

# Investigating Psychometric Properties of the Thai Version of the Zarit Burden Interview using Rasch Model and Confirmatory Factor Analysis

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## Research note

**Keywords:** Zarit Burden Interview (ZBI), Alzheimer's disease, caregivers, Rasch analysis, perceived stress, depression, psychometric property

**Posted Date:** January 21st, 2020

**DOI:** <https://doi.org/10.21203/rs.2.18428/v2>

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**Version of Record:** A version of this preprint was published at BMC Research Notes on March 2nd, 2020. See the published version at <https://doi.org/10.1186/s13104-020-04967-w>.

# Abstract

**Objective:** The Zarit Burden Interview (ZBI) has been widely used to assess caregiver burden. Few research papers have investigated the Thai version of the ZBI. The study aimed to examine the psychometric properties of the Thai version of both the full length (ZBI-22) and short versions (ZBI-12) using Rasch analysis and confirmatory factor analysis among a sample of Alzheimer's disease caregivers.

**Results:** The ZBI-22 fitted the Rasch measurement model regarding unidimensionality but not for ZBI-12. Five items from ZBI-22, and 2 items from ZBI-12 were shown to be misfitting items. Half of ZBI items were shown to be disordered category or threshold, and were locally dependent. CFA revealed three-factor and four-factor fitted the data the best for ZBI-22 and ZBI-12, respectively. Reliability was good for both forms of the ZBI ( $\alpha = 0.86 - 0.92$ ). Significant correlations were found with caregiver's perceived stress, anxiety/depression, pain and mobility but not with self-care and usual activity ( $p > 0.05$ ), indicating convergent and discriminant validity. To conclude, the Thai version ZBI-22, but not ZBI-12, supported the reliability and unidimensional scale among Alzheimer's disease caregivers. Some misfitting items of the ZBI undermined the unidimensionality of the scale, and need revision.

## Introduction

Caregiver burden is a state where the physical and psychological well-being, family relations or financial status of the caregiver could be threatened by providing the necessary care to another [1]. Caregiving, especially for elderly with dementia, usually causes burden among caregivers [2-5]. Studies showed that burden can ultimately lead to depression [6], and could lead to the poor treatment outcomes of the patients [7].

Thailand is becoming an aging society which would increase the number of dependent individuals and tendency of a household's need for caregivers [8], so the burden of caregivers should be concerned. Studies have shown that over 40 to 70% of caregivers perceiving a burden [9, 10].

One of the oldest and most common measurements to assess dementia caregiver burden is the Zarit Burden Interview (ZBI) [11, 12]. It measures multidimensional aspects including physical, emotional, financial and social burden and the relation with the care receiver. It originated as a 29-item questionnaire but currently has been translated to many languages and revised to a 22-item form (ZBI-22) [13]. Shorter forms of ZBI have been developed by researchers over the past decades, ranging from 1 to 14 items [14]. However, the most widely used is ZBI-12, introduced by Be'dard et al.[15]. ZBI-12 has shown good psychometric properties in various languages and cultures [16-25]. Regarding its factor structure, the dimensions of ZBI range from 2 to 5 [15, 20]. Due to its multidimensional nature, it may not be accurately captured by a global score [26-28]. The ZBI has demonstrated high correlations with other psychological tools [17, 23-25, 29]. For ZBI-12, factor analysis revealed a two-factor rather than a unidimensional model despite being shorter[27]. Correlations between the ZBI-12 and ZBI-22 received a value of 0.96 in the

initial study. To capture the global score of burden, the unidimensional ZBI was developed using item response theory (IRT), yielding a different set of items for the short scale as compared with the former 12-item ZBI[30].

To our knowledge, only one study examined the Thai version of ZBI-12 using factor analysis [31]. The Thai ZBI has never been tested for psychometric properties among Thai dementia caregivers and using IRT or Rasch measurement model. Therefore, the present study aimed to examine the ZBI construct by means of convergent, discriminant and concurrent validity, using both Rasch analysis and confirmatory factor analysis (CFA).

