

Validating the 11-Item Revised University of California Los Angeles Scale to Assess Loneliness Among Older Adults: An Evaluation of Factor Structure and Other Measurement Properties

Joonyup Lee, M.S.W., John G. Cagle, Ph.D.

Objective: To examine the measurement properties and factor structure of the short version of the Revised University of California Los Angeles (R-UCLA) loneliness scale from the Health and Retirement Study (HRS). **Methods:** Based on data from 3,706 HRS participants aged 65 + who completed the 2012 wave of the HRS and its Psychosocial Supplement, the measurement properties and factorability of the R-UCLA were examined by conducting an exploratory factor analysis (EFA) and the confirmatory factor analysis (CFA) on randomly split halves. **Results:** The average score for the 11-item loneliness scale was 16.4 (standard deviation: 4.5). An evaluation of the internal consistency produced a Cronbach's α of 0.87. Results from the EFA showed that two- and three-factor models were appropriate. However, based on the results of the CFA, only a two-factor model was determined to be suitable because there was a very high correlation between two factors identified in the three-factor model, available social connections and sense of belonging. **Conclusion:** This study provides important data on the properties of the 11-item R-UCLA scale by identifying a two-factor model of loneliness: feeling isolated and available social connections. Our findings suggest the 11-item R-UCLA has good factorability and internal reliability. (Am J Geriatr Psychiatry 2017; 25:1173–1183)

Key Words: Loneliness, R-UCLA scale, factor structure, measurement properties, older adults, confirmatory factor analysis

Highlights

- This study aims to examine the measurement properties and factor structure of the short version (11-item) of Revised University of California Los Angeles (R-UCLA) loneliness scale from the Health and Retirement Study (HRS).
- Based on the psychometric properties we examined, the 11-item version of the R-UCLA has a good internal reliability (Cronbach's $\alpha = 0.87$) and factorability.

Received January 30, 2017; revised May 1, 2017; accepted June 5, 2017. From the School of Social Work, University of Maryland, Baltimore, MD. Send correspondence and reprint requests to Joonyup Lee, School of Social Work, University of Maryland, Baltimore, 525 West Redwood Street, Baltimore, MD 21201. e-mail: jlee1@ssw.umaryland.edu

© 2017 American Association for Geriatric Psychiatry. Published by Elsevier Inc. All rights reserved.

<https://doi.org/10.1016/j.jagp.2017.06.004>

- Initial EFA results suggested that two-factor model (*feeling isolated* and *available social connections*) and three-factor model (*feeling isolated*, *available social connections*, and *sense of belonging*) were appropriate.
 - However, based on the results of the CFA, only a two-factor model was determined to be suitable because there was a very high correlation between two of the factors identified in the three-factor model (*available social connections* and *sense of belonging*).
 - This study contributes to the current knowledge base by examining the factor of loneliness using a large population-based dataset. Loneliness as measured by the brief 11-item R-UCLA consists of two conceptual dimensions: *feeling isolated* and *available social connections*.
-

INTRODUCTION

Loneliness is a depressed feeling related to perceived social isolation and a lack of meaningful companionship. It is associated with impaired quality of life, suffering, and distress.^{1,2} Prior geriatric research and practice have used loneliness as an indicator of poor quality of life.³ However, loneliness does not necessarily indicate a lack of belonging or complete absence of companionship. Also, it is distinct from objective assessments of social isolation such as living alone, marital status, and number of relationships. Thus, loneliness is a complex concept. Loneliness is the difference between desired social connection and one's perception of his or her actual relationships.² Loneliness has been classified into two types: emotional loneliness and social loneliness.⁴ Emotional loneliness is related to feeling disconnected, whereas social loneliness is associated with one's belief that his or her social relationship network is inadequate.

Loneliness can negatively affect one's life satisfaction and well-being. Furthermore, loneliness is a risk factor for pain, depression, and fatigue. Lonelier people experienced more pain, depression, and fatigue than those who had more social connections.⁵ Loneliness is a mediator between self-esteem and life satisfaction.⁶ Also, loneliness is a predictor of functional deterioration, poor health, and mortality.^{1,2} That is, to increase life satisfaction or well-being, an individual's loneliness should be considered and, if warranted, addressed.

Older adults are especially vulnerable to loneliness. For example, older adults more often experience the death of friends or family members and may have greater difficulties mobilizing for social activities

because of functional limitations.¹ Life course transitions such as retirement, chronic diseases or disability, and limited mobility have a negative effect on older adults' loneliness. That is, loneliness is negatively associated with social relationships among older adults. Risk factors of loneliness include sociodemographic, health, and social characteristics (e.g., depression, gender, marital status, and institutionalization). When these risk factors are present, older adults are more likely to lose key members of their social network.⁷

In summary, loneliness is an important element of quality of life and mental health, which has health implications for older adults. By understanding and measuring loneliness, we can indirectly predict health-related outcomes. To this end, researchers have tried to develop and test a number of loneliness scales.^{8,9} Through these endeavors, only a limited number of reliable instruments have been produced. One of the most widely used measurement tools for assessing self-reported loneliness is the Revised University of California Los Angeles (R-UCLA) scale.¹⁰ The full version of the scale consists of 20 items with a four-point response set (1 = never to 4 = often). Data on the reliability and validity of the 20-item version R-UCLA scale have been reported in prior studies. However, findings regarding the factorability of the scale have been inconsistent.^{11,12}

