying factors, we applied a multi-dimensional graded IRT model (Metropolis-Hastings Robbins-Monro Algorithm). Table 3 presents the discrimination values (*a* parameters) for the three dimensions. The highest discrimination values for the sense of mastery dimension were found in the following: "I can't solve some of the problems I have" (reversed, *a*=2.15); "I have little control over the things that happen to me" (reversed, *a*=2.39); and "I often feel helpless in dealing with the problems of life" (reversed, *a*=3.52). For the meaning in life dimension, the highest discriminating values were: "I understand my life's meaning" (*a*=3.62); "I have a good sense of what makes my life meaningful" (*a*=3.67); and "I have discovered a satisfying life purpose" (*a*=3.51). For the life satisfaction dimension, the highest discriminating values were found in: "The conditions of my life are excellent" (*a*=3.06); "I am satisfied with my life" (*a*=3.54); and "So far I have obtained the important things I want in life" (*a*=2.36). Since these three items all had substantial factor loadings on the corresponding dimensions in the ESEM analyses and no cross-loadings (i.e., pure indications of the dimension), we decided to retain these 9 items, 3 per dimension, for our SWIO. The complete SWIO and instruction manual can be found in Appendix A2.

- insert Table 3 here -

Cross-validation of the SWIO in the validation sample

All scales showed good internal consistency, as follows: sense of mastery α = .864; meaning in life α = .715; and life satisfaction α = .782. The confirmatory factor analyses on the 9 SWIO items resulted in good fit to the data ($\chi^2_{(24)}$ = 67.164, CFI = 0.973, TLI = 0.959, RMSEA = 0.064 (90% CI 0.046-0.083), SRMR = 0.041). Specified patterns and standardized factor loadings are displayed in Figure 1.

- insert Figure 1 here -

External validity: Correlation between frailty dimensions and the measures

Table 4 presents zero-order correlations to assess the relationship between the subdimensions of well-being and the validation measures. For the frailty dimensions, all correlations were negative, and most correlations were of a medium effect size. The highest correlations were found in psychological frailty, with large correlations with sense of mastery ($r=-.624$) and life satisfaction ($r=-.524$), and a medium correlation with meaning in life ($r=-.489$). Cognitive frailty had medium correlations with sense of mastery ($r=-.452$) and meaning in life ($r=-.322$), and a small correlation with life satisfaction ($r=-.258$). Social frailty had a small correlation with sense of mastery ($r=-.285$), but had medium correlations with meaning in life ($r=-.358$) and life satisfaction ($r=-.306$). Physical frailty had a medium correlation with sense of mastery ($r=-.395$) and small correlations with meaning in life ($r=-.237$) and life satisfaction ($r=-.259$). Finally, small correlations were found between environmental frailty and sense of mastery ($r=-.293$), meaning in life ($r=-.208$), and life satisfaction ($r=-.256$).

Regarding the correlation between the subdimensions of well-being and the numeric rating scales for quality of life, meaning in life, and community inclusion, all correlations were positive, whereas correlations for subjective frailty were negative. Most of them were of a medium effect size. The highest correlation was found between meaning in life as a subdimension and the MIL NRS ($r=.566$). Further, there was a large correlation with life satisfaction ($r=.528$) and a medium correlation with sense of mastery ($r=.435$). The QOL NRS had a large correlation with life satisfaction ($r=.541$) and medium correlations with sense of mastery ($r=.461$) and meaning in life ($r=.459$). The SOM NRS had medium correlations with sense of mastery ($r=.436$), meaning in life ($r=.406$), and life satisfaction ($r=.389$). Medium correlations were also found between the CI NRS and sense of mastery ($r=.444$), meaning in life ($r=.460$), and life satisfaction ($r=.406$). Finally, for the subjective frailty NRS, medium

correlations were found with sense of mastery ($r=-.370$) and life satisfaction ($r=-.367$), and a small correlation with meaning in life ($r=-.278$).

- insert Table 4 here -

Discussion

This study is one of the few to focus on *positive* outcomes for the frail and elderly instead of *adverse medical* outcomes. The purpose of the study was to develop an instrument that measures well-being in an elderly community-dwelling population with a high risk of frailty. To construct an instrument that is both short and discriminates sufficiently, a combination of confirmatory factor analysis (CFA) and IRT modelling was applied on a sample of 871 community-dwelling elderly adults with a high frailty risk profile. Earlier frailty research had identified a sense of mastery, meaning in life, life satisfaction, and community inclusion as positive outcomes (Dury et al., 2018; van der Vorst et al., 2017), and these were the subjects for the development of the SWIO. For the underlying structure, ESEM was performed on a calibration sample with 14 items from existing scales and 3 self-constructed items. With regard to the factor structure of all potential well-being items, the 3-factor model had a good fit to the data and these factors were labeled as sense of mastery, meaning in life, and life satisfaction. Subsequently, a multidimensional graded IRT model was applied. The result was 3 subscales with 3 items each for the final SWIO.