## Methods

### Subjects

Maharaj Nakorn Chiang Mai Hospital, participated in the study. Exclusion criteria was inability to communicate due to either language barrier or severe mental health problem.

### Data collection

Data were collected at an outpatient clinic through structured interviews by one physician (MP) who had no role in patient care planning. All gave written informed consent before completing the questionnaires. The questionnaires included sociodemographic data, records related to caregiving and specific measures, which were ZBI, Perceived stress scale (PSS), Patient Health Questionnaire (PHQ-9), and EQ-5D.

### Outcome measures

#### *ZBI*

The ZBI is a caregiver-reported questionnaire measuring the burden the respondent feels in providing care to the patient. Currently, it has two widely used forms, ZBI-22 and ZBI-12, with a Likert scoring scale between 0 (never) and 4 (nearly always)[15, 32]. Studies showed high correlation in both ZBI-22 and ZBI-12 with the Caregiver Activity Survey, and with other tools [25, 33].

The Thai version (translated version) of the ZBI used in this study was allowed by Professor Zarit and Mapi Research Trust [13]. The study sample showed a Cronbach's alpha of 0.921 for the ZBI-22 and 0.865 for ZBI-12.

#### *PSS*

The PSS is a self-reporting, 10-item questionnaire measuring the extent to which individuals perceived stress [34]. The 4-response Likert scale, ranges from 0 (not at all) to 4 (the most). The Thai version PSS showed a Cronbach's alpha of 0.85. It correlated with other measures including the State Trait Anxiety Inventory, but negatively correlated with the Rosenberg Self-Esteem Scale[35]. The study sample showed a Cronbach's alpha of 0.850.

### *PHQ-9*

The PHQ-9 is a self-reporting, 9-item questionnaire measuring the extent to which an individual feels bothered due to depressive symptoms over the past two weeks [36]. The 4-response Likert scale ranges from 0 (not at all) to 3 (nearly every day). The Thai version PHQ-9 showed a Cronbach's alpha of 0.79 and a positive association between the PHQ-9 and the HAM-D[37]. The study sample showed a Cronbach's alpha of 0.849.

### *EQ-5D*

The EQ-5D is a self-reporting questionnaire measuring health-related quality of life [38]. It comprises 5 items assessing 5 domains of health state: mobility, self-care, usual activities, pain and anxiety/depression, with a 5-response scale ranging from 1 (no problem) to 5 (severe problem). All 5 aspects were calculated to an index score with the maximum of 1.000 [39]. An intraclass correlation coefficient of 0.987 for the EQ-5D index score, and a significant correlation with WHOQOL-BREF were noted [40]. The study sample showed that Cronbach's alpha was 0.723.

### *Statistical Analysis*

Sociodemographic data were analyzed using descriptive statistics. Pearson's or Spearman's rank was used for correlational analysis. The same items were presented in both tests, leading to an overestimate of the "true" correlation, so a corrected correlation was made between both forms of ZBI [41].

Based on measurement theory, a scale should demonstrate that all items contribute to the same construct, and has monotonically increasing steps. All these properties can be illustrated by the Rasch model. The following approach was conducted for analysis.

### *Correlation analysis*

We tested the ZBI against the EQ5D subscale, hypothesizing that ZBI should relate more to anxiety/depression than mobility. We expected to find a correlation between ZBI and PSS and PHQ-9 to demonstrate concurrent validity.

### *Rasch analysis*

The Rasch model belongs to the item-response latent trait models, a probabilistic logistic model that predicts that the response to a particular item is influenced by the quality of both person and item. More details can be found elsewhere [42]. The partial credit Rasch model was used [43], with the following criteria. First, unidimensionality and local independence, which were evaluated by a) the first principal component of the residuals (or first contrast) should have an eigen value less than 2, b) disattenuated correlation >0.7 and c) item fit statistics (INFIT and OUTFIT mean-square) indicating the consistency of each item to the other items, should be .70 and 1.30 [44]. To evaluate local independency, a standardized residual correlation should be less than 0.3 [45]. Second, response category functioning and ordered

categories and thresholds are expected for measurement [46]. Third, a reliability coefficient of 0.80 or higher and of 0.90 or higher are considered acceptable for person reliability and item reliability, respectively.

