

# Investigating Psychometric Properties of the Thai Version of Zarit Burden Interview using Rasch Model

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## Research note

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# Abstract

**Objective:** The Zarit Burden Interview (ZBI) has been widely used to assess caregiver's burden. Research investigating the Thai version of the ZBI is few. The study aimed to examine the psychometric properties of both the full length (ZBI-22) and short versions (ZBI-12) using Rasch 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 two items from ZBI-12 were shown to be misfitting items. The model of ZBI-12 was improved when item "should do more" and "could do a better job caring" were removed. Reliability was good for both forms of the ZBI ( $\alpha = 0.86 - 0.92$ ). Significant correlations were found with caregiver's perceived stress and caregiver's depression. Significant correlation with subscales of anxiety/depression, pain and mobility were indicative of discriminant validity but not with self-care and usual activity ( $p > 0.05$ ). To conclude, the Thai version ZBI was supported for the reliability and validity in both the full length and 12 short forms among Alzheimer's disease caregivers; however, some misfitting items of the ZBI undermined the unidimensionality of the scale, and need revision.

## Introduction

Feeling burden is stressor-related and varies from one to another. Studies showed that burden can ultimately lead to depression [1]. Caregiving especially for elderly with dementia usually causes burden among caregivers, so identifying feeling of burden to have early as possible intervention is important.

One of the oldest and most common measurements to assess caregiving burden is the Zarit Burden Interview (ZBI)[2, 3]. It currently has two forms, a long form, consisting of 22 items, and a short form. The short version of the ZBI, consisting of 12-items, was introduced by Be'dard et al. in 2001[4] and shown to have good psychometric properties in various languages and cultures [5–13]. Mostly, the ZBI was examined through classic test theory, e.g., factor analysis, to explore its factor structure. Recently, the ZBI was tested using item response theory, yielding a different set of items for the short scale as compared with the former 12-item ZBI [14].

Thailand is a becoming ageing society, so burden of the caregivers is important and associated with mental health problems. To quantify the level of burden would allow caregivers an opportunity to be helped in a timely fashion. Thus, the ZBI is one vital tool to gauge the level of burden as it shows good psychometric properties. However, the ZBI has never been tested for psychometric property in a Thai population using Rasch measurement model. We aimed to examine its construct by means of convergent, discriminant and concurrent validity, using both Rasch analysis and confirmatory factor analysis.

## Methods

### Population

Maharaj Nakorn Chiang Mai Hospital, participated in the study. All gave written informed consent before completing the questionnaires. Sociodemographic data and records related to caregiving were obtained in addition to specific measurement.

## Measurement

### ZBI

The ZBI is a caregiver-reported questionnaire measuring the burden the respondent feels in providing caregiving to the patient. Currently, it has two forms, long (22 items) and short (12 items), with a Likert scoring scale between 0 (never) and 4 (nearly always). The ZBI offers the interpretation of score as follows; 0 to 20, little or no burden, 21 to 40, mild to moderate burden, 41 to 60, moderate to severe burden and 61 to 80, severe burden[4, 15].

The Thai version of the ZBI was allowed to be used for the present study by Professor Zarit and Mapi Research Trust[16]. The study sample showed a Cronbach's alpha of .921 for the full-length version, and .865 for the short version.

### Perceived stress scale (PSS)

The PSS is a self-reporting, 10-item questionnaire measuring the extent to which individuals perceived stress [17]. The 4-response Likert scale, ranges from 0 (not at all) to 4 (the most); the total scores ranges from 0 to 40 and the higher the score, the higher the level of feeling stress.

The Thai version showed good psychometric properties [18]. The study sample showed a Cronbach's alpha of .850.

### Patient Health Questionnaire (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 [19]. The 4-response Likert scale ranges

from 0 (not at all) to 3 (nearly every day); the total scores ranges from 0 to 27 and the higher the score, the higher the level of feeling depression. The Thai version showed good psychometric properties [20]. The study sample showed a Cronbach's alpha of .849.

## EQ-5D

The EQ5D is a self-reporting questionnaire measuring health-related quality of life [21]. It comprises a 5-item questionnaire assessing 5 domains of health state: mobility, self-care, usual activities, pain and anxiety/depression, with a 5-response type ranging from 1 (no problem) to 5 (severe problem). All 5 aspects were calculated to an index score, with the maximum of 1.000, the higher the score, the better the quality of life. The utility values for EQ-5D health states were estimated from the Thai general population [22]. The study sample showed a Cronbach's alpha was .723.