It is critical to understand the instrument's factor structure because assessing scale dimensionality is a key component of validity testing. For example, previous studies conducted exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) of the 20-item R-UCLA using the 2002 wave of the Health and Retirement Study (HRS)¹² and Canadian Longitudinal Study on Aging.¹¹ Results from the former study

confirmed a three-factor model.¹² Alternately, results from the latter study produced a four-factor model.¹¹ However, an explicit description of these factors from both studies was not provided. In addition, using different samples (college students, nurses, and older adults), inconsistent factor structures of the 20-item R-UCLA scale were revealed through CFA. Results from these diverse samples confirmed a three-factor model: global loneliness, negative items, and positive items. On the contrary, an examination of the original UCLA scale revealed a four-factor model: social risk-taking, negative affect, social desirability, and affiliative motivation.¹³ However, the original UCLA scale had several noteworthy limitations. All items were worded in the same direction (e.g., higher response values indicating greater dissatisfaction with social relationships). This problem can lead to systematic response bias.¹³ To resolve this issue, the 20-item R-UCLA scale incorporated 10 positively worded and 10 negatively worded items. These items reflected satisfaction and dissatisfaction with social relationships.

In 2008, the HRS began using a brief, but generally untested, version of R-UCLA scale. To date, no study has examined the measurement properties, validity, or factor structure of the 11-item R-UCLA. Using methods consistent with previous work,^{11,12} our study focuses on the instrument properties, internal reliability, and factorability (using EFA and CFA) of the 11-item version of the R-UCLA.

METHODS

Data Source

The HRS is a nationally representative study of the health and economic status of older adults 50 + in the United States. Using data from nearly 22,000 respondents, the HRS covers various topics such as family structure, finances, health, and labor force involvement. The HRS' population-based sampling approach (probability sampling at the household level) and high response rates (e.g., 88.6% of 2010 core wave) make it a unique and in-depth data source. For HRS participants, a Psychosocial Supplement questionnaire is also administered to a random 50% of the full sample biannually (since 2004). The HRS Psychosocial Supplement covers six areas: subjective well-being (including loneliness as measured by the 11-item

R-UCLA scale), lifestyle and experience of stress, quality of social ties, personality traits, work-related beliefs, and self-rated beliefs.

For the purposes of this study, data were restricted to the 2012 wave of the HRS because it was the most recent available wave with complete information at the time the study was initiated. Recent administrations of HRS Psychosocial Supplement questionnaires used the 11-item R-UCLA scale.¹⁴ Until now, this version has not been tested or validated, with the exception of a reliability coefficient ($\alpha = 0.88$) reported in 2008.¹⁴ The HRS and its Psychosocial Supplement are public data available through the Inter-university Consortium for Political and Social Research (see <https://www.icpsr.umich.edu/icpsrweb/landing.jsp>). Methods for the HRS were approved by Institutional Review Board of the University of Michigan, and informed consent was provided by all participants. The present study was reviewed by the University of Maryland, Baltimore Institutional Review Board and determined not to be human subject research.

Sample

Based on respondents who were eligible for and completed the 2012 Psychosocial Supplement questionnaire, we established an initial sample of 7,305 valid cases. People < 65 years old were excluded from the pool of possible sample participants (eliminating 3,243). Less than 9% of cases ($N = 356$) had missing data on at least one item on the loneliness scale. These cases with missing data were removed from the sample. (Note: we conducted main analyses both with and without these 356 cases with similar results each time.) Thus, from the original 7,305 cases, the final analytic study sample included 3,706 cases.

Measure

The R-UCLA scale was designed to measure loneliness. Each of the 11 items begins with a question stem, "How much of the time do you feel..." and uses a three-point Likert scale ranging from 1 (often) to 3 (hardly ever or never). The 11-items are as follows: "you lack companionship?"; "left out?"; "isolated from others?"; "that you are 'in tune' with the people around you?"; "alone?"; "that there are people you can talk to?"; "that there are people you can turn to?"; "that there are people who really understand you?"; "that

there are people you feel close to?"; "part of a group of friends?"; and "that you have a lot in common with the people around you?" Among these 11 questions, 4 questions are reverse-coding items: "you lack companionship?"; "left out?"; "isolated from others?"; and "alone?" Thus, the 11-item measure incorporates seven positively and four negatively worded items. Loneliness is measured by calculating the average scores across the 11 items. Higher scores indicate greater loneliness. However, no established clinical cut-point indicates significant levels of loneliness.

The nine items that were excluded from the original R-UCLA scale are described in Table 1. The original 20-item instrument used a different response set, a four-point Likert scale ranging from 1 (never) to 4 (often).