### *CFA*

To test how data were well modeled with the unidimensional construct, CFA was performed for both ZBI-22 and ZBI-12. The Weighted Least Square Mean and Variance corrected method of estimation was used for the nonnormality and ordinal types of items. Assessment model fit used Chi-square ( $p > .05$ ), comparative fit index and Tucker Lewis Index, where values 0.95 or higher are preferable [47]. Root mean square error of approximation value  $<0.08$  was indicative of an acceptable model fit [48].

### *Computer software*

For CFA, Mplus, Version 8.4 was used (Muthén and Muthén 2015). Rasch analysis used Winsteps, Version 4.4.8 (Beaverton, Oregon: Winsteps.com). All other analyses were performed using IBM SPSS, Version 22 (SPSS Inc., Chicago, IL, USA).

## **Results**

The average age of the caregiver sample was 55 years (S.D.= 12.9); most were women (77.5%). According to ZBI level, the sample was reported to have low burden. The quality of life index score was quite high on average, while perceived stress and depressive symptoms were low (Table 1).

For the distribution of the ZBI-items, some had unacceptable kurtosis ( $>\pm 3$ ), which contributed to the high frequency of zero categories on these respective items (Table S1).

Correlation analysis showed that ZBI-22 had a coefficient of 0.855 ( $p<0.01$ ) with ZBI-12 for the uncorrected correlation, and 0.784 ( $p<0.01$ ). Both ZBI-22 and ZBI-21 significantly related to PHQ-9, PSS, the EQ-5D index score, subscale mobility, pain and anxiety/depression, but not to self-care and usual activity indicating convergent and discriminant validity (Table 2).

Rasch analysis results showed that the unexplained variance in the first contrast yielded eigen values of 2.52 and 3.03, implying a possible second dimension. However, based on disattenuated correlation between person measure  $>0.7$ , the second dimension could noise for ZBI-22. Five items of ZBI-22, and two items of ZBI-12 were shown to be misfitted. Five pairs of items from ZBI-22 and three pairs of items from ZBI-12 had standardized residual correlations above 0.2, indicating item dependency of both forms of ZBI. For category function, 33 to 50% of items were found to be disordered category or threshold (Table 3). For this reason, the four original rating categories were combined in different ways until the criteria were best met. This was obtained by rescaling as follows: 0 = 0; 1 = 1; 2 = 2; 3 = 3 and 4 = 3 for ZBI-22, and 0 = 0; 1 = 1; 2 = 2; 3 = 2 and 4 = 3 for ZBI-12. After rescaling, the data fit better with Rasch model as the misfitting items reduced while reliability increased. All reliability values were shown to be in an acceptable range.

The CFA showed that the unidimensional model did not fit with the data for both versions of ZBI. Three-factor model provided the best-fitted statistics for ZBI-22, while the four-factor model with the correlated error terms of items 11 and item 12, provided the best-fitted statistics for ZBI-12 (Table S2).

## Discussion

The present study aimed to evaluate the psychometric properties of the Thai version of the ZBI among caregivers of patients with Alzheimer's disease. Consistent with related studies, both ZBI-22 and ZBI-12 did not demonstrate a unidimensional scale [49, 50], even though the ZBI-22 seemed to be favored over ZBI-12. Three-factor and four-factor fitted the data the best for ZBI-22 and ZBI-12, respectively. However, the disattenuated correlation ( $>0.70$ ) in ZBI-22 suggested that it could be sufficiently unidimensional, but not for ZBI-12.