In the validation sample, the SWIO was cross-validated and all scales had good internal consistency. The CFA resulted in a good fit of the data. To establish convergent validity, the SWIO was subsequently externally validated with five frailty dimensions of the CFAI (i.e., physical, environmental, cognitive, social, and psychological frailty) and the numeric measures of QOL, MIL, CI, SOM, and subjective frailty. As expected, the SWIO was negatively associated with all frailty domains as well as with subjective frailty, and positively associated with the numeric measures.

The SWIO can be used in the screening and evaluation of well-being for community-dwelling older adults at risk of frailty. None of the self-constructed items were used in the final version of the SWIO. In appreciation of the researchers and authors of the original instruments that were used in this short instrument, the full names of the instruments, the names of the authors, and references to publications of the original instruments, are represented at the bottom of the SWIO questionnaire and manual (see also Appendix A2). The primary purpose of the SWIO development was to evaluate the well-being of community-dwelling older adults. Since all of the items in the final version of the SWIO are derived from international instruments that are used in nursing homes or geriatric care units, we encourage its use in such settings.

This study does have certain limitations and, therefore, the findings should be interpreted with some caution. First, the SWIO is a brief instrument that only gives an indication of an older adult's well-being. For a more comprehensive and in-depth evaluation of well-being, other instruments might be more appropriate, such as the Flourishing Scale and the Scale of Positive and Negative Experience (Diener et al., 2010). Second, in addition to the frailty domains, a cross-validation occurred with the numeric rating scales for QOL, MIL, CI, SOM, and subjective frailty. However, these scales were used in earlier research (van der Vorst et al., 2017) and cannot be considered as a validated measurement, in contrast to the CFAI which is a validated instrument (De Witte et al., 2013). Third, the efficacy of the SWIO as an outcome measurement for treatment remains to be further explored. Fourth, in order to further strengthen the construct validity of the instrument, the SWIO should be validated in future studies against another well-being scale, such as the Warwick-Edinburgh Mental Well-being Scale (Tennant et al., 2007) or the Ryff scales (Ryff, 2014).

Conclusions

In frailty research, the focus of geriatric and gerontological studies is mostly on adverse outcomes rather than positive outcomes such as well-being. This study has presented a short instrument to evaluate three domains of well-being: namely, sense of mastery; meaning in life; and life satisfaction. By performing IRT analyses, a Short Well-being Instrument for Older adults (SWIO) was developed and cross-validated. The instrument can be used to identify the level of well-being in vulnerable or community-dwelling elderly adults at risk of frailty.

Conflicts of interest

None.

Description of the authors' roles

Daan Duppen collected the data, performed the statistical analysis, analyzed the data, and wrote the manuscript. Gina Rossi helped with the study design, performed the statistical analysis, analyzed the data, and wrote the manuscript. Lieve Hoeyberghs collected the data and wrote the manuscript. Liesbeth De Donder and Eva Dierckx helped with the study design, supervised the data collection, analyzed the data, and wrote the manuscript.

Acknowledgments

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Tables and figures.

Table 1: Participant characteristics

	total	no to low frail	mild frail	severe frail	χ^2	*P*-value
	N (%)	N (%)	N (%)	N (%)		
physical frailty						
women	422 (49.2)	176 (42.5)	172 (52.8)	74 (63.2)	18.3	.000
75 years or older	439 (51.3)	171 (41.4)	184 (56.6)	84 (71.8)	39.5	.000
marital status (married/living together)	329 (38.5)	177 (42.9)	111 (34.2)	41 (35.0)	6.5	.039
poor educational level	322 (37.8)	110 (26.8)	150 (46.3)	62 (53.4)	43.3	.000
psychological frailty						
women	419 (49.6)	241 (45.6)	120 (55.6)	58 (58.6)	9.7	.008
75 years or older	430 (45.1)	249 (47.2)	130 (60.5)	51 (51.5)	10.8	.004
marital status (married/living together)	322 (38.2)	241 (45.7)	61 (28.2)	20 (20.2)	35.3	.000
poor educational level	319 (38.0)	170 (32.3)	105 (48.6)	44 (45.8)	20.2	.000
social frailty						
women	421 (49.2)	134 (51.5)	215 (51.2)	72 (41.1)	5.8	*ns*
75 years or older	437 (51.2)	121 (46.5)	226 (54.1)	90 (51.4)	3.6	*ns*
marital status (married/living together)	329 (38.6)	134 (51.5)	136 (32.5)	59 (33.7)	26.6	.000
poor educational level	321 (37.8)	101 (39.0)	152 (36.5)	68 (39.3)	0.6	*ns*
cognitive frailty						
women	423 (49.6)	179 (44.0)	86 (52.1)	158 (56.2)	10.5	.005
75 years or older	434 (51.0)	161 (39.7)	87 (53.0)	186 (66.2)	47.1	.000
marital status (married/living together)	328 (38.5)	180 (44.2)	68 (41.5)	80 (28.6)	17.9	.000
poor educational level	319 (37.7)	103 (25.4)	69 (42.3)	147 (52.7)	54.2	.000
environmental frailty						
women	418 (49.1)	193 (49.0)	192 (51.5)	33 (38.8)	4.4	*ns*
75 years or older	437 (51.4)	197 (50.0)	203 (54.7)	37 (43.5)	4.1	*ns*
marital status (married/living together)	330 (38.8)	152 (38.7)	146 (39.2)	32 (37.6)	0.1	*ns*
poor educational level	325 (38.4)	135 (34.4)	149 (40.3)	41 (48.8)	6.9	.030

