



# Cutoff of the Zarit Burden Interview in predicting depression and anxiety

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## Abstract

**Background** The purpose of the present study was to determine a statistically valid cutoff score for the Zarit Burden Interview (ZBI) in order to identify family caregivers at risk for depression and anxiety to guide for further assessment and future intervention.

**Methods** The ZBI, the Patient Health Questionnaire (PHQ), and the Generalized Anxiety Disorder Scale (GAD) were administered to a representative community sample of 327 family caregivers of schizophrenia individuals. A ZBI cutoff score was determined using three different statistical methods: tree-based modeling, K-means clustering technique and linear regression, followed by contingency analysis and receiver operating characteristic (ROC) curve to compare between depression and anxiety scale scores with the ZBI cutoff.

**Results** Findings suggest that a cutoff score of 48 in ZBI has significant predictive validity for identifying caregivers at risk for both depression and anxiety. A ZBI cutoff of 48 showed sensitivity of 73% for PHQ and 70% for GAD, specificity of 80% for PHQ and 79% for GAD, PPV (positive predictive value) of 75% for PHQ and 73% for GAD, NPV (negative predictive value) of 78% for PHQ and 76% for GAD.

**Conclusions** This cutoff score would enable health care providers to assess family caregivers at risk and provide necessary interventions to improve their quality of life in this important role.

**Keywords** Cutoff · The Zarit Burden Interview (ZBI) · Depression · Anxiety · Schizophrenia

## Abbreviations

ZBI Zarit Burden Interview  
PHQ Patient Health Questionnaire-9  
GAD Generalized Anxiety Disorder Scale-7

CCMD-3 Chinese Classification of Mental Disorders-3  
ICD-10 International Classification of Diseases-10  
ROC Receiver operating characteristic  
AUC Areas under the curves  
PPV Positive predictive values  
NPV Negative predictive values

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## Background

Persons with schizophrenia often require intensive care, and family members overwhelmingly assume the task of caregiving, which imposes a significant burden on caregivers, with negative physical, mental, social and financial impacts, known as ‘caregiver burden’ [1–3]. Moreover, caregivers of persons with schizophrenia are faced with substantial challenges due to the omnipresent social stigma attached to mental illness, which further aggravates their burden [4, 5]. There are various scales for measuring caregiver burden, involving the physical, psychological, and emotional connotations. A recent literature review on tools measuring impact of caregiving has identified 105 scales, such as Family Burden Interview Schedule (FBIS), Burden Assessment Scale (BAS), Caregiver Strain Index (CSI), Screen for Caregiver Burden (SCB), Burden Index of Caregivers (BIC), etc. [6]. Among the various scales used in the research, the Zarit Burden Interview (ZBI) was proposed as the most useful tool for researchers and clinicians due to its user-friendliness, extensive validation, and international use, making comparisons between groups possible [6].

ZBI was originally developed to measure caregiver burden of people with dementia [7]. It has been extensively validated in caregivers of people with neuropsychiatric disorders as a golden standard, and also widely used in schizophrenia research to assess caregiving experiences [8]. As the most widely used measurement of caregiver burden, ZBI has been translated into various languages and validated across countries and cultures, such as Europe, Africa, and Asian countries like China and Japan, allowing for international comparison [9]. A meta-analytic study has proved that the ZBI are reliable across populations of caregivers (i.e., spouses/partners, children, and parents), care-recipients (i.e., AD/dementia, physical illness, and mental illness), and most language versions (e.g., French, Spanish, and Chinese) [10]. In 2006, the ZBI was first translated into Chinese [11, 12] and then widely used as a standard measure for caregiver burden, with satisfactory psychometric properties being reported [13–15].