Pairs of error variances to be correlated suggested by CFA corresponded to local dependence by Rasch analysis. This was consistent with Ballesteros et al.'s study [30] in that both items, "should do more" and "could do a better job caring" were excluded from the new 12-item ZBI. In addition to these two items, more pairs were shown to be locally dependent. Violations of local independence in a unidimensional scale can lead to inflated estimates of reliability, providing a false impression of the accuracy and precision of estimates[51].

Disordered categories and thresholds indicated that respondents had difficulty discriminating between response categories given their level of caregiver burden. In ZBI-22, the response categories were collapsed from five to four categories and by that category 3 (quite frequently) and 4 (nearly always) were collapsed together. Oddly, for ZBI-12, collapsing category 2 (sometimes) and 3 (quite frequently) yielded better results. It remains unclear why the participants responded differently to the same items of different scales.

Suggestions from our findings are twofold if interpretation of mean scores, or changes in total scores is to be meaningful, First, is to revise or remove the locally dependent and misfitting items 11 and 12 of ZBI-12 to make it better unidimensional scale. Second, is to look for the fitted items with ordered category and threshold from ZBI-22 to form a new short ZBI.

Taken together, the Thai version of ZBI-12 may not be regarded as unidimensional, an interval rating scale of burden among caregivers to patients with Alzheimer's disease. The ZBI-22 showed sufficient unidimensionality. Some items were suggested to be removed if ZBI-12 is to be used.

## Limitations and future study

Clinicians should interpret the results in light of the limitation in sample size. Replication in a larger sample size should be encouraged. Test-retest reliability, sensitivity to change and equivalence test in different populations and cultures should be warranted.

# Abbreviations

ZBI	Zarit Burden Interview
CFA	Confirmatory Factor Analysis
PCA	Principal Component Analysis
RMSEA	Root Mean Square Error of Approximation
CFI	Comparative Fit Index
TLI	Tucker Lewis Index
WLSMV	Weighted Least Square Mean and Variance Corrected

# Declarations

## Ethics approval and consent to participate

This study was approved by the research ethics committee of the Faculty of Medicine, Chiang Mai University (PSY-2560-05110). All patients provided written informed consent to the study,

## Consent for publication

Consent for publication is not applicable.

## Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Competing interests

The authors declare that they have no competing interests.

## Funding

This research was supported by the Research Medical Fund, Grant Number 066-2561, Faculty of Medicine, Chiang Mai University.

## Authors' contributions

KP, MP, NW, TW, and AS participated in the concept and design of the study. KP granted permission of ZBI. MP, KP and AS collected data. NW and TW performed the statistical analyses. KP, NW, TW and PK drafted and edited the manuscript. All authors made substantial contributions to interpret data and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

## Acknowledgements

The authors wish to thank all the patients and caregivers for their participation and encouragement for us to do this research.

## References

1. Sherman CW, Burgio LD, Kowalkowski JD: **Chapter 10 - Assessment of Dementia Family Caregivers.** In *Handbook of Assessment in Clinical Gerontology (Second Edition)*. Edited by Lichtenberg PA. San Diego: Academic Press; 2008: 243-271
2. Alfakhri AS, Alshudukhi AW, Alqahtani AA, Alhumaid AM, Alhathlol OA, Almojali AI, Alotaibi MA, Alaqeel MK: **Depression Among Caregivers of Patients With Dementia.** *Inquiry* 2018, **55**:46958017750432.
3. Schulz R, McGinnis KA, Zhang S, Martire LM, Hebert RS, Beach SR, Zdaniuk B, Czaja SJ, Belle SH: **Dementia Patient Suffering and Caregiver Depression.** *Alzheimer disease and associated disorders* 2008, **22**:170-176.
4. Covinsky KE, Newcomer R, Fox P, Wood J, Sands L, Dane K, Yaffe K: **Patient and caregiver characteristics associated with depression in caregivers of patients with dementia.** *J Gen Intern Med* 2003, **18**:1006-1014.
5. Ostojic D, Vidovic D, Bacekovic A, Brecic P, Jukic V: **Prevalence of anxiety and depression in caregivers of Alzheimer's dementia patients.** *Acta Clin Croat* 2014, **53**:17-21.
6. del-Pino-Casado R, Rodríguez Cardoso M, López-Martínez C, Orgeta V: **The association between subjective caregiver burden and depressive symptoms in carers of older relatives: A systematic review and meta-analysis.** *PLOS ONE* 2019, **14**:e0217648.
7. Kuzuya M, Enoki H, Hasegawa J, Izawa S, Hirakawa Y, Shimokata H, Akihisa I: **Impact of caregiver burden on adverse health outcomes in community-dwelling dependent older care recipients.** *Am J*



