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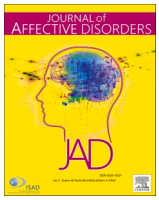

Research paper

Longitudinal measurement invariance of EURO-D scale across 27 countries in SHARE wave 8 and wave 9: A cross-country alignment study

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ABSTRACT

Background: The EURO-D is a widely used measure of 12 depressive symptoms among middle-aged and older adults in Europe. The present study aims to evaluate the psychometric properties and measurement invariance of EURO-D across gender, age, time, and countries.

Methods: This study utilized population-representative samples of participants aged 50 and above from Waves 8 and 9 (N = 52,369–67,744, Mean age = 69.9, 57 % female) of the Survey of Health, Aging, and Retirement in Europe (SHARE) across 27 countries. The factorial validity, reliability, and convergent validity of EURO-D were assessed using confirmatory factor analysis. The alignment approach was used to examine the longitudinal measurement invariance of EURO-D across countries in Waves 8 and 9.

Results: The modified 1-factor model, with two residual correlations, provided a parsimonious and acceptable fit in both Waves 8 and 9. EURO-D demonstrated exact scalar invariance across gender, age groups, and time points, and was significantly associated with greater loneliness, functional limitations and lower cognitive function. Across countries, EURO-D showed approximate scalar invariance at Wave 8 and Wave 9, with 30.2 % and 30.4 % of measurement parameters being non-invariant, respectively. Variations were observed at the country level in the temporal changes in the aligned EURO-D factor mean.

Conclusions: The findings support satisfactory psychometric properties and measurement equivalence of EURO-D across gender, age groups, time points, and countries. These results have important clinical implications for ensuring cross-cultural comparability in aging populations in future cross-national research using the SHARE dataset.

1. Introduction

Depression is a common mental health problem worldwide with substantial impact on individuals' functioning and well-being. A meta-analytic review on 20 studies involving 18,953 participants found a global prevalence rate of 13.3 % for major depressive disorder in older adults (Abdoli et al., 2022), and Europe showed the second highest prevalence of major depression (12.9 %) after Australia (20.1 %). Depressive symptoms have shown bidirectional associations with loneliness and anxiety symptoms in 5066 middle-aged and older adults in the Irish Longitudinal Study on Aging (Domènech-Abella et al., 2019). The high prevalence of depression has led to a call for screening for depressive symptoms in adults for early diagnosis and timely interventions.

A number of self-reported measures are available in the literature to assess depressive symptoms, including the Patient Health Questionnaire (PHQ) (Levis et al., 2019), Center for Epidemiologic Studies – Depression Scale (CES—D) (Mohebbi et al., 2018), Beck Depression Inventory (BDI) (Segal et al., 2008), and Geriatric Depression Scale (GDS) (Krishnamoorthy et al., 2020). The EURO-D scale was developed by Prince et al. (1999) to measure 12 depressive symptoms in 21,724 older adults in 11 European countries. The EURO-D has been adopted in Survey of Health, Aging and Retirement in Europe (SHARE), which is a large-scale longitudinal survey of people aged 50 years or above across

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European countries as well as Israel.

In terms of dimensionality, previous studies suggested a two-factor solution (Affective Suffering and Amotivation) for the EURO-D. The two-factor model was replicated in 17,852 older adults from nine non-European countries (Guerra et al., 2015), and SHARE samples in Wave 1 (N = 22,777) (Castro-Costa et al., 2008), Wave 5 (N = 62,182) (Portellano-Ortiz et al., 2018), and Wave 6 (N = 41,862) (Maskileyson et al., 2021). Overall, the EURO-D factors showed acceptable levels of reliability (Cronbach's alpha = 0.71–0.72) (Courtin et al., 2015; Portellano-Ortiz et al., 2018). However, results of two previous studies (Castro-Costa et al., 2008; Guerra et al., 2015) were derived from principal component analysis and orthogonal varimax rotation, which could bias the factor structure and are inappropriate analytic methods for determining latent structure and testing for measurement invariance. Indeed, a recent validation study on the EURO-D (Tomás et al., 2022) found a better fit for the bi-factor model over the two-factor model among 46,317 respondents in SHARE Wave 8. The inconsistency in factor structure warrants further research in the EURO-D.

Besides, two existing studies did not conduct any measurement invariance tests for the EURO-D (Portellano-Ortiz et al., 2018; Prince et al., 1999); two other studies examined metric invariance on factor loadings but not scalar invariance on item thresholds among 10 countries (Castro-Costa et al., 2008; Guerra et al., 2015); and Tomás et al. (2022) recently established scalar measurement invariance of the EURO-D across gender. Using the alignment approach, Maskileyson et al. (2021) established partial scalar measurement invariance of the EURO-D across 18 countries in SHARE Wave 6. However, their invariance model was only based on a trimmed version of 8 EURO-D items with four items (Suicidality, Appetite, Sleep, Fatigue) removed. Given the long-term panel design of SHARE across multiple countries with diverse geographical and cultural backgrounds in Europe, examination of longitudinal and cross-country measurement invariance is essential to ensure meaningful comparisons of depressive symptoms across time and countries.

Löwe and Kohlmann (2023) emphasized the importance of international comparability of self-report scales for assessing depression scores. To our knowledge, existing studies have yet to systematically evaluate measurement invariance of the 12-item EURO-D across age groups, time, and countries. In particular, no existing research has examined the longitudinal measurement invariance of EURO-D across countries. In view of these research gaps, the present study had three objectives. First, we aimed to re-examine the factorial validity, reliability, and convergent validity of EURO-D with loneliness, functional limitations, and cognitive function in the latest Wave 9 of SHARE. Second, we evaluated the measurement invariance of the EURO-D across gender, age groups, and time. Third, we examined the longitudinal measurement invariance of the EURO-D across 27 countries in Europe using the alignment approach and the temporal changes in the aligned factor means across Wave 8 and Wave 9.

2. Methods

2.1. Study sample and procedures

The present study had a longitudinal design and population representative samples from SHARE Wave 8 and Wave 9. SHARE is the largest European panel survey on health, aging, and well-being of middle-aged and older adults aged 50 years or above (Börsch-Supan et al., 2013). SHARE Wave 8 data collection took place in 27 countries between October 2019 and March 2020 and Wave 9 took place in 28 countries between October 2021 and September 2022 via computer-assisted personal interviews. SHARE adopts a multi-stage, probability-based sampling strategy. After specifying the sampling frame and procedures in the participating countries, the data were collected in each country. The collected data were then processed and uploaded to the SHARE headquarters for merging. Details on sampling strategies and data collection procedures of the two waves are available elsewhere (Bergmann and Börsch-Supan, 2021; Bergmann et al., 2024).