Data Analytic Methods

Data analyses were conducted in four stages. First, the sample was randomly split into two subsamples using SPSS 21.0 (SPSS Inc., Chicago, IL). The two subsamples were equivalent in size, 1,853. Second, to shed light on differences between the two subsamples, χ^2 and t-test analyses were conducted. Third, to determine the optimal rotation method, correlation analysis (Spearman's rho) was conducted. Correlations among items indicate that oblique rotation is appropriate, whereas noncorrelations indicate that orthogonal rotation is suitable.^{15,16} Finally, Mplus Version 7.3 (Muthén & Muthén, Los Angeles, CA) was used for the EFA and the CFA. An EFA was conducted to examine the factor structure of the loneliness scale using the first subsample (N = 1,853). EFA is designed to examine the relationships between observed and latent variables.¹⁷ In other words, it discovers the structure of measured variables by examining the number and nature of factors.¹⁸ After identifying the structures from the result of the EFA, a CFA was conducted using the second subsample (N = 1,853).

The EFA, using oblique rotation and the weighted least squares with mean- and variance-adjusted estimation (WLSMV), was conducted to identify the initial factor structure.¹⁸ To identify the optimal number of factors, we used eigenvalues, the scree plot, and factor interpretability.¹⁹ The Kaiser criterion (eigenvalue > 1) and the scree plot assessment were used to identify the number of factors.^{18,20} Using an absolute eigenvalue was deemed insufficient because of the potential for over- or underestimation of the number of factors.²¹

Generally, factors above the scree plot elbow point are regarded as factors that explain a sufficient degree of variance. In this study, the number of factors in the EFA was decided through the eigenvalue (>1) and the scree plot.

Regarding the CFA, the WLSMV estimator was used because it is appropriate for ordered categorical data.²² Also, multiple fit indices were examined to determine how well models fit the data and to compare fit of EFA and CFA models. In the EFA with WLSMV estimator, the fit indices indicated the χ^2 goodness-of-fit index along with its degrees of freedom, the root mean square error of approximation (RMSEA) along with its confidence interval (CI), comparative fit index (CFI), Tucker-Lewis Index (TLI), and standardized root mean square residual (SRMR; only for the EFA with WLSMV estimators). The following criteria were used to determine good model fit: nonsignificant χ^2 goodness-of-fit index, RMSEA ≤ 0.06 ,²² a value of 0.95 or above for CFI and TLI,¹⁶ and SRMR ≤ 0.05 .¹⁷ For the purposes of our study, a nonsignificant χ^2 value indicated good model fit. However, when the sample size is large, as is the case with our study, a significant χ^2 value in the model fit test is not necessarily problematic.²³ Furthermore, χ^2 goodness-of-fit values are susceptible to sample size fluctuations and non-normality.²⁴

RESULTS

Descriptive Statistics

The mean age of the analytic sample was 75.38 (standard deviation: 6.76). Among the 3,706 participants, 58% were women. White individuals made up 85% of the sample, whereas other racial groups accounted for the remaining 15%. Most of the sample was non-Hispanic (92.3%). The overall mean score of the R-UCLA was 16.40 (standard deviation: 4.49). Total combined scores for the 11-item loneliness scale ranged from 11 to 33 and skewness was 0.71. Thus, the distribution of loneliness was slightly skewed, indicating that a large majority of participants had low or moderate levels of loneliness. Also, the assessment of internal reliability of the 11 items was satisfactory (Cronbach's $\alpha = 0.87$).

There were no differences between the two subsamples on age, gender, race, ethnicity, or the total combined score for the loneliness scale (Table 2). Also, no statistically significant differences were observed

TABLE 1. Response Distributions for the 11-Item R-UCLA Loneliness Scale Among Split-Half Samples (N = 3,706)

Questions and Answers	Sample 1		Sample 2		χ^2	p
	N	%	N	%		
Q1. You lack companionship ^a					2.31	0.32
Often	165	8.9	192	10.4		
Some of the time	630	34.0	626	33.8		
Hardly ever or never	1,058	57.1	1,035	55.9		
Q2. Left out ^d					1.00	0.61
Often	91	4.9	90	4.9		
Some of the time	651	35.1	623	33.6		
Hardly ever or never	1,111	60.0	1,140	61.5		
Q3. Isolated from others ^a					2.35	0.31
Often	90	4.9	91	4.9		
Some of the time	511	27.5	470	25.4		
Hardly ever or never	1,252	67.6	1,292	69.7		
Q4. That you are "in tune" with the people around you					2.34	0.31
Often	905	48.8	879	47.4		
Some of the time	789	42.6	789	42.6		
Hardly ever or never	159	8.6	185	10.0		
Q5. Alone ^a					0.31	0.86
Often	176	9.5	186	10.0		
Some of the time	584	31.5	582	31.4		
Hardly ever or never	1,093	59.0	1,085	58.6		
Q6. That there are people you can talk to					1.31	0.52
Often	1,211	65.4	1,178	63.6		
Some of the time	541	29.1	571	30.8		
Hardly ever or never	101	5.5	104	5.6		
Q7. That there are people you can turn to					2.78	0.25
Often	1,234	66.6	1,202	64.9		
Some of the time	520	28.1	563	30.4		
Hardly ever or never	99	5.3	88	4.7		
Q8. That there are people you really understand you					0.24	0.89
Often	927	50.0	941	50.8		
Some of the time	820	44.3	810	43.7		
Hardly ever or never	106	5.7	102	5.5		
Q9. That there are people you feel close to					0.86	0.65
Often	1,285	69.3	1,282	69.2		
Some of the time	490	26.5	503	27.1		
Hardly ever or never	78	4.2	68	3.7		
Q10. Part of a group of friends					3.68	0.16
Often	892	48.1	876	47.3		
Some of the time	672	36.3	720	38.9		
Hardly ever or never	289	15.6	257	13.9		
Q11. That you have a lot in common with the people around you					1.53	0.47
Often	954	51.5	920	49.7		
Some of the time	755	40.7	792	42.7		
Hardly ever or never	144	7.8	141	7.6		