*Geriatr Psychiatry* 2011, **19**:382-391.

8. Phetsitong R, Vapattanawong P, Sunpuwan M, Volker M: **State of household need for caregivers and determinants of psychological burden among caregivers of older people in Thailand: An analysis from national surveys on older persons.** *PLoS One* 2019, **14**:e0226330.
9. Chaobankrang C, Anothaisintawee T, Kittichai K, Boongird C: **Predictors of Depression among Thai Family Caregivers of Dementia Patients in Primary Care.** *Int J Gerontol Geriatr Res* 2019, **3**:007-013.
10. Sittironnarit G: **Quality of life and subjective burden of primary dementia caregivers in Bangkok, Thailand.** *Asian Journal of Psychiatry* 2020, **48**:101913.
11. Zarit SH, Todd PA, Zarit JM: **Subjective burden of husbands and wives as caregivers: a longitudinal study.** *Gerontologist* 1986, **26**:260-266.
12. Zarit SH: **Diagnosis and management of caregiver burden in dementia.** *Handb Clin Neurol* 2008, **89**:101-106.
13. **Zarit Burden Interview (ZBI)** [<http://mapi-trust.org/>]
14. Yu Y, Liu Z-w, Zhou W, Chen X-c, Zhang X-y, Hu M, Xiao S-y: **Assessment of Burden Among Family Caregivers of Schizophrenia: Psychometric Testing for Short-Form Zarit Burden Interviews.** *Frontiers in Psychology* 2018, **9**.
15. Bédard M, Molloy DW, Squire L, Dubois S, Lever JA, O'Donnell M: **The Zarit Burden Interview: a new short version and screening version.** *Gerontologist* 2001, **41**:652-657.
16. Grato ACM, Brigola AG, Ottaviani AC, Luchesi BM, Souza É, Rossetti ES, de Oliveira NA, Terassi M, Pavarini SCI: **Brief version of Zarit Burden Interview (ZBI) for burden assessment in older caregivers.** *Dement Neuropsychol* 2019, **13**:122-129.
17. Chattat R, Cortesi V, Izzicupo F, Del Re ML, Sgarbi C, Fabbo A, Bergonzini E: **The Italian version of the Zarit Burden interview: a validation study.** *Int Psychogeriatr* 2011, **23**:797-805.
18. Goncalves-Pereira M, Zarit SH: **The Zarit Burden Interview in Portugal: Validity and recommendations in dementia and palliative care.** *Acta Med Port* 2014, **27**:163-165.
19. Iecovich E: **Psychometric properties of the Hebrew version of the Zarit Caregiver Burden Scale short version.** *Aging Ment Health* 2012, **16**:254-263.
20. Lu L, Wang L, Yang X, Feng Q: **Zarit Caregiver Burden Interview: development, reliability and validity of the Chinese version.** *Psychiatry Clin Neurosci* 2009, **63**:730-734.
21. Ojifinni OO, Uchendu OC: **Validation and Reliability of the 12-item Zarit Burden Interview among Informal Caregivers of Elderly Persons in Nigeria.** *Arch Basic Appl Med* 2018, **6**:45-49.
22. Ozer N, Yurttaş A, Akyil R: **Psychometric evaluation of the Turkish version of the Zarit Burden Interview in family caregivers of inpatients in medical and surgical clinics.** *J Transcult Nurs* 2012, **23**:65-71.
23. Seng BK, Luo N, Ng WY, Lim J, Chionh HL, Goh J, Yap P: **Validity and reliability of the Zarit Burden Interview in assessing caregiving burden.** *Ann Acad Med Singapore* 2010, **39**:758-763.