In the present study, inclusion criteria were SHARE participants aged 50 years or older who provided at least partial responses to EURO-D items at a given wave. Of the baseline samples, 53,695 respondents in Wave 8 and 69,447 respondents in Wave 9 were initially considered. Exclusions included 410 respondents in Wave 8 and 441 in Wave 9 who were younger than 50 years. In addition, 916 participants in Wave 8 and 1262 in Wave 9 were excluded due to completely missing responses to all EURO-D items. This resulted in effective sample sizes of 52,369 for Wave 8 and 67,744 for Wave 9. A subset of 38,047 participants completed both waves, with 14,531 respondents being lost to follow-up at Wave 9. Ethical approval for SHARE Wave 8 and Wave 9 was obtained from the Ethics Council of the Max Planck Society. The purpose of the study, along with its voluntary and confidential nature, was explained to participants, and informed consent was obtained from all respondents.

In the present study, over half (57.1 % - 57.4 %) of the samples were females, with a mean age of 69.8 (SD = 9.72) in Wave 8 and 69.9 (SD = 9.59) in Wave 9. Two-thirds of them were aged between 60 and 79 years. The present sample comprised middle-aged and older adults recruited from 28 countries in the European region (Table 1). In Wave 9, the sample size available in each country ranged from a minimum of 721 respondents (1.1 %) for Israel and a maximum of 4694 (6.9 %) for Poland. Respondents from Portugal did not provide data on EURO-D in Wave 8 and this country was excluded in the examination of longitudinal measurement invariance.

Table 1
Demographic and psychological profiles of Wave 8 and Wave 9 SHARE cohorts.

	Wave 8 (N = 52,369)	Wave 9 (N = 67,744)	Wave 9 Country	N (%)
	N (%)	N (%)	Austria	3279 (4.8)
Gender			Germany	4399 (6.5)
Females	29,895 (57.1)	38,872 (57.4)	Sweden	2385 (3.5)
Age group			Netherlands	2052 (3.0)
50–59 years	8422 (16.1)	10,574 (15.6)	Spain	2011 (3.0)
60–69 years	18,216 (34.8)	23,478 (34.7)	Italy	3521 (5.2)
70–79 years	16,428 (31.4)	21,868 (32.3)	France	2876 (4.3)
≥80 years	9303 (17.8)	11,824 (17.5)	Denmark	2323 (3.4)
EURO-D items	Yes %	Yes %	Greece	3047 (4.5)
Depression	40.1	41.4	Switzerland	1832 (2.7)
Pessimism	18.0	18.1	Belgium	4384 (6.5)
Suicidality	6.0	6.0	Israel	721 (1.1)
Guilt	7.7	7.6	Czech Republic	3246 (4.8)
Sleep	36.7	35.2	Poland	4694 (6.9)
Interest	10.8	10.8	Luxembourg	788 (1.2)
Irritability	26.4	26.5	Hungary	1793 (2.7)
Appetite	9.4	9.5	Portugal	1523 (2.3)
Fatigue	35.3	36.4	Slovenia	4253 (6.3)
Concentration	17.3	18.0	Estonia	4373 (6.5)
Enjoyment	13.8	13.8	Croatia	4477 (6.6)
Tearfulness	23.7	24.1	Lithuania	1401 (2.1)
	Mean (SD)	*Mean (SD)*	Bulgaria	826 (1.2)
Age (years)	69.8 (9.72)	69.9 (9.59)	Cyprus	730 (1.1)
EURO-D total score	2.43 (2.25)	2.45 (2.28)	Finland	1743 (2.6)
Loneliness	3.96 (1.41)	4.01 (1.44)	Latvia	1681 (2.5)
IADL limitations	0.54 (1.52)	0.52 (1.48)	Malta	868 (1.3)
Numeracy	4.07 (1.47)	4.08 (1.49)	Romania	1469 (2.2)
Temporal orientation	3.81 (0.61)	3.82 (0.60)	Slovakia	1049 (1.6)

SHARE = Survey of Health, Aging and Retirement in Europe; EURO-D = European Depression Scale; IADL = instrumental activities of daily living.

2.2. Measures

SHARE collected a variety of individual-level data using standardized questionnaires. The EURO-D scale was the primary measure in the present study. This scale assesses the presence of 12 depressive symptoms: depressed mood, pessimism, suicidality, guilt, sleep disturbance, lack of interest, irritability, appetite problems, fatigue, concentration problems, lack of enjoyment, and tearfulness. The items are answered in a binary format (0 = absence and 1 = presence of symptoms). The total EURO-D score has a theoretical range from 0 to 12. A recent psychometric study supported a bi-factor structure with a general depression factor and two specific factors (Tomás et al., 2022).

Apart from EURO-D scale and socio-demographic characteristics on age, gender, and country, the present study included the following measures on loneliness, functional limitations, and cognitive function. Loneliness was measured via the 3-item Loneliness Scale (Hughes et al., 2004), which was a brief version of the R-UCLA Loneliness Scale (Russell et al., 1980). This measure asks the frequency of three feelings (lack of companionship, left out, and isolated) on a three-point Likert format (1 = hardly never or never, 2 = sometimes, 3 = often). The items are summed up to produce the total loneliness score with a theoretical range from 3 to 9. The loneliness factor showed satisfactory reliability (Mcdonald's omega $\omega = 0.76$) in both Wave 8 and Wave 9.

Functional limitations were assessed in SHARE via the Instrumental Activities of Daily Living Index (Lawton and Brody, 1969). In SHARE Wave 8 and Wave 9, this scale evaluates the number of limitations with the following nine activities: 1) using a map for navigation, 2) preparing a hot meal, 3) shopping for groceries, 4) making phone calls, 5) taking medications, 6) doing housework, 7) managing money, 8) leaving home independently and accessing transportation, and 9) doing laundry. The total score has a theoretical range from 0 to 9 and denotes the degree of IADL limitations of the respondents.

The present study included two cognitive measures on temporal orientation and numeracy via the Telephone Interview of Cognition Status (Seo et al., 2011). The respondents were asked the date, month, year, and day of week on the day of interview and one point was awarded for each correct response. The total score on temporal orientation has a theoretical range from 0 to 4. The numeracy test assessed the working memory of the respondents via serial subtraction of 7 from 100 for five times. One point was awarded for each correct response and the total numeracy score has a theoretical range from 0 to 5.

2.3. Statistical analyses

Paired *t*-tests and chi-square test were used to analyze the change in EURO-D items and validating variables from Wave 8 to Wave 9. Attrition analysis was conducted in Wave 8 data to compare the baseline characteristics between the study completers ($N = 38{,}047$) and those who were lost to follow-up in Wave 9 ($N = 14{,}531$). All 12 EURO-D items were modelled as binary variables in the analysis. The present study examined the psychometric properties of EURO-D in the following four steps.

