Differential item functioning analysis on UCLA Loneliness Scale 8 using Rasch model

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Abstract

Background: Loneliness measurement is profound to assess inidividuals in enforced social isolation from government due to the COVID-19 pandemic. Major scales including UCLA Loneliness Scale 8 or ULS-8 have been employed for this reason. However, comprehensive validation study, including differential item functioning (DIF) to sought different estimation between groups are seldomly studied in adaptation study. **Study aims:** This study aims to analyze DIF of ULS-8 using Rasch model detection method. **Method:** 1500 Indonesian respondents data were obtained with online questionnaire inspecting three different subgroups; age group (young and middle adult age group), gender (male and female), and marital statuses (married or not married). **Result and Conclusion:** Based on probability ($p < .05$) and t-value higher than 2 (|t|>2), it was found that one item was different significantly in age group comparison, two items were differed in gender subgroup, and no DIF detected in marital statuses subgroup.
Keywords: Loneliness, UCLA Loneliness Scale 8, differential item functioning, Rasch model

Abstrak

Pendahuluan: Pengukuran kesepian sangat mendalam untuk menilai inidividuals dalam isolasi sosial yang diberlakukan dari pemerintah karena pandemi COVID-19. Skala utama termasuk UCLA Loneliness Scale 8 atau ULS-8 telah digunakan untuk alasan ini. Namun, studi validasi komprehensif, termasuk fungsi item diferensial (DIF) untuk mencari estimasi yang berbeda antar kelompok jarang dipelajari dalam studi adaptasi. **Tujuan penelitian**: menganalisis DIF ULS-8 dengan menggunakan metode deteksi model Rasch. **Metode:** 1500 data responden Indonesia diperoleh dengan kuesioner online yang memeriksa tiga subkelompok yang berbeda; kelompok usia (kelompok usia dewasa muda dan menengah), jenis kelamin (pria dan wanita), dan status perkawinan (menikah atau tidak menikah). **Hasil dan kesimpulan:** Berdasarkan probabilitas ($p < 0,05$) dan nilai-t lebih tinggi dari 2 (|t|>2), ditemukan bahwa satu item berbeda secara signifikan dalam perbandingan kelompok usia, dua item berbeda dalam subkelompok gender, dan tidak ada DIF yang terdeteksi dalam subkelompok status perkawinan.
Kata Kunci: Kesepian, UCLA Loneliness Scale 8, differential item functioning, Rasch model

INTRODUCTION

Measuring loneliness has been profound during the COVID-19 pandemic, where social isolation and self-quarantine are recommended and even enforced. This statement was confirmed by 2020 reports from the Indonesian Psychiatrists Association where 57.6% of respondents had depression symptoms, including mood swings, insomnia, and loneliness (Virdhani, 2020). Similar results have been found across different samples, including college students (Fathoni & Listiyandini, 2021), teenagers (Sagita & Hermawan, 2020), and elders (Sari & Hamidah, 2021). With a range of poor health outcomes that may emerge from loneliness (Office for National Statistics, 2018), studies to improve loneliness measurements' quality are recommended to ensure its validity.

UCLA (University of California, Los Angeles) Loneliness Scale is a unidimensional scale to measure loneliness that was designed in 1978 with 20 items (ULS-20) and keep revised with several item variations, including the revised version ULS-8 and ULS-4 (Xu et al., 2018). The scale has been included among one primary loneliness measurement (Yanguas et al., 2018). As one of the versions, ULS 8 provides a substitute of ULS-20 without a significant loss of information encountered on ULS-4 (Hays & Dimatteo, 1987). ULS 8 has been adapted into multiple languages, including Chinese (Xu et al., 2018), Taiwanese (Wu & Yao, 2008), Turkish (Yildiz & Duy, 2014), and Malay (Swami, 2009) with the evaluation of their psychometric properties to ensure validity and reliability for the respective language and culture.