Notes: Sample size of Sample 1 (N = 1,853), and Sample 2 (N = 1,853). Excluded nine items with a four-point Likert scale: (1) there is no one I can turn to, (2) I am no longer close to anyone, (3) my interests and ideas are not shared by those around me, (4) I am an outgoing person, (5) my social relationships are superficial, (6) no one really knows me well, (7) I can find companionship when I want it, (8) I am unhappy being so withdrawn, (and 9) people are around me but not with me.

^aReverse coding (higher score indicates greater loneliness).

between the two subsamples for specific responses to any of 11 items on the scale (Table 1).

Based on χ^2 tests, there were statistically significant differences between the analytic sample and cases

that were excluded because of missing values. Gender (women: 58.1% versus 65.7%; $\chi^2 = 7.89$; df = 1; $p < 0.01$), race (white: 84.9% versus 75.6%; $\chi^2 = 21.95$; df = 3; $p < 0.001$), and ethnicity (non-Hispanic: 92.3% versus

TABLE 2. Demographic Statistics for Random Split-Half Samples (N = 3,706)

Variables	Sample 1 (N = 1,853)		Sample 2 (N = 1,853)		t / χ^2	df	p
	N or Mean	% or SD	N or Mean	% or SD			
Age	75.34	6.70	75.43	6.82	-0.41	3,704	0.69
Gender					0.46	1	0.50
Male	767	41.4	787	42.5			
Female	1,086	58.6	1,065	57.5			
Race					2.47	1	0.12
White	1,591	85.9	1,556	84.1			
Other	261	14.1	295	15.9			
Ethnicity					0.13	1	0.72
Non-Hispanic	1,708	92.2	1,712	92.5			
Hispanic	145	7.8	139	7.5			
Loneliness	16.37	4.50	16.43	4.48	-0.36	3,704	0.72

TABLE 3. Correlation Analysis Between the 11 Factors (Spearman's rho)

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
Q1	1.00										
Q2	0.54 ^a	1.00									
Q3	0.50 ^a	0.60 ^a	1.00								
Q4	0.14 ^a	0.22 ^a	0.22 ^a	1.00							
Q5	0.60 ^a	0.51 ^a	0.53 ^a	0.17 ^a	1.00						
Q6	0.24 ^a	0.29 ^a	0.32 ^a	0.39 ^a	0.27 ^a	1.00					
Q7	0.22 ^a	0.27 ^a	0.32 ^a	0.35 ^a	0.25 ^a	0.72 ^a	1.00				
Q8	0.23 ^a	0.30 ^a	0.30 ^a	0.37 ^a	0.24 ^a	0.54 ^a	0.60 ^a	1.00			
Q9	0.23 ^a	0.29 ^a	0.32 ^a	0.35 ^a	0.24 ^a	0.57 ^a	0.61 ^a	0.60 ^a	1.00		
Q10	0.29 ^a	0.32 ^a	0.34 ^a	0.35 ^a	0.28 ^a	0.43 ^a	0.46 ^a	0.45 ^a	0.49 ^a	1.00	
Q11	0.29 ^a	0.35 ^a	0.37 ^a	0.41 ^a	0.29 ^a	0.45 ^a	0.46 ^a	0.48 ^a	0.49 ^a	0.63 ^a	1.00

Notes: Q1. You lack companionship; Q2. Left out; Q3. Isolated from others; Q4. That you are "in tune" with the people around you; Q5. Alone; Q6. That there are people you can talk to; Q7. That there are people you can turn to; Q8. That there are people you really understand you; Q9. That there are people you feel close to; Q10. Part of a group of friends; Q11. That you have a lot in common with the people around you.

^ap < 0.01.

87.6%; $\chi^2 = 9.38$; df = 1; p < 0.01) were statistically different between the final analytic sample and cases with missing data on the R-UCLA. Independent t-test showed that mean age (75.4 versus 77.6) also differed (t = 16.69; df = 3,704; p < 0.001).

Table 3 displays results of a correlation matrix analysis between all 11 items. Results showed that all items were correlated (Spearman's rho > 0.14, p < 0.01), and, thus, an oblique rotation method was most appropriate for the EFA.^{15,16}

Exploratory Factor Analysis

The EFA was conducted with a random split-half sample (N = 1,853). Table 4 provides fit indices for the EFA models. Results showed that only two factors had

TABLE 4. Fit Indices for EFA Models (Sample 1)

Fit Indices Test	1 Factor	2 Factor	3 Factor
χ^2	2711.513	817.556	219.030
df	44	34	25
p	0.000	0.000	0.000
RMSEA	0.181 ^a	0.112 ^a	0.065 ^a
RMSEA 90% CI	(0.175, 0.187)	(0.105, 0.118)	(0.057, 0.073)
CFI	0.887	0.967	0.992
TLI	0.858	0.946	0.982
SRMR	0.148	0.045	0.019

Note: ^ap < 0.001.