Firstly, factorial validity of EURO-D was evaluated via confirmatory factor analysis (CFA) in SHARE Wave 8 and Wave 9. CFA was performed to estimate the 1-factor, 2-factor (Affective Suffering and Amotivation), and bi-factor models using the robust weighted least square (WLSMV) estimator in Mplus 8.8 (Muthén and Muthén, 2017). The WLSMV estimator uses a probit link for the binary response items. The bi-factor model specified a general depression factor and two uncorrelated specific factors. Model fit was assessed by the following criteria (Hu and Bentler, 1999): comparative fit index (CFI) and Tucker-Lewis index (TLI) should be at least 0.90 and preferably close to or >0.95, and root mean square error of approximation (RMSEA) and standardized root mean square residuals (SRMR) should be less than or equal to 0.06. The large SHARE sample sizes could imply over-sensitivity of chi-square tests to trivial misspecifications. Model comparison was based on the model fit indices rather than chi-square difference tests. Reliability of EURO-D factors was assessed using Mcdonald's omega (ω) coefficient. For bifactor models, reliability of general and specific factors was evaluated by omega hierarchical (ω_H) and omega hierarchical subscale (ω_{HS}) (Rodriguez et al., 2016), with cutoff values as follows: ω_H – moderate = 0.70–0.80, high ≥0.80; ω_{HS} – moderate = 0.20–0.30, high ≥0.30 (Dueber and Toland, 2023). The bifactor CFA model had in total 36 estimated parameters. The sample sizes across countries (N = 721–4694) had a ratio of 20–130 participants per parameter, implying adequate statistical power for factor analysis.

Second, we examined exact measurement invariance of EURO-D across gender (males and females) and four age groups (50–59, 60–69, 70–79, 80+) in Wave 9 and longitudinal measurement invariance across Waves 8 and 9. After estimating configural invariance models via multiple-group CFA with different loadings and thresholds across groups, scalar invariance models imposed equality constraints on item loadings and thresholds across groups (Van de Schoot et al., 2012). The longitudinal invariance model was estimated using a combined sample of 79,491 respondents who had completed either Wave 8 or Wave 9 or both. Autoregressive residual covariance was added for each EURO-D item across Waves. Model comparison was based on changes in fit indices, with $\Delta CFI \leq -0.01$ or $\Delta RMSEA \geq 0.01$ indicating potential measurement non-invariance (Chen, 2007). Structural invariance of the EURO-D factor was evaluated across groups on a standardized metric.

Third, convergent validity of EURO-D factor was evaluated with loneliness, physical health, and cognitive function in Wave 9. The EURO-D factor was entered as independent variables to predict loneliness, IADL limitations, numeracy, and temporal orientation as ordinal categorical outcomes. Age and gender were included as the control variables in the probit regression model. Values of 0.10, 0.30, and 0.50 denoted small, moderate, and large standardized regression effects, respectively. Change in explained R-square indicated the additional explanatory power of EURO-D factor in the outcome variables. All the EURO-D items and external variables showed minimal missing data (< 1 %), which were handled by full information maximum likelihood under the WLSMV estimator. Statistical significance was set at 0.01 level given the large sample sizes in SHARE.

Finally, we examined the measurement invariance of EURO-D across 28 countries in Wave 9. We did not expect exact measurement invariance to hold given the high number of countries in SHARE. Approximate measurement invariance was evaluated using the alignment approach with free alignment (Muthén and Asparouhov, 2014). The alignment procedure starts with the configural invariance model without any equality constraints. A component loss function will search for the optimal arrangement of measurement parameters to minimize the degree of measurement non-invariance. This approach is more flexible and allows approximate measurement invariance across groups. Then, we evaluated longitudinal measurement invariance of EURO-D across Wave 8 and Wave 9. When the proportion of non-invariant parameters in the alignment model is under 25 % - 30 %, the degree of non-invariance is deemed acceptable and the aligned factor means can be compared without bias (Muthen and Asparouhov, 2018). Then, we compared the aligned EURO-D factor means across the 27 countries over the two waves and visualized the temporal change in aligned factor means across the two waves in a scatter plot by geographical regions.

3. Results

3.1. Descriptive statistics and attrition analysis

As Table 1 displays, the Wave 8 and Wave 9 samples showed similar demographic profiles in gender, age, and endorsement of EURO-D items. Respondents showed similar levels of EURO-D total scores, loneliness, IADL limitations, and cognitive function across the two waves. Attrition analysis found that compared to the study completers, the dropouts were significantly older ($d = 0.15$, $p < 0.01$), had significantly higher

depressive symptoms, loneliness, and IADL limitations ($d = 0.09$–0.29, $p < 0.01$), and lower levels of numeracy and temporal orientation ($d = -0.19$ to -0.27, $p < 0.00$).

3.2. Factorial validity and reliability

As Table 2 shows, the 1-factor model provided a mediocre fit for EURO-D in both Wave 8 and Wave 9 with TLI < 0.90 and SRMR >0.06. The modified 1-factor model with two added residual correlations showed a superior fit over the 1-factor and 2-factor models with lower chi-squares and better model fit indices. Although the bifactor models provided best model fit in both waves in terms of the fit indices, the two specific factors had weak loadings ($\lambda < 0.35$) on over half of the items. The modified 1-factor model was adopted for subsequent analyses as a parsimonious and interpretable model for EURO-D. Fig. 1 displays the 1-factor structure of the 12 EURO-D items in Wave 8 and Wave 9. The latent factor showed significant loadings on the 12 EURO-D items in Wave 8 ($\lambda = 0.40$–0.70, $p < 0.01$) and Wave 9 ($\lambda = 0.38$–0.70, $p < 0.01$). Positive and moderate residual correlations ($r = 0.39$–0.45, $p < 0.01$) were found between item 1 "*Depressed mood*" and item 12 "*Tearfulness*", and between item 2 "*Pessimism*" and item 11 "*Lack of enjoyment*" in both waves. The latent EURO-D factor showed good reliability ($\omega = 0.85$) in both waves.

3.3. Measurement invariance across gender, age groups, and waves

Table 2 shows the fit indices of multiple-group modified 1-factor CFA models on measurement invariance of EURO-D across gender, age groups, and waves. Overall, the scalar invariance models showed comparable fit indices as the configural invariance models. This supported equal item loadings and thresholds across the subgroups. The EURO-D factors were significantly and strongly correlated ($r = 0.71$, $p < 0.001$) across Wave 8 and Wave 9. In terms of structural invariance, females showed significantly higher levels in EURO-D factor ($d = 0.73$, $p < 0.01$) than males. Compared to the youngest age group (50–59 years), the 60–69 age group showed significantly and slightly lower levels in EURO-D factor ($d = -0.10$, $p < 0.01$); the 70–79 age group showed no significant difference in EURO-D factor ($d = -0.02$, $p = 0.41$); and the oldest age group (80+ years) showed significantly higher levels in general EURO-D factor ($d = 0.21$, $p < 0.01$). There was no significant change ($d = 0.01$, $p = 0.83$) in the levels of EURO-D factor means across Wave 8 and Wave 9.

Table 2
Fit indices of CFA models for EURO-D in Wave 8 and Wave 9 SHARE cohort.