Decades of international research have established the positive correlation between high burden scores on the ZBI and caregiver’s psychological distress such as depression and anxiety [16, 17], which may result in the caregivers relinquishing their role and patients being institutionalized or left unattended and even homeless. However, to which extent the ZBI scores may constitute risk for caregiver distress remains a key question. Determining a valid cutoff for the ZBI to screen depression and anxiety may facilitate a deeper understanding of the relationship between caregiving role and caregiver distress, thus guiding for

further assessment and future intervention [18]. Only a few studies have explored cutoffs for the ZBI, yet with inconsistent results including 24 for predicting caregiver depression [18], 46 for predicting caregiver collapse [19], and 59 for predicting caregiver psychiatric cases [20]. All these studies were conducted among caregivers of people with dementia or physical diseases, no study ever assessed the cutoff of ZBI in predicting depression and anxiety among caregivers caring for people with mental illness such as schizophrenia, though the ZBI has been widely used among such a population.

In view of the research blank, the present study was conducted to define a valid cutoff score for ZBI to screen for the risk of depression and anxiety among caregivers of schizophrenia individuals.

## Methods

### Participants and procedure

We recruited primary caregivers of schizophrenia through a one-stage cluster-sampling method in Ningxiang County, Hunan Province of China from November 2015 to January 2016. All participants were recruited through the 686 program [21], which is China’s largest demonstration project in mental health service aimed at integrating hospital and community services for serious mental illness. Four towns/townships were firstly randomly selected from Ningxiang County, all communities/villages within each town/township were selected, leading to a total sampling frame of 55 representative communities/villages. In each community/village, one primary family caregiver of every registered person with schizophrenia was enrolled as the target population, leading to a total of 352 primary family caregivers as the final sample.

The inclusion criteria require that care recipients fulfilling the Chinese Classification of Mental Disorders-3 (CCMD-3) or the International Classification of Diseases-10 (ICD-10) criteria for schizophrenia and living in the community with at least one informal caregiver. The primary caregiver must be a family member who is living with the patient and has taken the most responsibility of caring, be  $\geq 16$  years of age, and able to understand and communicate. After excluding 14 participants who refused to participate, 11 withdrawals, our final sample included 327 community-dwelling primary caregivers of schizophrenia. Ethical approval was obtained from the Institutional Review Board of the Xiangya School of Public Health of Central South University. Data were collected using face-to-face interviews with primary caregivers at their home after obtaining written consent for the study. Details of the study enrollment and procedure have been published elsewhere [22].

## Instruments

### Zarit Burden Interview (ZBI-22)

The ZBI-22 [7] consists of 22 items scored in 5-point Likert scale from 0 (never) to 4 (nearly always), except for the final item on global burden, rated from 0 (not at all) to 4 (extremely). The total score ranges from 0 to 88 with higher scores indicating higher burden [15]. In the present study, the Chinese version of ZBI showed acceptable internal consistency with a Cronbach's  $\alpha$  of 0.89.

### Patient Health Questionnaire (PHQ)

The PHQ [23] is one of the most widely used tools for depression screening in non-psychiatric settings. It consists of nine diagnostic symptom criteria based on the diagnosis of Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) major depressive disorder (MDD) [24]. Being short and self-explanatory, the PHQ outperformed many other depression screening scales in addressing both depression severity and diagnosis, with good sensitivity and specificity demonstrated for depressive disorder [25]. Each of the 9 items is rated on a 4-point Likert scale from 0 (not at all) to 3 (nearly every day). The total score ranges from 0 to 27, with a cutoff point of 10 differentiating depression and non-depression [26, 27]. The Chinese version of the PHQ demonstrated good internal consistency in the current study with a Cronbach's  $\alpha$  coefficient of 0.89.

### Generalized Anxiety Disorder Scale (GAD)

The GAD [28] is one of the most widely used tools for anxiety screening in non-psychiatric settings. It consists of seven diagnostic symptom criteria based on the diagnosis of Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) generalized anxiety disorder (GAD) [24]. Being short and self-explanatory, the PHQ outperformed many other anxiety screening scales in addressing both anxiety severity and diagnosis, with good sensitivity and specificity demonstrated for anxiety. Each of the 7 items is rated on a 4-point Likert scale from 0 (not at all) to 3 (nearly every day). The total score ranges from 0 to 21, with a cutoff point of 10 differentiating anxiety and non-anxiety [29]. The Chinese version of the GAD demonstrated good internal consistency in the current study with a Cronbach's  $\alpha$  coefficient of 0.91.