p-values are less than 0.001.

eigenvalues greater than one, indicating that a two-factor model is appropriate to identify factor structure. The scree plot (figure not shown) showed that the elbow point occurred at a value of five, indicating that

TABLE 5. EFA Item Loadings (Sample 1)

	1 Factor	2 Factor		3 Factor		
	1	1	2	1	2	3
You lack companionship?	0.677	0.835	−0.013	0.852	−0.043	−0.002
Left out?	0.745	0.793	0.127	0.794	0.015	0.106
Isolated from others?	0.769	0.773	0.166	0.761	0.005	0.170
That you are “in tune” with the people around you?	0.525	0.033	0.548	−0.040	0.270	0.379
Alone?	0.687	0.838	−0.008	0.867	−0.008	−0.043
That there are people you can talk to?	0.848	−0.061	0.904	0.025	0.878	0.001
That there are people you can turn to?	0.910	−0.089	0.978	0.005	0.969	−0.016
That there are people you really understand you?	0.803	0.004	0.837	0.020	0.721	0.158
That there are people you feel close to?	0.834	0.013	0.863	−0.016	0.658	0.294
Part of a group of friends?	0.749	0.223	0.652	0.054	0.082	0.732
That you have a lot in common with the people around you?	0.784	0.234	0.681	0.007	−0.031	0.963

Note: Bold denotes items with factor loadings larger than 0.3.

a four-factor model would be appropriate. That is, a two-factor model and a four-factor model were appropriate based on the results of the eigenvalues and the scree plot. However, using the four-factor model was inappropriate because there were only 11 items. A CFA result of two or fewer indicators per factor is problematic because it provides too little information from the data. Thus, at least three indicators are recommended for each resulting factor.¹⁵

Results showed that a one-factor model did not fit well: χ^2 (df = 44) = 2,711.513, $p < 0.001$; RMSEA (90% CI) = 0.181 (0.175, 0.187); CFI = 0.887; TLI = 0.858; and SRMR = 0.148. On the other hand, the two-factor model fit well: χ^2 (df = 34) = 817.556, $p < 0.001$; CFI = 0.967; TLI = 0.946; and SRMR = 0.045. However, the value of RMSEA did not fit well: RMSEA (90% CI) = 0.112 (0.105, 0.118). Even though the value of RMSEA did not fit well, the CFI, TLI, and SRMR for the two-factor model were acceptable. In addition, a three-factor model fit well: χ^2 (df = 25) = 219.03, $p < 0.001$; RMSEA (90% CI) = 0.065 (0.057, 0.073); CFI = 0.992; TLI = 0.982; and SRMR = 0.019. Thus, in this study two- and three-factor models were examined. The three-factor model demonstrated the best fit to the data. Factor 1 indicated *feeling isolated*, Factor 2 indicated *available social connections*, and Factor 3 indicated *sense of belonging*.

Table 5 provides factor loadings for each factor from the single-, two-, and three-factor models. In this study, loadings greater than 0.32 were used in interpretation of the factors.²⁵ Most items had loadings greater than 0.54 on single-, two-, and three-factor models.

Confirmatory Factor Analysis

The CFA was conducted with the second random split-half sample (N = 1,853). The two- and three-factor CFA models were examined based on results from the EFA. Table 6 provides fit indices for the resulting CFA models. Results suggested that the fit indices of the three-factor model were acceptable, despite a statistically significant χ^2 value: χ^2 (df = 41) = 344.534, $p < 0.001$; RMSEA (90% CI) = 0.063 (0.057, 0.069); CFI = 0.987; and TLI = 0.983. On the other hand, most other fit indices of the two-factor model were satisfactory: χ^2 (df = 43) = 614.311, $p < 0.001$; RMSEA (90% CI) = 0.085 (0.079, 0.091); CFI = 0.976; and TLI = 0.969. In this result, the value of the RMSEA is not satisfactory, whereas it is close to the 0.08 cutoff for acceptable fit.¹⁷ In summary, the three-factor and the two-factor CFA model showed a good fit to the data. All fit indices with the exception of the χ^2 test supported these results.

TABLE 6. Fit Indices for CFA Models (Sample 2)

Fit Indices Test	1 Factor	2 Factor	3 Factor
χ^2	2957.159	614.311	344.534
df	44	43	41
p	0.000	0.000	0.000
RMSEA	0.189 ^a	0.085 ^a	0.063 ^a
RMSEA 90% CI	(0.183, 0.195)	(0.079, 0.091)	(0.057, 0.069)
CFI	0.878	0.976	0.987
TLI	0.848	0.969	0.983

Note: ^a $p < 0.001$.

p-values are less than 0.001.

TABLE 7. Standardized Estimators of Factor Loadings for CFA (2-Factor Model)

Items and factors	Standardized Estimators	Standard Error
Feeling Isolated		
Q1. You lack companionship?	0.824 ^a	0.014
Q2. Left out?	0.867 ^a	0.013
Q3. Isolated from others?	0.896 ^a	0.013
Q5. Alone?	0.835 ^a	0.014
Available social connections		
Q4. That you are "in tune" with the people around you?	0.562 ^a	0.021
Q6. That there are people you can talk to?	0.852 ^a	0.011
Q7. That there are people you can turn to?	0.896 ^a	0.009
Q8. That there are people you really understand you?	0.854 ^a	0.010
Q9. That there are people you feel close to?	0.878 ^a	0.010
Q10. Part of a group of friends?	0.787 ^a	0.013
Q11. That you have a lot in common with the people around you?	0.819 ^a	0.012
Feeling isolated—available social connections	0.516 ^a	0.022

Notes: Mplus version 7.3 does not provide degrees of freedom for (un-)standardized estimates.