Model specification	χ^2	df	CFI	TLI	RMSEA	SRMR
Wave 8: (N = 52,369)						
1-factor	10,083.2*	54	0.898	0.876	0.060	0.074
2-factor	5909.4*	53	0.941	0.926	0.046	0.058
1-factor with residual corr.	5544.0*	52	0.944	0.929	0.045	0.059
Bifactor (1 general +2 specific)	1213.8*	42	0.988	0.981	0.023	0.029
Wave 9: (N = 67,744)						
1-factor	11,192.6*	54	0.917	0.899	0.055	0.068
2-factor	6761.4*	53	0.950	0.938	0.043	0.053
1-factor with residual corr.	5777.5*	52	0.957	0.946	0.040	0.053
Bifactor (1 general +2 specific)	1344.4*	42	0.990	0.985	0.021	0.027
Gender invariance (N = 67,744):						
Configural	5652.7	104	0.956	0.945	0.040	0.052
Scalar	6915.5	114	0.946	0.938	0.042	0.058
Age group invariance (N = 67,744):						
Configural	5078.8	208	0.962	0.952	0.037	0.051
Scalar	7533.3	238	0.943	0.937	0.043	0.059
Longitudinal invariance (N = 79,491):						
Configural	15,118.4	235	0.949	0.940	0.028	0.058
Scalar	13,079.2	258	0.956	0.953	0.025	0.058
Country invariance (N = 67,744):						
Alignment	7006.5	1456	0.962	0.952	0.040	0.062
Country longitudinal invariance (N = 79,491):						
Alignment	19,348.9	6345	0.955	0.947	0.026	0.072

CFA = confirmatory factor analysis; SHARE = Survey of Health, Aging and Retirement in Europe; EURO-D = European Depression Scale; χ^2 = chi-square; df = degree of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

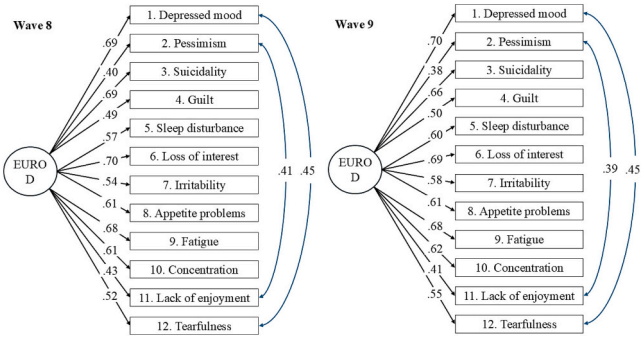

Fig. 1. Factor structure of the 1-factor model on standardized loadings for the 12 EURO-D items with two residual correlations in samples in SHARE Wave 8 (left) and Wave 9 (right).

3.4. Convergent validity

Table 3 displays the standardized regression coefficients between the EURO-D factor and the validating variables in SHARE Wave 9. Female and older respondents showed significantly higher levels of loneliness and IADL limitations and lower levels of numeracy and temporal orientation. Controlling for the effects of gender and age, the EURO-D factor showed positive and strongly associations ($\beta = 0.51$ to 0.55, $p < 0.01$) with loneliness and IADL limitations and negative and moderate associations ($\beta = -0.30$ to -0.34, $p < 0.01$) with numeracy and temporal orientation. The EURO-D factor explained additional 8.2 % – 28.2 % of the variance in the validating variables.

3.5. Measurement invariance across countries

As shown in Table 2, the country invariance model with alignment showed acceptable model fit indices (CFI and TLI ≥ 0.95, and RMSEA and SRMR ≤ 0.06) across 28 countries. Table 4 shows the results of approximate measurement invariance on factor loadings and thresholds of EURO-D items across 28 countries in Wave 9. For instance, the item "Suicidality" showed non-invariant parameters in factor loadings and thresholds in five out of 28 countries, supporting approximate measurement invariance across all countries. The alignment model yielded 204 non-invariant factor loadings and item thresholds out of the total 672 parameters (12 items* 28 countries * 2), implying 30.4 % non-invariance. The items "*Irritability*" and "*Enjoyment*" showed comparably more non-invariant measurement parameters across countries.

The longitudinal measurement invariance model with alignment showed acceptable model fit indices (CFI and TLI ~ 0.95, and RMSEA ≤ 0.06) across 27 countries. Supplementary Table 1 show the results of approximate measurement invariance on factor loadings and thresholds of EURO-D items across 27 countries in Wave 8. The alignment model produced 196 non-invariant factor loadings and item thresholds out of the total 648 parameters (12 items* 27 countries * 2), implying 30.2 % non-invariance. Fig. 2 shows the scatterplot of the aligned EURO-D factor means of the 27 countries over Wave 8 and Wave 9. In the

Table 3
Associations between EURO-D factor and validating variables in Wave 9 SHARE cohort.

Predictors	Outcome variables			
	Loneliness	IADL limitations	Numeracy	Temporal orientation
	β (SE)	β (SE)	β (SE)	β (SE)
Female	0.021 (0.004)*	0.030 (0.005)*	−0.032 (0.004)*	0.089 (0.006)*
Age	0.076 (0.004)*	0.336 (0.004)*	−0.179 (0.004)*	−0.243 (0.005)*
Explained R^2	4.9 %	20.8 %	6.5 %	10.0 %
EURO-D factor	0.551 (0.004)*	0.509 (0.005)*	−0.298 (0.005)*	−0.335 (0.007)*
Total explained R^2	33.1 %	44.9 %	14.7 %	20.4 %

N = 67,744; * $p < 0.001$; SHARE = Survey of Health, Aging and Retirement in Europe; EURO-D = European Depression Scale; IADL = instrumental activities of daily living; Standardized estimates are reported and standard errors are shown in parenthesis. Explained R^2 = proportion of variance of the validating variables explained by gender, age, and EURO-D factor.

Table 4
Approximate measurement invariance of item thresholds and factor loadings across 28 countries in Wave 9 SHARE (N = 67,744).

EURO-D Item	Approximate (non)invariance for countries	# noninvariant	
		loading	threshold
Depression	AT DE SE NL ES (IT) FR DK (GR) CH BE IL CZ PL LU (HU) PT SI EE HR LT BG CY FI (LV) MT RO (SK)	5	14
Pessimism	AT DE SE NL ES IT FR DK GR CH BE IL CZ (PL) LU HU PT SI EE HR LT BG CY (FI) LV MT RO (SK)	3	20
Suicidality	AT DE SE NL ES (IT) FR DK (GR) CH (BE) IL CZ (PL) LU HU PT SI EE HR LT BG CY FI LV MT (RO) SK	5	5
Guilt	AT DE SE NL ES IT FR (DK) GR CH (BE) IL CZ PL LU HU PT SI EE HR LT BG CY FI LV MT RO SK	2	16
Sleep	AT DE SE NL ES (IT) FR DK (GR) CH BE IL CZ (PL) LU (HU) PT SI EE (HR) (LT) BG CY FI LV MT RO (SK)	7	13
Interest	AT DE SE NL ES (IT) FR DK GR CH BE IL CZ (PL) LU HU PT SI EE HR LT BG CY FI LV MT RO SK	2	15
Irritability	(AT) DE SE NL ES (IT) (FR) DK (GR) CH BE IL CZ PL LU HU PT (SI) EE HR LT BG (CY) FI (LV) (MT) RO SK	8	16
Appetite	AT DE SE NL ES IT FR DK (GR) CH BE IL CZ PL LU HU PT SI EE HR LT BG CY FI LV MT RO SK	1	4
Fatigue	(AT) DE SE NL (ES) IT FR DK GR CH BE IL CZ PL LU HU PT SI (EE) HR LT BG (CY) FI LV MT RO SK	4	13
Concentration	AT DE SE NL ES IT FR DK GR CH BE IL CZ PL LU (HU) PT SI (EE) HR LT BG CY FI (LV) MT RO SK	3	10
Enjoyment	AT DE SE NL (ES) (IT) FR DK (GR) CH BE (IL) (CZ) PL LU (HU) (PT) (SI) (EE) (HR) (LT) (BG) (CY) FI (LV) MT (RO) SK	15	12
Tearfulness	AT DE SE NL ES IT FR DK GR CH BE IL CZ (PL) LU HU PT SI EE HR LT BG CY FI LV MT RO SK	1	10