One of the underused studies in measurement validation study is bias, such as differential item functioning (DIF). An adaptation study seldom included this particular study, even though measuring instruments bias enhances equity and fairness of a test, thus identifying and avoiding measurement bias issues across different demographics (Gómez-Benito et al., 2018). Martinková et al. (2017) also argued that DIF should be routinely assessed to evaluate items in developing conceptual assessments. DIF can be defined when two groups of equal ability levels are not equally able to answer an item (Karami, 2012) correctly. There are different methods to detect DIF, for example, classical and IRT-based methods (Martinková et al., 2017). IRT-based methods have the advantage of being more precise to estimate latent ability with a three-parameter (3PL) test; however it requires a large sample size.

As one of the other IRT models, the Rasch model required less sample size due to limits the analysis in one-parameter IRT model with constraining all items to the same discrimination levels and disallowing

for guessing (Martinková et al., 2017). Rasch model focuses on the probability of endorsing item *I* by person *m* and make a function of the difference between the person and ability to become item difficulty (Karami, 2012). The Rasch model can also analyze missing data and high-low ability group-splits, unlike the Mantel-Haenszel DIF analysis technique (Linacre, 2011). Therefore this study aims to apply the DIF detection method from the Rasch model.

Loneliness is correlated to demographic data both theoretically and empirically. Loneliness in the German population has declined across age groups, more prevalent in women, for individuals without a partner, living alone, and without children (Beutel et al., 2017). However, in the Netherlands, the prevalence reversed, with late middle-age adults have the highest prevalence among age groups (Franssen et al., 2020). In Indonesia, a study of loneliness demographic data with a national representative sample was only found in the 2019 Indonesia Health Profile. Loneliness (in relationship) predicts vulnerability on male and female adolescents' mental health disorder 19.6% and 11.4% respectively (in relationship . This data calls for an empirical study to determine whether loneliness scale has been majorly used (ULS-8) to measure the construct fairly in different age groups, genders, and marital statuses.

METHOD

Study design

Based on Kumar's (2011) types of study design, this study can be categorized as non-experimental, cross-sectional, and retrospective type. This type refers to the study aims to observe the variables without any modification to sought information from participants based on their current or past experience in a single time frame to obtain the prevalence of the studied phenomenon.

Participants

In total, 1500 respondents from Indonesian citizens with the age range 18-60 (36.5% female, *M*=24.8, *SD*=4.51) were obtained through the online questionnaire service Google Form. They responded to study information and the survey link shared to social media/networking services such as Twitter, WhatsApp, and LINE. They may also apply for a lucky draw as a reward for 10 people with a total amount of IDR 250.000 worth of electronic money. They can also submit email addresses to receive published articles related to this study.

Measurements

ULS-8. This measure was developed by Hays & Dimatteo (1987) based on indicators from the original version of the scale. This scale employed a 4-point Likert scale ranged from 1 (Not suitable) to 4 (very suitable). This measure was adapted to Bahasa Indonesia by Sugianto (2020) with valid and reliable results. The indicator for the measurement is described in Table 1.

Demographic data were also collected, such as age, gender, and marital status (married, single, divorced, widowed, and in a relationship). Marital status data was later coded as 1 (married) and 0 (other status) to make the DIF analysis easier.

Data analysis

Rasch Rating Scale Model (RSM) examined ULS-8 with unidimensionality and local independence assumptions, Rasch item measure, and fit statistics. This also includes reliability and separation indices and a DIF analysis based on age group, gender, and marital status. All Rasch model analyses were conducted with WINSTEPS ver 3.73. and confirmatory factor analysis was performed using LISREL 8.80.

Table 1.