## Data analysis

In order to identify a range of cutoff scores for the ZBI to predict the risk of depression and anxiety, we utilized three different statistical methods: Tree-based modeling, K-means

clustering technique, and linear regression. For Tree-based modeling, we treated the continuous variable FBIS score as input variable and segregated the sample based on ZBI to predict output categorical variable—depression and anxiety, which were assessed using the PHQ and GAD score using 10 as cutoff. K-means clustering is a kind of data clustering techniques to divide cases or variables of a dataset into non-overlapping groups/clusters, based on the characteristics uncovered. Here we classified the sample into high burden and low burden group based on the ZBI score alone to get a cutoff for ZBI. For linear regression, we treated the ZBI score as the dependent outcome variable and predicted its cutoff based on the cutoff values of independent input variable—GAD and PHQ.

In order to examine the predictive validity of the cutoffs proposed by the above-mentioned three methods, we categorized the sample into high and low depression groups (PHQ cutoff set at 10), high and low anxiety groups (GAD cutoff set at 10), which were compared against high and low burden groups using  $2 \times 2$  contingency tables. Based on the contingency tables, the following five indicators will be calculated to determine the optimal cutoff: sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV), and finally Youden index. In the present study, sensitivity refers to the ZBI cutoff's ability to correctly identify depression/anxiety subjects by the PHQ/GAD standard, which can be calculated by: number of true positives/(number of true positives + number of false negatives). Specificity means the ZBI cutoff's ability to correctly identify non-depression/non-anxiety subjects, which can be calculated by: number of true negatives/(number of true negatives + number of false positives). The PPV refers to the proportion of depression/anxiety screened by the scale that are true depression/anxiety, which can be calculated by: number of true positives/(number of true positives + number of false positive). The NPV refers to the proportion of non-depression/non-anxiety screened by the scale that are true non-depression/non-anxiety, which can be calculated by: number of true negatives/(number of true negatives + number of false negatives). The Youden index is a general summary of a diagnostic test, which can be calculated by: specificity + sensitivity - 1, with a higher score representing better screening ability [30].

Next, a receiver operating characteristic (ROC) curve was constructed by plotting sensitivity against 1-specificity, using the PHQ cutoff 10 and GAD cut off 10 as the reference, respectively. Each point of the ROC represented a sensitivity/1-specificity pair corresponding to a particular cutoff value. The areas under the curves (AUC) were calculated using the trapezoidal method to represent the scale's the ability to correctly classify those with and without burden [31]. The closer a ROC plot is to the upper-left corner, the higher the overall accuracy of the test. An AUC value of

no less than 0.8 indicates good discriminative ability of the scale. 95% Confidence intervals of AUCs were computed. A P value below 0.05 was considered as statistically significant. All analyses were carried out using SPSS 17.0 (SPSS Inc., Chicago, IL, USA).

## Results

### Sample characteristics

Table 1 shows descriptive data on the sample. The mean (SD) age of the caregivers was 57.6 (12.5) years, and they have been caring for the persons with schizophrenia for a mean (SD) length of 17.1 (10.8) years. The majority of caregivers were females (53.8%), married (82.3%), and half-employed (47.1%), with primary and below education (59.9%). As regards to caregiver-care recipient relationship,

151 were parents, 113 were spouses, 32 were children, 25 were siblings, and 6 were other relatives. Caregiver burden, depression and anxiety scores were measured as a mean (SD) of 42.6 (19.0) for ZBI, 9.8 (7.3) for PHQ and 9.3 (6.6) for GAD.