Items with noninvariant factor loading and threshold shown in parenthesis and underline, respectively. SHARE = Survey of Health, Aging and Retirement in Europe; EURO-D = European Depression Scale. AT: Austria; DE: Germany; SE: Sweden; NL: Netherlands; ES: Spain; IT: Italy; FR: France; DK: Denmark; GR: Greece; CH: Switzerland; BE: Belgium; IL: Israel; CZ: Czech Republic; PL: Poland; LU: Luxemburg; HU: Hungary; PT: Portugal; SI: Slovenia; EE: Estonia; HR: Croatia; LT: Lithuania; BG: Bulgaria; CY: Cyprus; FI: Finland; LV: Latvia; MT: Malta; RO: Romania; SK: Slovakia.

figure, countries that are plotted above the dashed diagonal line show a temporal increase in the aligned factor mean from Wave 8 to Wave 9. 18 out of the 27 countries reported a small increase in the aligned factor mean from Wave 8 to Wave 9, with the greatest degrees of increments found in Malta (MT), and Sweden (SE), and Denmark (DK). Eight remaining countries reported a decrease in the aligned factor mean from Wave 8 to Wave 9, with the greatest degrees of decline found in Latvia (LV) and Poland (PL).

4. Discussion

The present study systematically examined the psychometric properties of EURO-D in large, representative samples of middle-aged and older adults from SHARE Wave 8 and Wave 9. Our analysis provided the first results on longitudinal and cross-country measurement invariance across 27 European countries. Regarding the factor structure, our CFA found the best model fit for a bifactor model with a general factor and two specific factors in both Waves 8 and 9. This aligns with recent findings by Tomás et al. (2022) and studies on other depression measures such as the Center for Epidemiologic Studies - Depression Scale and Chinese Health Questionnaire (Fong et al., 2016; Fong et al., 2022).

However, when modeling binary indicators, fit indices tend to be more conservative due to limited response variability and non-normality. Under such conditions, overly strict cutoff criteria for model fit indices may increase the risk of overfitting, as greater model complexity is often required to meet these thresholds. Despite the overall good fit of the bifactor model, examination of local fit revealed low loadings for both specific factors (Affective Suffering and Amotivation) in over half of their respective items. This raises concerns about the stability of these specific factors and suggests that adding complexity to subsequent models may not yield sufficient explanatory benefits. Consistent with previous findings (Courtin et al., 2015; Portellano-Ortiz et al., 2018), a revised 1-factor model provided acceptable fit, good reliability, and consistently stronger factor loadings. The two residual correlations indicate substantial overlap between specific pairs of items ("*Depressed mood*" - "*Tearfulness*" and "*Pessimism*" - "*Lack of enjoyment*") beyond the latent depression factor. These results provide a more parsimonious and interpretable representation of general depression in both waves compared to the bifactor model and support the unidimensional model to represent the latent structure of EURO-D in SHARE.

The EURO-D factor demonstrated measurement invariance in both factor loadings and item thresholds across gender in Wave 9. In line with existing literature (Curran et al., 2020; Tomás et al., 2022), female respondents showed higher levels of depressive symptoms than their male counterparts. Our findings also showed scalar measurement invariance of the EURO-D across four age groups and both waves, indicating that the EURO-D is a reliable measure of depressive symptoms over time for both middle-aged and older adults. This implies that EURO-D factor scores can be meaningfully compared across different age cohorts and time points. Although no significant differences in depressive symptoms were observed between respondents aged 50 to 79 years, those aged 80 and above showed significantly higher levels of depressive symptoms. Luppa et al. (2012) reported higher rates of depressive disorders that reached 20–25 % in the 85–89 age group and 30–50 % in those 90 and older. Our findings corroborate the increased risk of depression among the oldest age group (80+ years) and highlight the need for targeted mental health interventions for this vulnerable subgroup.

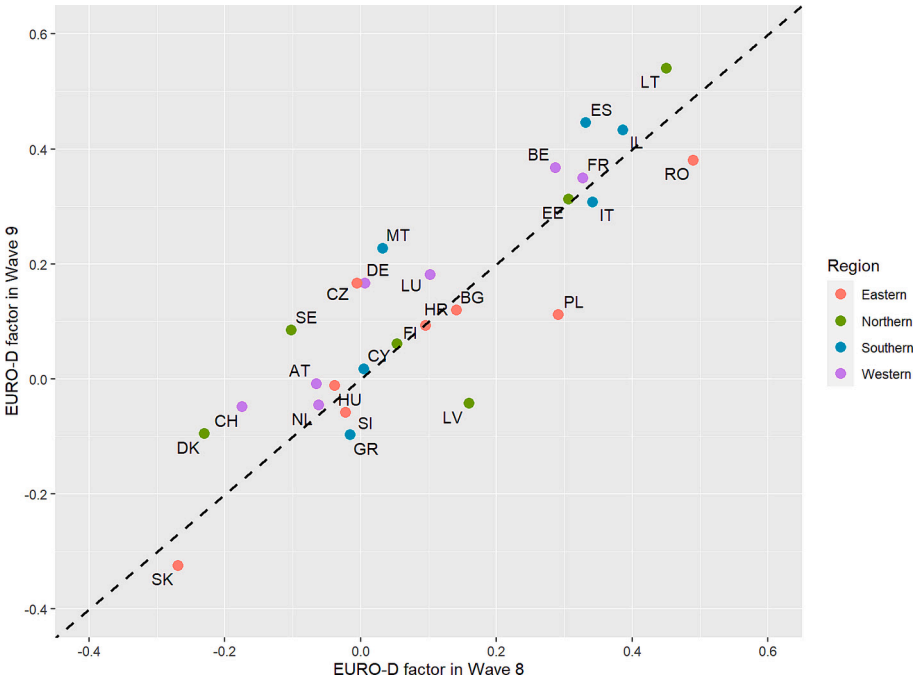

Fig. 2. Scatter plot of the aligned general EURO-D factor means of the 27 countries in SHARE over Wave 8 and Wave 9 by geographical regions.