ULS-8 Blueprint

Dimension	Indicator	Items	
		Favorable	Unfavorable
Loneliness	Not dependent on anyone else	1	-
	Not satisfactory relationship	2	-
	No friends, family, or others on social network	3,5	7,8
	Rejection from the social environment	4,6	-

Results and Discussion

Unidimensionality and local independence

To measure whether ULS-8 can fit the Rasch model assumption, unidimensionality uses Principal component analysis of a standardized residual or PCAR. ULS-8 can explain variance by 44.2% (14.3 in eigenvalue unit), with the first contrast of unexplained variance decreased in 14.3% or 2 eigenvalue unit. The explained variance was fit to the minimum 40% variance explained required to state unidimensionality in the scale (Holster & Lake, 2016). Local independence also examined using standardized residual correlation

between items, where ULS-8 ranged from -0.24 to -0.33, which still fits criteria within 0.07 residual correlation as still accepted (Cecilio-Fernandes et al., 2017; Gonzalez-de Paz et al., 2015; Linacre, 2011). In addition, confirmatory factor analysis was performed, with [χ^2 (13, N=1500) =83.51, p < 0.0001, RMSEA=0.060, SRMR = 0.033] with nine correlated residuals and all t-value items were larger than 1.96 (|t| > 1.96). This indicates the result to confirm the model of the scale is unidimensional.

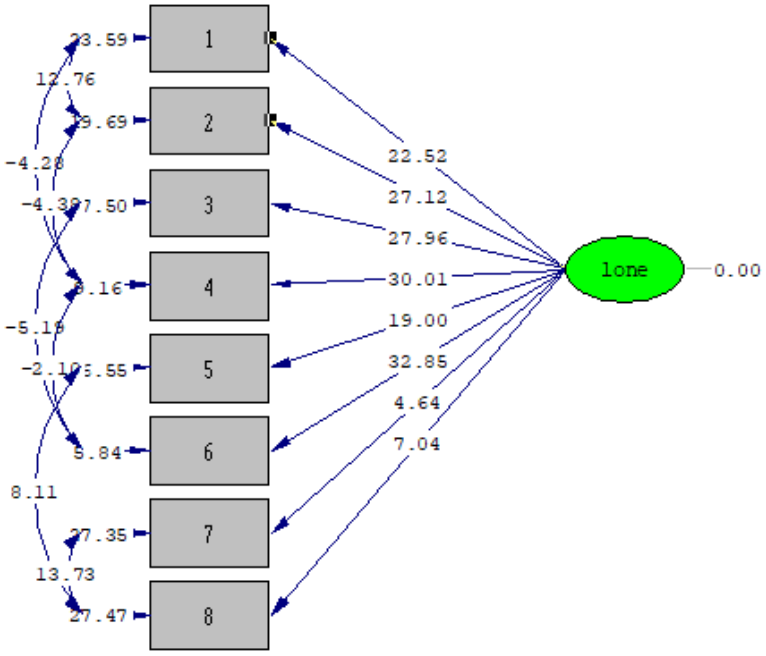

Figure 1 CFA result of ULS-8

Item fit statistics

Rasch model's item fit was analyzed with infit and outfit mean squares (MNSQs) with expected values for both values was 1.0 and .5-1.5 were considered acceptable value range (Linacre, 2011). All ULS-8 items were satisfied with this range with .71 to 1.77. The highest mean square belonged to the outfit mean square of item 7. Full result on item fit were depicted on Table 2.

Reliability and separation index

Reliability estimation was analyzed from person and item reliability and separation or ability to separate items or individuals with a high or low probability of answering the items right. Person and item reliability of ULS-8 were 0.68 and 1, while person and item separation were 1.46 and 16.73, respectively. Good reliability criterion falls above 0.8 and

separation above 2 (Ariffin et al., 2010). Person reliability and separation index were found below criteria, which according to Linacre (2011) with relevant person sample might imply the instrument may not be sensitive enough to distinguish between high and low performers, thus more items may be needed.