24. Tang JY, Ho AH, Luo H, Wong GH, Lau BH, Lum TY, Cheung KS: **Validating a Cantonese short version of the Zarit Burden Interview (CZBI-Short) for dementia caregivers.** *Aging Ment Health* 2016, **20**:996-1001.
25. Wang G, Cheng Q, Wang Y, Deng YL, Ren RJ, Xu W, Zeng J, Bai L, Chen SD: **The metric properties of Zarit caregiver burden scale: validation study of a Chinese version.** *Alzheimer Dis Assoc Disord* 2008, **22**:321-326.
26. Springate BA, Tremont G: **Dimensions of Caregiver Burden in Dementia: Impact of Demographic, Mood, and Care Recipient Variables.** *Am J Geriatr Psychiatry* 2014, **22**:294-300.
27. Branger C, O'Connell ME, Morgan DG: **Factor Analysis of the 12-Item Zarit Burden Interview in Caregivers of Persons Diagnosed With Dementia.** *J Appl Gerontol* 2016, **35**:489-507.
28. Cheng S-T: **Dementia Caregiver Burden: a Research Update and Critical Analysis.** *Current Psychiatry Reports* 2017, **19**:64.
29. Lin C-Y, Wang J-D, Pai M-C, Ku L-JE: **Measuring burden in dementia caregivers: Confirmatory factor analysis for short forms of the Zarit Burden Interview.** *Archives of Gerontology and Geriatrics* 2017, **68**:8-13.
30. Ballesteros J, Santos B, González-Fraile E, Muñoz-Hermoso P, Domínguez-Panchón AI, Martín-Carrasco M: **Unidimensional 12-Item Zarit Caregiver Burden Interview for the Assessment of Dementia Caregivers' Burden Obtained by Item Response Theory.** *Value in Health* 2012, **15**:1141-1147.
31. Silpakit O, Silpakit C, Chomchuen R: **Psychometric study of the Thai version of Zarit Burden Interview in psychiatric caregivers.** *Journal of Mental Health of Thailand* 2015, **23**:12-24.
32. Zarit SH, Reever KE, Bach-Peterson J: **Relatives of the impaired elderly: correlates of feelings of burden.** *Gerontologist* 1980, **20**:649-655.
33. Ko K-T, Yip P-K, Liu S-I, Huang C-R: **Chinese Version of the Zarit Caregiver Burden Interview: A Validation Study.** *The American Journal of Geriatric Psychiatry* 2008, **16**:513-518.
34. Cohen S, Kamarck T, Mermelstein R: **A global measure of perceived stress.** *Journal of Health and Social Behavior* 1983, **24**:385-396.
35. Wongpakaran N, Wongpakaran T: **The Thai version of the PSS-10: An Investigation of its psychometric properties.** *Biopsychosoc Med* 2010, **4**:6.
36. Kroenke K, Spitzer RL, Williams JB: **The PHQ-9: validity of a brief depression severity measure.** *J Gen Intern Med* 2001, **16**:606-613.
37. Lotrakul M, Sumrithe S, Saipanish R: **Reliability and validity of the Thai version of the PHQ-9.** *BMC Psychiatry* 2008, **8**:46.
38. The EuroQol Group: **EuroQol—a new facility for the measurement of health-related quality of life.** *Health Policy* 1990, **16**:199-208.
39. Tongsiri S, Cairns J: **Estimating population-based values for EQ-5D health states in Thailand.** *Value Health* 2011, **14**:1142-1145.

40. Li L, Liu C, Cai X, Yu H, Zeng X, Sui M, Zheng E, Li Y, Xu J, Zhou J, Huang W: **Validity and reliability of the EQ-5D-5 L in family caregivers of leukemia patients.** *BMC Cancer* 2019, **19**:522.