In terms of convergent validity, Tomás et al. (2022) found significant and positive correlations between the EURO-D factor and loneliness and negative correlations with self-perceived health in SHARE Wave 8. Our analysis not only replicated the positive associations between the EURO-D factor and loneliness in Wave 9, but also found significant associations with greater functional limitations and worse cognitive function. Yan et al. (2023) have significantly linked depressive symptoms with functional disability in Chinese older adults. A 10-year study from SHARE Wave 2 to Wave 7 found a dose-response positive relationship between depressive symptoms and risk of dementia (Wu et al., 2020). Social network has played a significant role in the relationship between depressive symptoms and loneliness in Spanish middle-aged and older adults (Domènech-Abella et al., 2017). Further research could explore the bidirectional relationships between depressive symptoms and cognitive decline in SHARE waves and elucidate the potential risk factors.

The EURO-D did not exhibit exact measurement invariance across countries in the present sample. This finding was expected, given the inclusion of 27 countries in SHARE and the complexity of the measurement invariance model. The alignment approach has previously been applied to compare attitudes toward immigrants among youths across Europe from 1999 to 2009 (Munck et al., 2018). Recently, de la Torre et al. (2023) established cross-country measurement equivalence of the 8-item PHQ for assessing depression across European nations. Our study is the first to utilize the alignment approach to evaluate approximate measurement invariance of the EURO-D across 27 countries between Waves 8 and 9. The alignment model indicated considerable non-invariance, with 30.2 % to 30.4 % of measurement parameters being non-invariant. This highlights the importance of using the alignment approach to enhance cross-country comparability and ensure meaningful comparisons of the aligned EURO-D factor scores over time and across countries.

In the longitudinal invariance analysis, the overall EURO-D factor means remained stable between Waves 8 and 9. However, significant country-level variations were observed in the temporal changes of the EURO-D factor. Two-thirds of the 27 countries showed increased EURO-D scores from Wave 8 to Wave 9. Elevated depressive and anxiety symptoms have been found among family members and friends of critically ill COVID-19 patients (Lovik et al., 2023). Besides, countries experiencing increased levels of depression were predominantly located in Northwestern Europe, while those with decreased depression levels were mainly in Eastern Europe. This intriguing pattern suggests a potential link between geographic context and the severity of mental health symptoms during the COVID-19 pandemic. Further cross-national research should investigate the role of contextual factors such as socio-economic conditions, healthcare systems, and cultural differences in contributing to regional disparities in mental health at the country level. Such insights could inform targeted interventions for researchers and policymakers to address the specific mental health needs of older populations across different European regions.

5. Limitations and future directions

Several limitations should be acknowledged in this study. First, the study was based on population-representative samples that included both middle-aged and older adults across 27 countries in Europe. Attrition analysis indicated potential non-response bias, as Wave 9 dropouts showed worse psychosocial, physical, and cognitive functioning at Wave 8 compared to the study completers. Since the alignment approach can handle partial responses and accommodate missing data using full information maximum likelihood (FIML) estimation, we did not exclude partial responders (those who did not complete assessments at either Wave 8 or Wave 9) from the combined longitudinal sample. The use of FIML should mitigate attrition bias, reducing the risk of underestimating depression severity and minimizing biases in factor structure and measurement invariance tests. Second, our study did not evaluate the criterion validity of EURO-D against other established depression scales such as PHQ-9, CES—D, BDI, or GDS. Recently, the network approach has been used to evaluate central symptoms of depression in older adults during the COVID-19 pandemic (Tao et al., 2023). Future research could explore symptom comorbidity between EURO-D and other self-report measures to identify core symptoms common to major depression.

Third, the present study focused on the temporal change in the aligned EURO-D factor scores across countries and waves. Apart from using the aggregate scores, future studies could analyze the temporal

change in EURO-D items at the symptom level using the network approach. The network perspective could provide nuanced findings on targeted interventions on specific symptoms. A previous study (Handing et al., 2022) has identified predictors of depressive symptoms using machine learning approach in middle-aged and older adults in Europe. Fourth, this study only examined the convergent validity of the EURO-D with reference to loneliness and measures on physical and cognitive functions. Given the multidimensional determinants of depression, further research should examine the associations between the EURO-D factors and factors in other domains such as psychological (resilience and rumination), social (social network and support), behavioral (substance use), and lifestyle (physical inactivity and dietary habits) dimensions.

6. Conclusion

The present study systematically examined the psychometric properties of the EURO-D in population-based representative samples of middle-aged and older adults in SHARE Wave 8 and Wave 9 across 27 countries in Europe. We provided the first results on longitudinal measurement invariance of the EURO-D across countries in Europe. This supports cross-country comparability and meaningful comparisons of the aligned factor means across time and countries. Future cross-national research could explore country-level determinants of temporal changes in EURO-D factor scores across geographic contexts.

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CRediT authorship contribution statement

Ted C.T. Fong: Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Funding acquisition. **Ryder T.H. Chan:** Conceptualization, Methodology, Validation, Writing – review & editing.

Ethics approval and consent to participate

Ethical approval for SHARE Wave 8 and Wave 9 was obtained from the Ethics Council of the Max Planck Society. The present study obtained ethical approval from the Human Research Ethics Committee of the University of Hong Kong (Approval No.: EA240667). All procedures performed in the present study were in accordance with the 1964 Helsinki Declaration and its later amendments. Participants gave informed consent before completing the survey, and they understood that they could withdraw anytime.

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Declaration of competing interest

All authors declare that they have no conflict of interest.

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Data availability

The SHARE Wave 8 and Wave 9 datasets are available for download from the SHARE Research Data Center released on 28 March 2024 upon registration (https://share-eric.eu/data/data-access). The Mplus syntax in this study are available from the first author upon email request.

References

Abdoli, N., Salari, N., Darvishi, N., Jafarpour, S., Solaymani, M., Mohammadi, M., Shohaimi, S., 2022. The global prevalence of major depressive disorder (MDD) among the elderly: a systematic review and meta-analysis. Neurosci. Biobehav. Rev. 132, 1067–1073. https://doi.org/10.1016/j.neubiorev.2021.10.041.

Bergmann, M., Börsch-Supan, A., 2021. SHARE Wave 8 Methodology: Collecting Cross-National Survey Data in Times of COVID-19. MEA, Max Planck Institute for Social Law and Social Policy, Munich.

Bergmann, M., Wagner, M., Börsch-Supan, A., 2024. SHARE Wave 9 Methodology: From the SHARE Corona Survey 2 to the SHARE Main Wave 9 Interview. SHARE-ERIC, Munich.

Börsch-Supan, A., Brandt, M., Hunkler, C., Kneip, T., Korbmacher, J., Malter, F., Schaan, B., Stuck, S., Zuber, S., Team, S.C.C, 2013. Data resource profile: the survey of health, ageing and retirement in Europe (SHARE). Int. J. Epidemiol. 42, 992–1001. https://doi.org/10.1093/ije/dyt088.