Table 2.
Item measures and fit statistics for ULS-8

Item	Item wording	Measure	Infit	Outfit	PT-Measure
4	Tidak ada orang yang dapat saya andalkan	0.8	0.81	0.71	0.61
8	Ada banyak orang di sekitar saya, tetapi tidak untuk saya	0.68	1.17	1.26	0.36
7	Saya tidak memiliki sahabat	0.52	1.42	1.77	0.3
3	Saya dijauhi oleh orang-orang di sekitar saya	0.27	1	0.96	0.62
6	Saya merupakan orang yang pemalu	-0.18	0.78	0.76	0.7
1	Saya merasa ditinggalkan	-0.46	0.97	0.98	0.63
5	Saya dapat menjalin persahabatan jika saya menginginkannya	-0.72	1.13	1.17	0.56
2	Saya merupakan orang yang ramah dan bersahabat	-0.9	0.78	0.78	0.71

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DIF analysis

DIF analysis was performed to see whether ULS-8 items performed similar when subgroup introduced. An item can be detected as DIF if items included below 0.05 probability and t statistics above 2 (Linacre, 2011). Age group was separated as 2, emerging adult (less than or equal to 25 years old) and young-middle adult (above 26 years old) (Papalia & Martorell, 2013). DIF for age group (Table 3) was indicated on item 7 where young adult perceive this item more difficult than middle adult. DIF for gender (Table 4) indicated items 4 and 8 as significantly different with item 4 ("There is no one I can depend on") were perceived as more difficult by female and item 8 ("There's many people in my surroundings but they are not for me") was perceived more difficult by male. As for marital status (Table 5), there was no DIF found between married and not married respondents.

Table 3

DIF detection between age group

Item	Chi-Square	df	Probability	Mean square	t=ZTSD	Interpretation
1	0.4025	1	0.5258	0.2604	-0.2954	DIF not indicated
2	7.1077	1	0.0077	3.1073	1.4456	DIF not indicated
3	0.2038	1	0.6517	0.1524	-0.5169	DIF not indicated
4	1.8003	1	0.1797	0.7382	0.2673	DIF not indicated
5	2.6305	1	0.1048	1.1548	0.5757	DIF not indicated
6	4.3589	1	0.0368	1.9034	0.979	DIF not indicated
7	13.4314	1	0.0002	5.7135	2.1424	DIF indicated
8	0	1	1	0.0142	-1.1357	DIF not indicated

Table 4

DIF detection between gender groups

Item	Chi-Square	df	Probability	Mean square	t=ZTSD	Interpretation
1	6.1108	1	0.0134	2.8641	1.3627	DIF not indicated
2	0	1	1	0.0137	-1.1424	DIF not indicated
3	0	1	1	0.059	-0.8242	DIF not indicated
4	11.7459	1	0.0006	5.6065	2.1186	DIF indicated
5	3.9655	1	0.0464	1.8496	0.954	DIF not indicated
6	2.1434	1	0.1432	0.9979	0.4699	DIF not indicated
7	5.6397	1	0.0176	2.6918	1.301	DIF not indicated
8	16.6476	1	0	7.831	2.5626	DIF indicated

Table 5

DIF detection between marital status

Item	Chi-Square	df	Probability	Mean square	t=ZTSD	Interpretation
1	1.6502	1	0.1989	0.4196	-0.0618	DIF not indicated
2	9.9842	1	0.0016	2.277	1.1409	DIF not indicated
3	0.0532	1	0.8175	0.0074	-1.2365	DIF not indicated
4	0.6377	1	0.4245	0.1137	-0.6223	DIF not indicated
5	0.5101	1	0.4751	0.136	-0.5591	DIF not indicated
6	8.5311	1	0.0035	1.8959	0.9756	DIF not indicated
7	21.0762	1	0	4.3574	1.8149	DIF not indicated
8	5.9203	1	0.015	1.1388	0.5653	DIF not indicated

Conclusion

Based on this study, ULS-8 has an adequate fit to Rasch model; however, DIF items across demographic data prove that the ULS-8 Bahasa Indonesia version needs to be reviewed before further application on loneliness study so that fair results between different demographic variables can be endorsed.

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