ns = not significant

Table 2: Geomin rotated factor loadings and correlations between factors for the 3-factor ESEM solution in the calibration sample

ITEM CONTENT		F1 SENSE OF MASTERY	F2 LIFE SATISFACTION	F3 MEANING IN LIFE
1R	I can't solve some of the problems I have	0.646*	-0.035	0.020
2R	I have little control over the things that happen to me	0.722*	-0.068	-0.018
3R	I often feel helpless in dealing with the problems of life	0.730*	0.088	-0.006
4	I can do about anything I set my mind to	0.653*	0.013	0.022
5	I can determine how I want things in my life	0.618*	-0.105	0.014
6	My life has a clear sense of purpose	-0.022	0.844*	-0.026
7	I understand my life's meaning	-0.033	0.826*	0.020
8	I have a good sense of what makes my life meaningful	-0.022	0.807*	-0.018
9	I have discovered a satisfying life purpose	0.026	0.738*	0.100
10R	My life has no clear purpose	0.065	0.534*	0.096
11	I have the feeling I am included in the community	0.011	0.561*	0.090
12	I am looking forward to events in the future	0.003	0.577*	-0.067
13	In most ways my life is close to my ideal	0.002	0.102	0.710*
14	The conditions of my life are excellent	0.332*	0.026	0.499*
15	I am satisfied with my life	0.083	0.144*	0.599*
16	So far I have gotten the important things I want in life	-0.121	-0.020	0.814*
17	If I could live my life over, I would change almost nothing	-0.145	-0.009	0.739*
F1	Sense of mastery	1.000		
F2	Life satisfaction	0.556*	1.000	
F3	Meaning in life	0.585*	0.565*	1.000

R = reversed scored item, * significant at p<.05

Table 3: Multidimensional Graded Model Item Parameter Estimates

	ITEM CONTENT	a_1	s.e.	a_2	s.e.	a_3	s.e.
1R	I can't solve some of the problems I have	**2.15**	0.23	0.00	–	0.00	–
2R	I have little control over the things that happen to me	**2.39**	0.25	0.00	–	0.00	–
3R	I often feel helpless in dealing with the problems of life	**3.52**	0.44	0.00	–	0.00	–
4	I can do about anything I set my mind to	1.90	0.18	0.00	–	0.00	–
5	I can determine how I want things in my life	1.70	0.18	0.00	–	0.00	–
6	My life has a clear sense of purpose	0.00	–	3.40	0.30	0.00	–
7	I understand my life's meaning	0.00	–	**3.62**	0.33	0.00	–
8	I have a good sense of what makes my life meaningful	0.00	–	**3.67**	0.32	0.00	–
9	I have discovered a satisfying life purpose	0.00	–	**3.51**	0.29	0.00	–
10R	My life has no clear purpose	0.00	–	1.95	0.18	0.00	–
11	I have the feeling I am included in the community	0.00	–	2.09	0.18	0.00	–
12	I am looking forward to events in the future	0.00	–	1.57	0.15	0.00	–
13	In most ways my life is close to my ideal	0.00	–	0.00	–	2.32	0.20
14	The conditions of my life are excellent	0.00	–	0.00	–	**3.06**	0.28
15	I am satisfied with my life	0.00	–	0.00	–	**3.54**	0.37
16	So far I have gotten the important things I want in life	0.00	–	0.00	–	**2.36**	0.20
17	If I could live my life over, I would change almost nothing	0.00	–	0.00	–	1.52	0.14

R= reversed scored item

Table 4: Pearsons correlations among subdimensions of well-being and validation measures