## ***Statistical Analysis***

Sociodemographic data was analyzed using descriptive statistics. Pearson or Spearman rank was used for correlational analysis. The same items are present in both tests, leading to an overestimate of the "true" correlation, so a corrected correlation was made between the full length and short forms ZBI[23].

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.

## **Rasch analysis**

The Rasch model belongs to the item-response latent trait models, probabilistic logistic model that predicts that the response to a particular item is influenced by the quality of both person and item. To

investigate the ZBI data, the partial credit Rasch model was used [24], with the following criteria. First, unidimensionality and local independence, which were evaluated by a) the first principal component of the residuals (PCA) (or first contrast) should have an eigen value less than 2, b) disattenuated correlation > 0.7, and c) item fit statistics (inlier-pattern-sensitive-INFIT, outlier-sensitive fit -OUTFIT mean-square) indicating the consistency of each item to the other items, should be .70 and 1.30 [25]. To evaluate local independency, an inter-item residual correlation should be less than 0.3 [26]. Second, response category functioning and ordered categories and thresholds are expected for measurement. [27, 28]. Third, for reliability, a reliability coefficient of 0.80 or higher and of 0.90 or higher are considered acceptable for person reliability and item reliability, respectively.

### **Convergent, discriminant and concurrent validity**

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

### **Confirmatory factor analysis (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 (WLSMV) method of estimation was used for the nonnormality and ordinal types of items. Assessment model fit used Chi-square ( $p > .05$ ), comparative fit index (CFI) and Tucker Lewis Index (TLI), where values 0.95 or higher are preferable [29]. Root mean square error of approximation (RMSEA) was also performed. A RMSEA value <0.08 was indicative of an acceptable model fit [30]. Internal consistency was determined using Cronbach's alpha.

For CFA, Mplus, Version 8.4 was used (Muthén and Muthén 2015). All the 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%), with a high school level of education. The details are shown in Table 1.

According to ZBI level, the sample was reported to have little or no burden (< 21). However, nearly 10% felt they had moderate to severe burden. The quality of life index score was quite high on average (0.88), while perceived stress and depressive symptoms were low (Table 1).

Correlation analysis showed that ZBI-22 had a coefficient of 0.855 with ZBI-12 for the uncorrected correlation, and 0.784 for correlation when error variance due to sharing items was corrected. Both forms

of ZBI significantly related to the EQ5D index score, PHQ-9 and PSS. For the EQ5D subscale, ZBI significantly related to subscale mobility, pain and anxiety/depression, but not with self-care and usual activity (Table 2).

For the distribution of the ZBI-items. Items 10, 13, 16, 17 and 18 for ZBI-22 and items 4, 6, 8 and 9 for ZBI-12 had unacceptable kurtosis ( $>\pm 3$ ). The kurtosis contributed to the high frequency of zero categories on these respective items (Table S1).

Rasch analysis of the ZBI showed that PCA of the residual yielded 46% variance, explained by measure for ZBI-22, and 48.7% by ZBI-12. The unexplained variance in the first contrast yielded eigen values of 2.52 and 3.03, indicating that 2 to 3 items formed another dimension, i.e., items 20 (should do more) and 21 (could do a better job caring) for ZBI-22, likewise for ZBI-12. However, based on disattenuated correlation between person measure, ZBI-22 was shown to be more unidimensional than ZBI-12 (all coefficients  $> 0.7$ ). Items 1, 14, 15, 18 and 21 for ZBI-22, and items 11 and 12 of ZBI-12 were shown to be misfitting items. In addition, 3 pairs of items from ZBI-22 and two pairs of items from ZBI-12 had standardized residual correlations above 0.3, indicating item dependency of both forms of ZBI (data not shown). Item and person separation and reliability were shown to be in an acceptable range. For category function, one-half of ZBI-22 and 4 of 12 of ZBI-12 were found to be disordered category or threshold. From all, three was common between ZBI-22 and ZBI-12 (Table 3).

## CFA

The CFA showed that the unidimensional model did not fit with the ZBI-22 (Chi-square of 448.483,  $df = 209$ ,  $p < 0.001$ , RMSEA = 0.108, CFI = 0.918 and TLI = 0.909). The model fit was better when error of item 20 and 21 was correlated (Chi-square = 318.167,  $df = 208$ ,  $p < .001$ , RMSEA = 0.073, CFI = 0.962 and TLI = 0.958).