This table shows StdYX standardization as results of CFA from Sample 2 (N = 1,853). StdYX is a standardized option of Mplus and uses the variances of the continuous latent variables and the variables of the background and outcome variables for standardization.

^ap < 0.001.

Tables 7 and 8 provide standardized estimators of factor loadings with standard errors for the two- and three-factor models. Also, the standardized factor loadings for the two-factor model are provided in Figure 1. All standardized factor loadings were higher than 0.56. The value of standardized factor loadings between the feeling isolated and the sense of belonging was 0.516. In addition, loadings for the three-factor model are provided in Figure 2. With the exception of two indicators: *That you are "in tune" with the people around you?*; and *Part of a group of friends?*, all values of standardized factor loadings were higher than 0.8. Also, the value of standardized factor loadings between the *feeling isolated* and the *available social connections* factors was 0.469, the value between the *feeling isolated* and the *sense of belonging* was 0.55, and the value between the *available social connections* and the *sense of belonging* was 0.838. These standardized factor loadings between latent variables should be equal to the factor correlation. A value over 0.85 (high factor correlation) indicates the poor discriminant validity.¹⁵

TABLE 8. Standardized Estimators of Factor Loadings for CFA (3-Factor Model)

Items and factors	Standardized Estimators	Standard Error
Feeling isolated		
Q1. You lack companionship?	0.824 ^a	0.014
Q2. Left out?	0.867 ^a	0.013
Q3. Isolated from others?	0.896 ^a	0.013
Q5. Alone?	0.835 ^a	0.014
Available social connections		
Q6. That there are people you can talk to?	0.865 ^a	0.011
Q7. That there are people you can turn to?	0.909 ^a	0.009
Q8. That there are people you really understand you?	0.872 ^a	0.009
Q9. That there are people you feel close to?	0.895 ^a	0.010
Sense of belonging		
Q4. That you are "in tune" with the people around you?	0.592 ^a	0.022
Q10. Part of a group of friends?	0.836 ^a	0.013
Q11. That you have a lot in common with the people around you?	0.877 ^a	0.011
Feeling isolated—available social connections	0.469 ^a	0.024
Feeling isolated—sense of belonging	0.550 ^a	0.024
Available social connections—sense of belonging	0.838 ^a	0.014

Notes: Mplus version 7.3 does not provide degrees of freedom for (un-)standardized estimates.

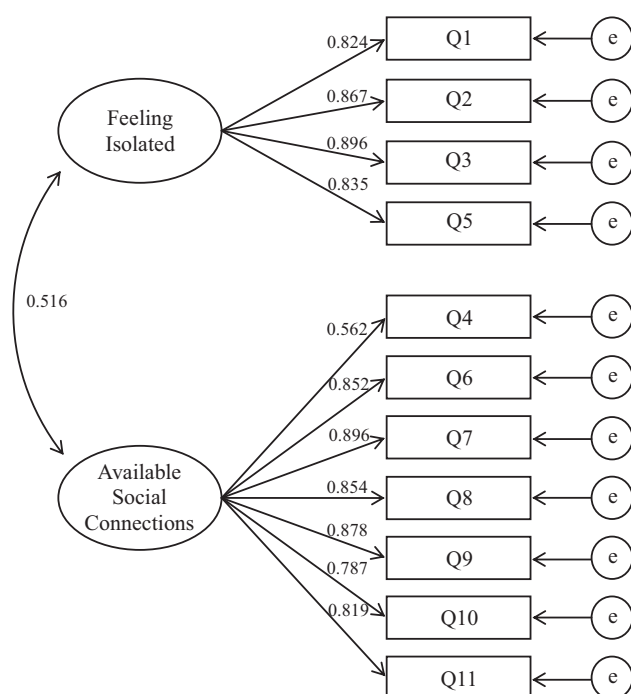
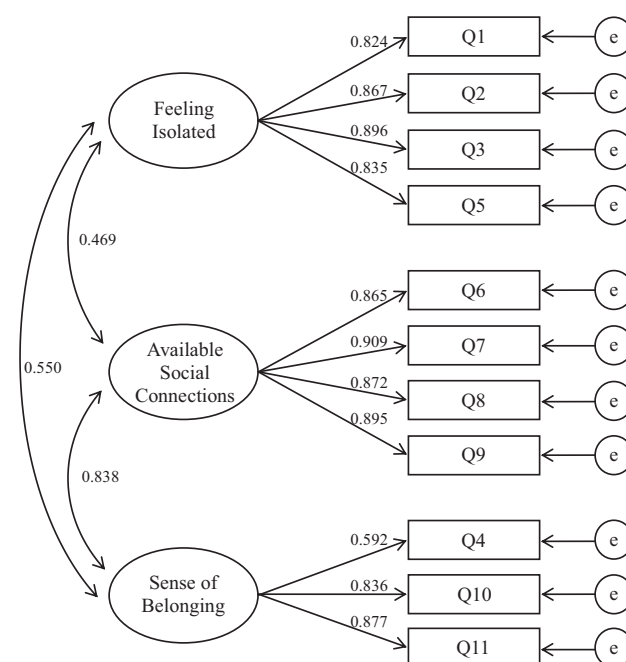
This table shows StdYX standardization as results of CFA from Sample 2 (n = 1,853). StdYX is a standardized option of Mplus and it uses the variances of the continuous latent variables and the variables of the background and outcome variables for standardization.