### Cutoff values

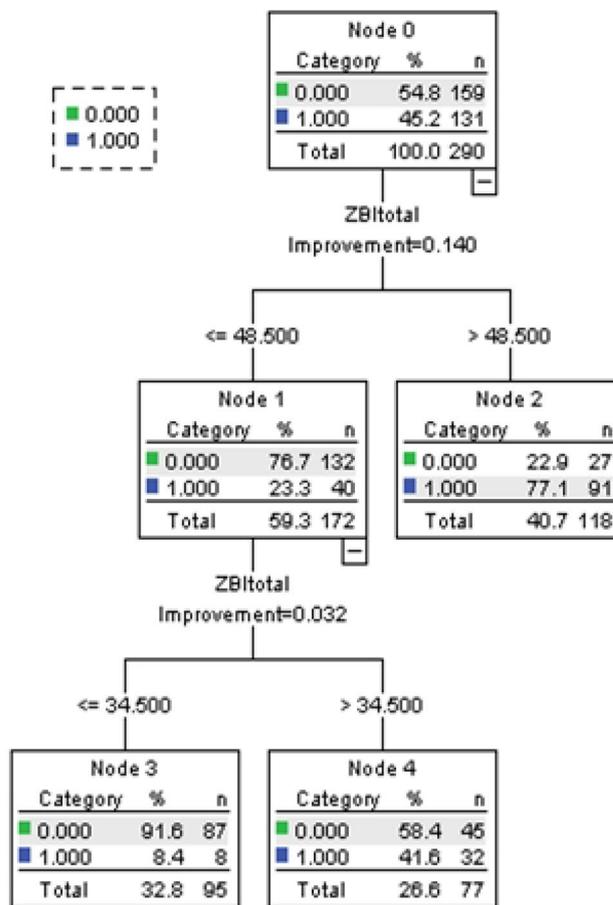
Tree-based modeling generated a basic cutoff score of 48.5 for PHQ (Fig. 1) and 47.5 for GAD (Fig. 2). The K-means clustering assigned a cutoff score of 42 to distinguish between high and low burden. The regression model produced a cutoff score of 43.2 for PHQ (cutoff set at 10) and 43.6 for GAD (cutoff set at 10) (Table 2). Thus, three unique methods confirmed a ZBI cutoff ranging from 42 to 48.5 for predicting depression and anxiety. In an effort to search for an optimal cutoff value, we expanded our cutoff candidates by using 11 different burden cutoffs ranging from 40 to 50.

**Table 1** Sample characteristics (n = 327)

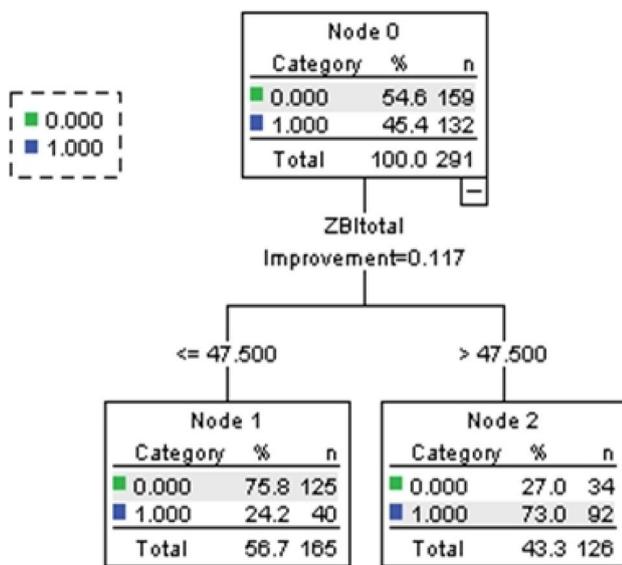
Variables	n (%) / M (SD)
Age	57.6 (12.5)
Gender	
Male	151 (46.2)
Female	176 (53.8)
Marriage	
Married	269 (82.3)
Unmarried <sup>a</sup>	58 (17.7)
Occupation	
Full-employed	19 (5.8)
Half-employed	154 (47.1)
Housewife/husband	97 (29.7)
Retired	23 (7.0)
Unemployed	34 (10.4)
Education	
Primary (primary and below)	196 (59.9)
Middle (middle school)	87 (26.6)
High (high school and above)	44 (13.5)
Kinship	
Parents	151 (46.2)
Spouse	113 (34.6)
Siblings	25 (7.6)
Children	32 (9.8)
Other	6 (1.8)
Length of caring	17.1 (10.8)
ZBI score	42.6 (19.0)
PHQ score	9.8 (7.3)
GAD score	9.3 (6.6)