41. Levy P: **The correction for spurious correlation in the evaluation of short-form tests.** *Journal of Clinical Psychology* 1967, **23**:84-86.

42. Tennant A, Conaghan PG: **The Rasch measurement model in rheumatology: what is it and why use it? When should it be applied, and what should one look for in a Rasch paper?** *Arthritis Care Res* 2007, **57**.

43. Masters GN: **A Rasch model for partial credit scoring.** *Psychometrika* 1982, **47**:149-174.

44. Wright BD, Linacre JM: **Reasonable mean-square fit values.** *Rasch Measurement Transactions* 1994:370-371.

45. Christensen KB, Makransky G, Horton M: **Critical Values for Yen's Q(3): Identification of Local Dependence in the Rasch Model Using Residual Correlations.** *Applied psychological measurement* 2017, **41**:178-194.

46. Andrich D: **An Expanded Derivation of the Threshold Structure of the Polytomous Rasch Model That Dispers Any "Threshold Disorder Controversy".** *Educational and Psychological Measurement* 2012, **73**:78-124.

47. Hu LT, Bentler PM: **Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives.** *Structural Equation Modeling* 1999, **6**.

48. Browne MW, Cudeck R: **Alternative Ways of Assessing Model Fit.** *Sociological Methods & Research* 1992, **21**:230-258.

49. Landfeldt E, Mayhew A, Straub V, Bushby K, Lochmüller H, Lindgren P: **Psychometric properties of the Zarit Caregiver Burden Interview administered to caregivers to patients with Duchenne muscular dystrophy: a Rasch analysis.** *Disability and Rehabilitation* 2019, **41**:966-973.

50. Siegert RJ, Jackson DM, Tennant A, Turner-Stokes L: **Factor analysis and Rasch analysis of the Zarit Burden Interview for acquired brain injury carer research.** *J Rehabil Med* 2010, **42**:302-309.

51. Marais I, Andrich D: **Effects of varying magnitude and patterns of response dependence in the unidimensional Rasch model.** *J Appl Meas* 2008, **9**:105-124.

## Tables

**Table 1:** Demographic characteristics of participants

Demographic characteristics	Number (%) or Mean (S.D.)
Age (year) – Mean (S.D.)	55.0 (12.9)
Sex, female	79 (77.5)
Years of education	13.8 (4.6)
Relationship to the patient	
- Spouse	21 (20.6)
- Parents	1 (1.0)
- Offspring	70 (68.6)
- Relatives	5 (4.9)
- Nonrelated (hired caregiver)	5 (4.9)
Length of caregiving, median, IQR, min-max (years)	3, 5, (0.3-50.0)
Number of hours per day	15.4 (8.1)
Number of days per week	6.3 (1.4)
Having physical illness	53 (52.0)
Having mental problems	8 (7.8)
<b>Clinical data</b>	
ZBI-22	18.4 (14.3)
ZBI-12	10.6 (7.49)
EQ-5D	0.88 (0.15)
- Mobility	1.47 (0.83)
- Self-care	1.17 (0.69)
- Usual activities	1.32 (0.77)
- Pain/ discomfort	1.90 (0.79)
- Anxiety/ depression	1.63 (0.80)
PSS	14.6 (4.95)
PHQ-9	4.11 (3.96)
S.D. = standard deviation, IQR = interquartile range, ZBI = Zarit Burden Interview, PHQ-9 = Patient Health Questionnaire -9, PSS = Perceived stress scale	

**Table 2.** Zero correlation between variables

	1	2	3	4	5	6	7	8	9	10
1.ZBI-12	1	0.855**	0.281**	0.001	0.153	0.377**	0.466**	-0.366**	0.540**	0.452**
2.ZBI-22		1	0.289**	0.036	0.120	0.364**	0.418**	-0.356**	0.510**	0.366**
3.EQ-5D: mobility			1	0.341**	0.481**	0.451**	0.240*	-0.738**	0.356**	0.122
4.EQ-5D: self-care				1	0.534**	0.127	0.118	-0.644**	0.273**	0.109
5.EQ-5D: usual activities					1	0.291**	0.380**	-0.778**	0.473**	0.223*
6.EQ-5D: pain/discomfort						1	0.488**	-0.623**	0.426**	0.166
7.EQ-5D: anxiety/depression							1	-0.617**	0.590**	0.379**
8.EQ-5D Utility index								1	-0.623**	-0.298**
9.PHQ-9									1	0.392**
10. PSS										1