Castro-Costa, E., Dewey, M., Stewart, R., Banerjee, S., Huppert, F., Mendonca-Lima, C., Bula, C., Reisches, F., Wancata, J., Ritchie, K., Tsolaki, M., Mateos, R., Prince, M., 2008. Ascertaining late-life depressive symptoms in Europe: an evaluation of the survey version of the EURO-D scale in 10 nations. The SHARE project. Int. J. Methods Psychiatr. Res. 17, 12–29. https://doi.org/10.1002/mpr.236.

Chen, F.F., 2007. Sensitivity of goodness of fit indexes to lack of measurement invariance. Struct. Equ. Model. Multidiscip. J. 14, 464–504. https://doi.org/10.1080/10705510701301834.

Courtin, E., Knapp, M., Grundy, E., Avendano-Pabon, M., 2015. Are different measures of depressive symptoms in old age comparable? An analysis of the CES-D and Euro-D scales in 13 countries. Int. J. Methods Psychiatr. Res. 24, 287–304. https://doi.org/10.1002/mpr.1489.

Curran, E., Rosato, M., Ferry, F., Leavey, G., 2020. Prevalence and factors associated with anxiety and depression in older adults: gender differences in psychosocial indicators. J. Affect. Disord. 267, 114–122. https://doi.org/10.1016/j.jad.2020.02.018.

de la Torre, J.A., Vilagut, G., Ronaldson, A., Valderas, J.M., Bakolis, I., Dregan, A., Molina, A.J., Navarro-Mateu, F., Pérez, K., Bartoll-Roca, X., Elices, M., Pérez-Sola, V., Serrano-Blanco, A., Martín, V., Alonso, J., 2023. Reliability and cross-country equivalence of the 8-item version of the patient health questionnaire (PHQ-8) for the assessment of depression: results from 27 countries in Europe. Lancet Regional Health-Europe. 31, 100659. https://doi.org/10.1016/j.lanepe.2023.100659.

Domènech-Abella, J., Lara, E., Rubio-Valera, M., Olaya, B., Moneta, M.V., Rico-Uribe, L. A., Ayuso-Mateos, J.L., Mundó, J., Haro, J.M., 2017. Loneliness and depression in the elderly: the role of social network. Soc. Psychiatry Psychiatr. Epidemiol. 52, 381–390. https://doi.org/10.1007/s00127-017-1339-3.

Domènech-Abella, J., Mundó, J., Haro, J.M., Rubio-Valera, M., 2019. Anxiety, depression, loneliness and social network in the elderly: longitudinal associations from the Irish longitudinal study on ageing (TILDA). J. Affect. Disord. 246, 82–88. https://doi.org/10.1016/j.jad.2018.12.043.

Dueber, D.M., Toland, M.D., 2023. A bifactor approach to subscore assessment. Psychol. Methods 28, 222–241. https://doi.org/10.1037/met0000459.

Fong, T.C., Chan, C.L., Ho, R.T., Chan, J.S., Chan, C.H., Ng, S.M., 2016. Dimensionality of the center for epidemiologic studies depression scale: an exploratory bi-factor