The same was found with the ZBI-12 (Chi-square = 466.433,  $df = 54$ ,  $p < 0.001$ , RMSEA = 0.278, CFI = 0.850, and TLI = 0.816). The model fit was better when error of items 11 and 12 were correlated (Chi-square = 132.591,  $df = 53$ ,  $p < .001$ , RMSEA = 0.123, CFI = 0.971, and TLI was 0.964).

## Discussion

The present study aimed to evaluate the psychometric properties of the full length and short form of the Thai version of the ZBI among caregivers of the patients with Alzheimer's disease. In general, both forms of ZBI demonstrated a valid and reliable scale.

According to Rasch analysis and CFA, both ZBI-22 and ZBI-12 did not; however, demonstrate a unidimensional scale as expected using the measurement model, even though the ZBI-22 seemed to be

favorable over ZBI-12.

Both Rasch analysis and CFA identified items 11 (should do more) and 12 (could do a better job caring) as problematic for the scale. In addition to these two items, CFA suggested more pairs of error variances to be correlated to make the model an acceptable fit for ZBI-12. These included items 5 (feel strained) vs. 3 (feel angry); 8 (lack of social life) vs. 7 (lack of privacy) and 8 (lack of social life) vs. 9 (lost control of life). This was indicative of item dependence, which was usually ignored in CFA, but unacceptable by the measurement model according to the Rasch model.

The fact that disattenuated correlation ( $>0.70$ ) in ZBI-22 indicated that it could be sufficient unidimensional, another real dimension did not exist. Our results showed that all acceptable items of ZBI-22 were embedded in ZBI-12. Hence, the ZBI-12, except for items 11 and 12, looked promising. Disordered category and threshold; however, indicated that the response might need to be collapsed to improve measurement ability.

Our results were consistent with Ballesteros et al. [14] using the same item response theory; items 11 (should do more) and 12 (could do a better job caring) were excluded from the new 12-item ZBI.

This was interesting because it might go against the investigators' intention to make the scale shorter for practical use while maintaining acceptable unidimensionality, or else the notion to use the ZBI-12 by sum or total score would be unjustified. From these findings, ZBI-10 (excluding items 11 and 12) could be promising for the short ZBI rather than the ZBI-12 version by Bedard et al. [4].

In conclusion, the Thai version of ZBI showed adequate psychometric properties to measure burden among caregivers of patient with Alzheimer's disease. The ZBI-12, despite being shorter, showed less unidimensionality than the original ZBI-22, and some items were suggested to be removed.

## Limitations and future study

Replication in a larger sample size should be encouraged. Some other tests such as test-retest reliability, sensitivity to change and equivalence test in different populations as well as in different 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.

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### 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.

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## 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				
o.	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 me	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
0 health decreased	0.31	0.646	0.795	No	6	0.40	0.806	1.083	No
1 lack of privacy	-0.04	0.616	0.730	No	7	0.11	0.893	1.062	No
2 lack of social life	0.19	0.675	0.639	No	8	0.32	0.701	0.682	No
3 feel uncomfortable	0.38	0.943	1.967	No					
4 expecting to be cared for	-0.58	1.512	1.612	Yes					
5 lack of money	0.12	1.355	1.399	No					
6 unable to care much longer	0.72	0.789	0.777	Yes					
7 lost control of life	0.60	0.844	0.737	Yes	9	0.35	0.918	0.796	Yes
8 leave the care	0.40	1.423	1.358	Yes					
9 uncertain about what to do	0.14	0.795	0.704	Yes	10	0.40	1.035	1.029	Yes
0 should do more	-0.71	1.264	1.256	No	11	-1.08	1.406	1.339	No
1 could do a better job caring	-0.80	1.383	1.367	No	12	-1.06	1.449	1.317	No
2 Overall feeling of burden	-0.50	0.912	0.973	Yes					
CA	ZBI-22					ZBI-12			
variance explained by measures	46.0 %					48.7 %			
unexplained variance in first contrast	2.52 (6.2%)					3.03 (12.6%)			
isattenuated correlation	0.896 - 1.000					0.357 - 1.000			
tandardized residual correlation	0.24 - 0.68					0.23 - 0.77			
em separation/ reliability	2.57 / 0.87					2.03 / 0.80			
erson separation/ reliability	4.08 / 0.94					3.97 / 0.94			

BI = Zarit Burden Interview, PCA = Principal component analysis, INFIT = inlier-pattern-sensitive fit statistic, OUTFIT= outlier-sensitive fit statistic, MNSQ= mean-square