ZBI = Zarit Burden Interview, PHQ-9 = Patient Health Questionnaire -9, PSS = Perceived stress scale

\*p<.05, \*\*p<.01

**Table 3.** Rasch analysis results of the ZBI

ZBI-22					ZBI-12					
Q.	Measure	INFIT	OUTFIT	Disordered category or threshold	No.	Measure	INFIT	OUTFIT	Disordered category or threshold	
		MNSQ	MNSQ				MNSQ	MNSQ		
asks for more help than needs	0.44	1.321	1.453	Yes					No	
not have enough time	0.04	0.912	0.859	No	1	-0.19	0.903	0.897	No	
feel stressed	-0.03	0.697	0.614	Yes	2	-0.65	0.905	0.865	No	
feel embarrassed	0.14	1.120	1.099	Yes						
feel angry	0.13	0.891	0.932	No	3	0.40	0.978	1.014	No	
negative relationships	0.37	0.941	0.956	Yes	4	0.67	1.129	0.855	Yes	
afraid about the future	-0.64	1.082	1.134	No						
dependent on you	-0.92	1.258	1.334	Yes						
feel strained	0.23	0.760	0.655	No	5	0.33	0.818	0.781	Yes	
health decreased	0.31	0.646	0.795	No	6	0.40	0.806	1.083	No	
lack of privacy	-0.04	0.616	0.730	No	7	0.11	0.893	1.062	No	
lack of social life	0.19	0.675	0.639	No	8	0.32	0.701	0.682	No	
feel uncomfortable	0.38	0.943	1.967	No						
expecting to be cared for	-0.58	1.512	1.612	Yes						
lack of money	0.12	1.355	1.399	No						
unable to care much longer	0.72	0.789	0.777	Yes						
lost control of life	0.60	0.844	0.737	Yes	9	0.35	0.918	0.796	Yes	
leave the care	0.40	1.423	1.358	Yes						
uncertain about what to do	0.14	0.795	0.704	Yes	10	0.40	1.035	1.029	Yes	
should do more	-0.71	1.264	1.256	No	11	-1.08	1.406	1.339	No	
could do a better job caring	-0.80	1.383	1.367	No	12	-1.06	1.449	1.317	No	
Overall feeling of burden	-0.50	0.912	0.973	Yes						
PCA		ZBI-22					ZBI-12			
variance explained by measures		46.0 %					48.7 %			
unexplained variance in test contrast		2.52 (6.2%)					3.03 (12.6%)			
isattenuated correlation		0.896 - 1.000					0.357 - 1.000			
pair of item that standardized residual correlation> 0.2	#20(should do more) - #21(should do more)					#11(should do more) - #12(should do more)				
	#11(lack of privacy) - #12(lack of social life)					#3(feel angry) - #5(feel strained)				
	#1(asks for more help than needs) - #18(leave the care)					#8(lack of privacy) - #9(lack of social life)				
	#15(lack of money) - #16(unable to care much longer)									
	#5(feel angry) - #9(feel strained)									
item separation/ reliability		2.57 / 0.87					2.03 / 0.80			
person separation/ reliability		4.08 / 0.94					3.97 / 0.94			

ZBI = Zarit Burden Interview, PCA = Principal component analysis, INFIT = inlier-pattern-sensitive fit statistic, OUTFIT= outlier

nsitive fit statistic, MNSQ= mean-square, # = item number

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [TableS1Descriptivedataofthefull.docx](#)
- [TableS2CFAResults.docx](#)