<sup>a</sup>Unmarried includes single, divorced and widowed

ZBI Zarit Burden Interview, PHQ the 9-item Patient Health Questionnaire, GAD the 7-item Generalized Anxiety Disorder Scale



**Fig. 1** Tree-based modeling for ZBI cutoff by PHQ



**Fig. 2** Tree-based modeling for ZBI cutoff by GAD

**Table 2** Linear regression of burden scores on PHQ/GAD scores

ZBI	Unstandardized coefficients			
	B	SE	t	Sig.
(Constant) <sup>a</sup>	26.77	1.45	18.41	<0.001
PHQ <sup>a</sup>	1.64	0.12	13.67	<0.001
(Constant) <sup>b</sup>	27.81	1.61	17.23	<0.001
GAD <sup>b</sup>	1.58	0.14	11.17	<0.001

Dependent variable: ZBI total burden scores

ZBI Zarit Burden Interview, PHQ the 9-item Patient Health Questionnaire, GAD the 7-item Generalized Anxiety Disorder Scale

<sup>a</sup>Using the PHQ cutoff score of 10 results in a burden score of 43.17 (26.77c + 1.64b × 10 = 43.17)

<sup>b</sup>Using the GAD cutoff score of 10 results in a burden score of 43.61 (27.81c + 1.58b × 10 = 43.61)

### Contingency analysis

Tables 3 and 4 list all the 2 × 2 contingency tables between ZBI cutoffs ranging from 40 to 50 and the PHQ/GAD cutoff scores, respectively. This range of scores was all significant in predicting depression and anxiety, with  $p < 0.001$  for all. The score of 48 on ZBI showed a favorable Youden’s index for both PHQ and GAD, with sensitivity being 73% for PHQ and 70% for GAD, specificity being 80% for PHQ and 79% for GAD, PPV being 75% for PHQ and 73% for GAD, NPV being 78% for PHQ and 76% for GAD. The results indicated that a ZBI cutoff of 48 correctly identified 73% of high burden caregivers as at risk for depression, and 70% of high burden caregivers as at risk for anxiety. It also showed 80% of low burden caregivers at low risk of depression and 79%

of low burden caregivers at low risk of anxiety. Besides, a ZBI cutoff of 48 correctly identifies 75% of true depression caregivers and 73% of true anxiety caregivers, as well as 78% of true non-depression caregivers and 76% of true non-anxiety caregivers. Figures 3 and 4 show the ROC of ZBI using the PHQ cutoff 10 and GAD cutoff 10 as the reference, respectively. The most optimal combination of sensitivity and specificity, as visualized from ROC curves, also corresponds to the conclusion from the contingency tables proposing a cutoff of 48 for both PHQ and GAD as reference. This cutoff was overall successful in differentiating low- and high-burden individuals with AUCs being 0.83 for PHQ and 0.79 for GAD.