^ap < 0.001.

DISCUSSION

The purpose of this study was to examine the factor structure of the 11-item R-UCLA scale currently used by the HRS. Results of the CFA showed that two- and three-factor structures were supported. Compared with prior research, which conducted the EFA and the CFA by using the original 20-item scale, the results of this study are consistent with prior studies. However, as mentioned earlier, because recent versions of the HRS Psychosocial Supplement questionnaire include only 11 items of the R-UCLA, the results of this study and prior studies are not directly comparable.

Building off of work by previous R-UCLA researchers, we were able to confirm a two-factor structure. Initial EFA results suggested that a three-factor model (*feeling isolated*, *available social connections*, and *sense of belonging*) might be appropriate. However, the

FIGURE 1. CFA of the two-factor model (standardized estimators).**FIGURE 2. CFA of the three-factor model (standardized estimators).**

correlation coefficient of the factor between *available social connections* and *sense of belonging* ($r = 0.84$) was close to 0.85, suggesting a lack of discriminate validity. Based on this finding, our data supported the two-factor model (*feeling isolated* and *available social connections*). With a correlation of 0.52, the factors only have 27% (R^2) shared variance. This result combined with the improvement in fit indices for two-factor model, suggests the two-factor model is superior in terms of discriminate validity.

Although scale differences between the original 20-item R-UCLA and the shortened 11-item version make comparisons difficult, previous work informed our findings. As mentioned above, there was evidence for a three-factor model using the 20-item version of the R-UCLA.¹² However, based on the result of the CFA in our study with the 11-item version, the three-factor model had a very high correlation between two factors (*available social connections* and *sense of belonging*). This suggests that the three-factor model is inappropriate and has poor discriminant validity. Thus, the two-factor model is more appropriate for the 11-item

R-UCLA. This model further indicates that *feeling isolated* and *available social connections* are critical conceptual elements of loneliness.

Because of our study methods and approach, there are some important limitations to consider. Findings were somewhat inconsistent. First, initially the scree plot indicated that a four-factor model would be a factor structure for the R-UCLA. However, the lack of sufficient items (>2) per factor in the scale ruled out the four-factor model as each factor should have at least three indicators.¹⁶ Second, the RMSEA values of the two-factor model in the EFA and the CFA were slightly problematic. The RMSEA is a fit index based on the population error of approximation.²⁶ Interpretation of the RMSEA is dependent on its value: < 0.05 = a close fit, 0.05 – 0.08 = a fair fit, 0.08 – 0.10 = a mediocre fit, and > 0.10 = a poor fit. Thus, the RMSEA value of the CFA (0.085) in this study indicated that the two-factor model was a mediocre fit.²⁷ Although there were similar results using both with or without cases excluded because of missing values, differences of sample characteristics may contribute to these differing results. In addition,

the nine items excluded from the original 20-item scale may have an effect on measuring loneliness.

Our findings have important implications for future research. A growing body of evidence examines the relationships between loneliness and health among older adults.^{28,29} These studies mention that lonely older adults are more likely to have health risks. For example, lonely older adults have higher mortality than those who are not.³⁰ Studies also suggest that loneliness has a negative impact on mental health.^{28,29} Older adults who feel lonely are more likely to have depression than those who are not.²⁸ Thus, lonely older adults are at higher risk for both health-related complications and mental health concerns. In this sense, this study identifies two important factors of loneliness: feeling isolated and available social connections. Reducing feelings of isolation and improving available social connections may decrease loneliness among older adults. Reduced loneliness may in turn improve their health and sense of well-being.

This study also contributes to the current knowledge base by examining the factor of loneliness using a large population-based dataset. Our results give HRS researchers—and the clinicians who rely on HRS data—a more nuanced understanding of loneliness in older adulthood. Loneliness as measured by the brief 11-item R-UCLA consists of two conceptual dimensions: *feeling isolated* and *available social connections*.

Findings of this study help us better understand key psychometric properties of this newer, shorter version

of the scale. Even though the 11-item R-UCLA scale has been administered to thousands of individuals (through the HRS alone), until now we have not had empirical information about the factorability and reliability of this modified instrument. Furthermore, we should consider *feeling isolated* and *available social connections* when engaging in efforts to reduce loneliness and, further, to improve health-related outcomes. These two factors are conceptually associated with mental health (e.g., depression, well-being, social anxiety). However, future research should closely examine the linkages between the brief R-UCLA scale, its factors, and measures of mental health.

Based on the psychometric properties we examined, the 11-item version of the R-UCLA has a good internal reliability (Cronbach's $\alpha = 0.87$) and factorability. Thus, future studies should replicate this work and evaluate aspects of validity beyond factorial validity.