		1	2	3	4	5	6	7	8	9	10	11	12	13
Correlations (N)	1. Sense of mastery[†]	1 (853)												
	2. Meaning in life[†]	.440** (805)	1 (816)											
	3. Life satisfaction[†]	.492** (843)	.576** (808)	1 (858)										
	4. Physical frailty	-.395** (841)	-.237** (803)	-.259** (845)	1 (857)									
	5. Environmental frailty	-.293** (838)	-.208** (800)	-.256** (843)	.126** (840)	1 (852)								
	6. Cognitive frailty	-.452** (839)	-.322** (802)	-.258** (843)	.401** (840)	.213** (837)	1 (853)							
	7. Social frailty	-.285** (842)	-.358** (803)	-.306** (845)	.174** (843)	.209** (841)	.225** (841)	1 (855)						
	8. Psychological frailty	-.624** (841)	-.489** (804)	-.524** (847)	.357** (845)	.329** (841)	.418** (840)	.354** (844)	1 (855)					
	9. NRS Quality of life	.461** (847)	.459** (812)	.541** (854)	-.348** (851)	-.219** (846)	-.300** (847)	-.242** (849)	-.439** (851)	1 (863)				
	10. NRS Meaning in life	.435** (841)	.566** (807)	.528** (848)	-.299** (844)	-.220** (840)	-.285** (841)	-.303** (843)	-.487** (845)	.711** (855)	1 (856)			
	11. NRS Sense of mastery	.436** (838)	.406** (803)	.389** (843)	-.286** (838)	-.202** (835)	-.303** (838)	-.261** (838)	-.369** (839)	.523** (849)	.480** (846)	1 (851)		
	12. NRS Community inclusion	.444** (844)	.460** (810)	.406** (851)	-.285** (846)	-.250** (843)	-.311** (844)	-.406** (846)	-.431** (847)	.542** (857)	.612** (852)	.475** (848)	1 (859)	
	13. NRS Subjective frailty	-.370** (843)	-.278** (807)	-.367** (849)	.221** (845)	.160** (841)	.211** (842)	.203** (844)	.354** (845)	-.430** (855)	-.441** (850)	-.358** (845)	-.394** (852)	1 (857)

∗∗p < 0.01 (2-tailed). † Subdimensions of well-being.

Figure 1: standardized factor loadings of the 3-factor CFA model in the validation sample
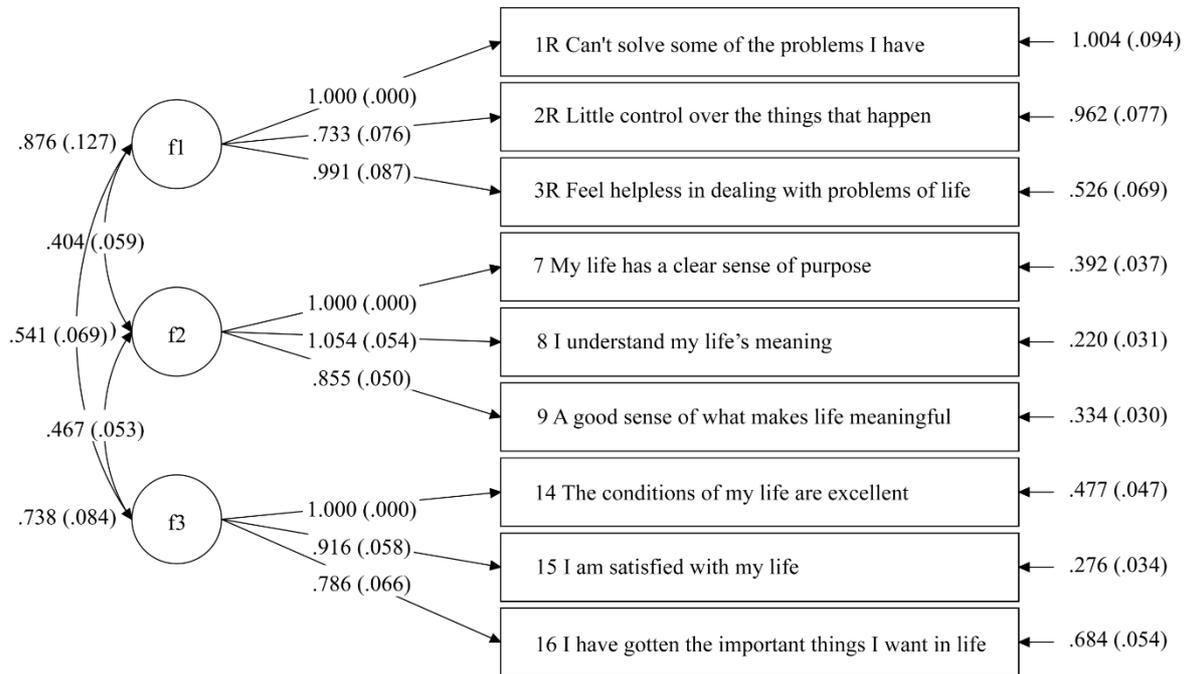
f1 = sense of mastery dimension, f2= meaning in life dimension, f3 = life satisfaction dimension