analytic study. Qual. Life Res. 25, 731–737. https://doi.org/10.1007/s11136-015-1105-5.
Fong, T.C.T., Yip, P.S.F., Ho, R.T.H., 2022. Psychometric validation of the Chinese health questionnaire among young people in Hong Kong across 2018 and 2019. Psychol. Assess. 34, 261–270. https://doi.org/10.1037/pas0001079.
Guerra, M., Ferri, C., Llibre, J., Prina, A.M., Prince, M., 2015. Psychometric properties of EURO-D, a geriatric depression scale: a cross-cultural validation study. BMC Psychiatry 15, 12. https://doi.org/10.1186/s12888-015-0390-4.
Handing, E.P., Strobl, C., Jiao, Y.Q., Feliciano, L., Aichele, S., 2022. Predictors of depression among middle-aged and older men and women in Europe: a machine learning approach. Lancet Reg. Health 18, 100391. https://doi.org/10.1016/j.lanepe.2022.100391.
Hu, L.T., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equ. Model. 6, 1–55. https://doi.org/10.1080/10705519909540118.
Hughes, M.E., Waite, L.J., Hawkley, L.C., Cacioppo, J.T., 2004. A short scale for measuring loneliness in large surveys - results from two population-based studies. Res. Aging 26, 655–672. https://doi.org/10.1177/0164027504268574.
Krishnamoorthy, Y., Rajaa, S., Rehman, T., 2020. Diagnostic accuracy of various forms of geriatric depression scale for screening of depression among older adults: systematic review and meta-analysis. Arch. Gerontol. Geriatr. 87, 104002. https://doi.org/10.1016/j.archger.2019.104002.
Lawton, M.P., Brody, E.M., 1969. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 9, 179–186.
Levis, B., Benedetti, A., Thombs, B.D., Akena, D.H., Arroll, B., Ayalon, L., Azar, M., Baradaran, H.R., Baron, M., Bombardier, C.H., Boruff, J., Butterworth, P., Carter, G., Chagas, M.H., Chan, J.C.N., Chiovitti, M.J., Clover, K., Conwell, Y., Cuijpers, P., de Man-van Ginkel, J.M., Delgadillo, J., Fann, J.R., Fischer, F.H., Fung, D., Gelaye, B., Gilbody, S., Goodyear-Smith, F., Greeno, C.G., Hall, B.J., Hambridge, J., Harrison, P. A., Harter, M., Hegerl, U., Hides, L., Hobfoll, S.E., Hudson, M., Inagaki, M., Ioannidis, J.P.A., Ismail, K., Jette, N., Khamseh, M.E., Kiely, K.M., Kloda, L.A., Kwan, Y.X., Levis, A.W., Liu, S.I., Lotrakul, M., Loureiro, S.R., Lowe, B., Marsh, L., McGuire, A., McMillan, D., Sidik, S.M., Munhoz, T.N., Muramatsu, K., Osorio, F.L., Patel, V., Patten, S.B., Pence, B.W., Persoons, P., Picardi, A., Rice, D.B., Riehm, K.E., Reuter, K., Rooney, A.G., Saadat, N., Sanchez, T.A., Santos, I.S., Shaaban, J., Sidebottom, A., Simning, A., Shrier, I., Stafford, L., Sung, S.C., Tan, P.L.L., Turner, A., van der Feltz-Cornelis, C.M., van Weert, H.C., Vohringer, P.A., White, J., Whooley, M.A., Winkley, K., Yamada, M., Ziegelstein, R.C., Zhang, Y.Y., 2019. Accuracy of patient health Questionnaire-9 (PHQ-9) for screening to detect major depression: individual participant data meta-analysis. Bmj-British Medical Journal. 365 (l1476), l1476. https://doi.org/10.1136/bmj.l1476.
Lovik, A., Gonzalez-Hijon, J., Hoffart, A., Fawns-Ritchie, C., Magnusdottir, I., Lu, L., Unnarsdottir, A.B., Kaehler, A.K., Campbell, A., Hauksdottir, A., Chourpiliadis, C., McCartney, D.L., Thordardottir, E.B., Joyce, E.E., Frans, E.M., Jakobsdottir, J., Trogstad, L., Andreassen, O.A., Magnus, P., Johnson, S.U., Sullivan, P.F., Aspelund, T., Porteous, D.J., Ask, H., Ebrahimi, O., Valdimarsdottir, U.A., Fang, F., 2023. Elevated symptoms of depression and anxiety among family members and friends of critically ill COVID-19 patients - an observational of five cohorts across four countries. Lancet Regional Health-Europe. 33, 100733. https://doi.org/10.1016/j.lanepe.2023.100733.
Löwe, B., Kohlmann, S., 2023. International comparability of depression scores from self-report scales: opportunities and challenges. Lancet Regional Health-Europe. 31, 100668. https://doi.org/10.1016/j.lanepe.2023.100668.
Luppa, M., Sikorski, C., Luck, T., Ehreke, L., Konnopka, A., Wiese, B., Weyerer, S., König, H.H., Riedel-Heller, S.G., 2012. Age- and gender-specific prevalence of depression in latest-life – systematic review and meta-analysis. J. Affect. Disord. 136, 212–221. https://doi.org/10.1016/j.jad.2010.11.033.
Maskileyson, D., Seddig, D., Davidov, E., 2021. The EURO-D measure of depressive symptoms in the aging population: comparability across European countries and Israel. Frontiers in Political Science. 3. https://doi.org/10.3389/fpos.2021.665004.
Mohebbi, M., Nguyen, V., McNeil, J.J., Woods, R.L., Nelson, M.R., Shah, R.C., Storey, E., Murray, A.M., Reid, C.M., Kirpach, B., Wolfe, R., Lockery, J.E., Berk, M., Grp, A.I., 2018. Psychometric properties of a short form of the Center for Epidemiologic Studies Depression (CES-D-10) scale for screening depressive symptoms in healthy community dwelling older adults. Gen. Hosp. Psychiatry 51, 118–125. https://doi.org/10.1016/j.genhosppsych.2017.08.002.
Munck, I., Barber, C., Torney-Purta, J., 2018. Measurement invariance in comparing attitudes toward immigrants among youth across Europe in 1999 and 2009: the alignment method applied to IEA CIVED and ICCS. Sociol. Methods Res. 47, 687–728. https://doi.org/10.1177/0049124117729691.
Muthén, B., Asparouhov, T., 2014. IRT studies of many groups: the alignment method. Front. Psychol. 5. https://doi.org/10.3389/fpsyg.2014.00978.
Muthen, B., Asparouhov, T., 2018. Recent methods for the study of measurement invariance with many groups: alignment and random effects. Sociol. Methods Res. 47, 637–664. https://doi.org/10.1177/0049124117701488.
Muthén, L.K., Muthén, B.O., 2017. Mplus user's guide, 8th ed. Muthén & Muthén, Los Angeles, CA.
Portellano-Ortiz, C., Garre-Olmo, J., Calvó-Perxas, L., Conde-Sala, J.L., 2018. Factor structure of depressive symptoms using the EURO-D scale in the over-50s in Europe. Findings from the SHARE project. Aging Ment. Health 22, 1477–1485. https://doi.org/10.1080/13607863.2017.1370688.
Prince, M.J., Reischies, F., Beekman, A.T.F., Fuhrer, R., Jonker, C., Kivela, S.L., Lawlor, B.A., Lobo, A., Magnusson, H., Fichter, M., Van Oyen, H., Roelands, M., Skoog, I., Turrina, C., Copeland, J.R.M., 1999. Development of the EURO–D scale – a European Union initiative to compare symptoms of depression in 14 European centres. Br. J. Psychiatry 174, 330–338. https://doi.org/10.1192/bjp.174.4.330.
Rodriguez, A., Reise, S.P., Haviland, M.G., 2016. Applying Bifactor statistical indices in the evaluation of psychological measures. J. Pers. Assess. 98, 223–237. https://doi.org/10.1080/00223891.2015.1089249.
Russell, D., Peplau, L.A., Cutrona, C.E., 1980. The revised UCLA loneliness scale: concurrent and discriminant validity evidence. J. Pers. Soc. Psychol. 39, 472–480. https://doi.org/10.1037//0022-3514.39.3.472.
Segal, D.L., Coolidge, F.L., Cahill, B.S., O'Riley, A.A., 2008. Psychometric properties of the Beck depression inventory-II (BDI-II) among community-dwelling older adults. Behav. Modif. 32, 3–20. https://doi.org/10.1177/0145445507303833.
Seo, E.H., Lee, D.Y., Kim, S.G., Kim, K.W., Kim, D.H., Kim, B.j., Kim, M.-D., Kim, S.Y., Kim, Y.H., Kim, J.-L., Kim, J.W., Moon, S.W., Park, J.H., Ryu, S.-H., Yoon, J.C., Lee, N.J., Lee, C.U., Jhoo, J.H., Choo, l.H., Woo, J.I., 2011. Validity of the telephone interview for cognitive status (TICS) and modified TICS (TICSm) for mild cognitive imparment (MCI) and dementia screening. Arch. Gerontol. Geriatr. 52, e26–e30. https://doi.org/10.1016/j.archger.2010.04.008.
Tao, Y.Q., Hou, W.X., Niu, H.Q., Ma, Z.J., Zheng, Z.Q., Wang, S.J., Liu, X.P., Zhang, L., 2023. Comparing the centrality symptoms of major depressive disorder samples across junior high school students, senior high school students, college students and elderly adults during city lockdown of COVID-19 pandemic-a network analysis. J. Affect. Disord. 324, 190–198. https://doi.org/10.1016/j.jad.2022.12.120.
Tomás, J.M., Torres, Z., Oliver, A., Enrique, S., Fernández, I., 2022. Psychometric properties of the EURO-D scale of depressive symptomatology: evidence from SHARE wave 8. J. Affect. Disord. 313, 49–55. https://doi.org/10.1016/j.jad.2022.06.079.
Van de Schoot, R., Lugtig, P., Hox, J., 2012. A checklist for testing measurement invariance. Eur. J. Dev. Psychol. 9, 486–492. https://doi.org/10.1080/17405629.2012.686740.
Wu, J.-J., Wang, H.-X., Yao, W., Yan, Z., Pei, J.-J., 2020. Late-life depression and the risk of dementia in 14 countries: a 10-year follow-up study from the survey of health, ageing and retirement in Europe. J. Affect. Disord. 274, 671–677. https://doi.org/10.1016/j.jad.2020.05.059.
Yan, Y.M., Du, Y.Q., Li, X., Ping, W.W., Chang, Y.Q., 2023. Physical function, ADL, and depressive symptoms in Chinese elderly: evidence from the CHARLS. Front. Public Health 11, 1017689. https://doi.org/10.3389/fpubh.2023.1017689.