Finally, intervention strategies for reducing loneliness among older adults have been developed and tested. For example, educational interventions have focused on maintenance and enhancement of social networks and that group format interventions were effective.³⁰ In this sense, through educational interventions, *available social connections* could be maintained and enhanced. Also, *feeling isolated* could be reduced by participating in group format interventions.

The authors declare that they have no conflicts of interest.

References

1. Coyle CE, Dugan E: Social isolation, loneliness and health among older adults. *J Aging Health* 2012; 24:1346–1363
2. Perissinotto CM, Cenzer IS, Covinsky KE: Loneliness in older persons: a predictor of functional decline and death. *Arch Intern Med* 2012; 172:1078–1084
3. Victor C, Scambler S, Bond J: *The Social World of Older People: Understanding Loneliness and Social Isolation in Later Life*. Maidenhead, UK: Open University Press/McGraw Hill Education, 2009
4. Weiss RS: *Loneliness: The Experience of Emotional and Social Isolation*. Cambridge, MA: MIT Press, 1973
5. Jaremka LM, Fagundes CP, Glaser R, et al: Loneliness predicts pain, depression, and fatigue: understanding the role of immune dysregulation. *Psychoneuroendocrinology* 2013; 38:1310–1317
6. Kong F, You X: Loneliness and self-esteem as mediators between social support and life satisfaction in late adolescence. *Soc Indic Res* 2013; 110:271–279
7. Prieto-Flores ME, Forjaz MJ, Fernandez-Mayoralas G, et al: Factors associated with loneliness of noninstitutionalized and institutionalized older adults. *J Aging Health* 2011; 23:177–194
8. DiTommaso E, Spinner B: The development and initial validation of the Social and Emotional Loneliness Scale for Adults (SELSA). *Pers Individ Dif* 1993; 14:127–134
9. Russell D, Peplau LA, Ferguson ML: Developing a measure of loneliness. *J Pers Assess* 1978; 42:290–294
10. Russell DW: UCLA Loneliness Scale (Version 3): reliability, validity, and factor structure. *J Pers Assess* 1996; 66:20–40
11. Penning MJ, Liu G, Chou PHB: Measuring loneliness among middle-aged and older adults: the UCLA and de Jong Gierveld Loneliness Scales. *Soc Indic Res* 2014; 118:1147–1166
12. Hughes ME, Waite LJ, Hawkey LC, et al: A short scale for measuring loneliness in large surveys results from two population-based studies. *Res Aging* 2004; 26:655–672
13. Russell D, Peplau LA, Cutrona CE: The revised UCLA Loneliness Scale: concurrent and discriminant validity evidence. *J Pers Soc Psychol* 1980; 39:472–480
14. Smith J, Fisher G, Ryan L, et al: *Psychosocial and Lifestyle Questionnaire 2006–2010. Documentation Report Core Section LB*. Ann Arbor, MI: University of Michigan, 2013
15. Brown TA: *Confirmatory Factor Analysis for Applied Research*. New York, NY: Guilford Publications, 2015

16. Kline RB: Principles and Practice of Structural Equation Modeling. 3rd ed. New York, NY: The Guilford Press, 2011
17. Byrne BM: Structural Equation Modeling with Mplus: Basic Concepts, Applications, and Programming. New York, NY: Routledge, 2012
18. Osborne JW, Costello AB: Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Pan-Pac Manag Rev* 2009; 12:131-146
19. Munn JC, Zimmerman S, Hanson LC, et al: Measuring the quality of dying in long-term care. *J Am Geriatr Soc* 2007; 55:1371-1379
20. Osborne JW: What is rotating in exploratory factor analysis? *Pract Assess Res Eval* 2015; 20:1-7
21. Floyd FJ, Widaman KF: Factor analysis in the development and refinement of clinical assessment instruments. *Psychol Assess* 1995; 7:286-299
22. Hu LT, Bentler PM: Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equat Model* 1999; 6:1-55
23. Hawkey LC, Browne MW, Cacioppo JT: How can I connect with thee? Let me count the ways. *Psychol Sci* 2005; 16:798-804
24. DiStefano C, Hess B: Using confirmatory factor analysis for construct validation: an empirical review. *J Psychoeduc Assess* 2005; 23:225-241
25. Tabachnick BG, Fidell LS: Using Multivariate Statistics. 4th ed. New York, NY: Harper & Row, 2001
26. Bal S, Crombez G, De Bourdeaudhuij I, et al: Symptomatology in adolescents following initial disclosure of sexual abuse: the roles of crisis support, appraisals and coping. *Child Abuse Negl* 2009; 33:717-727
27. Quintana SM, Maxwell SE: Implications of recent developments in structural equation modeling for counseling psychology. *Couns Psychol* 1999; 27:485-527
28. Luanaigh C Ó, Lawlor BA: Loneliness and the health of older people. *Int J Geriatr Psychiatry* 2008; 23:1213-1221
29. Luo Y, Hawkey LC, Waite LJ, et al: Loneliness, health, and mortality in old age: a national longitudinal study. *Soc Sci Med* 2012; 74:907-914
30. Cohen-Mansfield J, Perach R: Interventions for alleviating loneliness among older persons: a critical review. *Am J Health Promot* 2015; 29:109-125