### Discussion

To our knowledge, this is the first study to determine a statistically derived cutoff score for ZBI to predict both the risk of depression and anxiety among caregivers of schizophrenia patients in a Chinese rural community. While the importance of the ZBI scale for detecting psychological problems has been reported among the caregivers of patients with dementia [18–20, 32], the present study also provides support for its use among the caregivers of persons with schizophrenia. The results propose a ZBI cutoff score of 48 to identify caregivers potentially at risk of depression and anxiety. The cutoff score had a sensitivity of 73% for depression and 70% for anxiety, which indicated that 73% and 70% of caregivers above the ZBI cutoff were also above the depression cutoff and anxiety cutoff, respectively. The specificity of 80% for depression and 79% for anxiety implied that 80% and 79% of caregivers below the ZBI cutoff were also below the depression cutoff and anxiety cutoff, respectively. The PPV of 75% for PHQ and 73% for GAD indicated that 75% of caregivers above the depression cutoff and 73% of caregivers above the anxiety cutoff were above the ZBI cutoff. The NPV of 78% for PHQ and 76% for GAD meant that 78% of caregivers below the depression cutoff and 76% of caregivers below the anxiety cutoff were below the ZBI cutoff. One implication of the finding is that in occasions such as busy clinical practices, the administration of ZBI alone, rather than a battery of long and time-consuming instruments, may be enough to detect not only caregiver burden, but also potential caregiver depression and anxiety. Another implication is that future intervention programs targeted at alleviating caregiver burden and distress may benefit from using a ZBI cutoff score of 48 as the inclusion criterion to guide for further assessment and intervention.

In this study, the caregiver profile corresponds to a 58-year old, married, half-employed first degree relative (mostly parents or spouses), which is comparable to profiles reported in other studies on caregivers of dementia [18–20].

**Table 3** Contingency analysis of caregivers by depression and burden groups

Cutoff scores	High PHQ	Low PHQ	Total <i>N</i>	Chi square	<i>p</i>	Sensitivity (%)	Specificity (%)	Youden index (%)	PPV (%)	NPV (%)
High burden $\geq 40$	111	59	170	67.162	<0.001	84.73	62.89	47.63	65.29	83.33
Low burden <40	20	100	120							
High burden $\geq 41$	109	57	166	65.812	<0.001	83.21	64.15	47.36	65.66	82.26
Low burden <41	22	102	124							
High burden $\geq 42$	109	51	160	75.922	<0.001	83.21	67.92	51.13	68.13	83.08
Low burden <42	22	108	130							
High burden $\geq 43$	104	49	153	67.986	<0.001	79.39	69.18	48.57	67.97	80.29
Low burden <43	27	110	137							
High burden $\geq 44$	103	46	149	71.005	<0.001	78.63	71.07	49.70	69.13	80.14
Low burden <44	28	113	141							
High burden $\geq 45$	102	43	145	74.195	<0.001	77.86	72.96	50.82	70.34	80.00
Low burden <45	29	116	145							
High burden $\geq 46$	99	39	138	75.03	<0.001	75.57	75.47	51.04	71.74	78.95
Low burden <46	32	120	152							
High burden $\geq 47$	98	36	134	78.639	<0.001	74.81	77.36	52.17	73.13	78.85
Low burden <47	33	123	156							
High burden $\geq 48$	95	32	127	80.099	<0.001	72.52	79.87	52.39	74.80	77.91
Low burden <48	36	127	163							
High burden $\geq 49$	91	27	118	81.982	<0.001	69.47	83.02	52.48	77.12	76.74
Low burden <49	40	132	172							
High burden $\geq 50$	87	25	112	77.849	<0.001	66.41	84.28	50.69	77.68	75.28
Low burden <50	44	134	178							

*PHQ* the 9-item Patient Health Questionnaire, *GAD* the 7-item Generalized Anxiety Disorder Scale, *PPV* positive predictive value, *NPV* negative predictive value

However, the proposed ZBI cutoff score of 48 in the present study was much higher than the reported 24 for predicting caregiver depression in Schreiner et al.'s study [18], which may be related to the different care recipients between the two studies. Compared to caregivers of physical diseases such as stroke patients in Schreiner et al.'s study, caregivers of schizophrenia individuals in the current study may be more tolerant to the caregiving tasks after long-term care and less likely to suffer from psychological distress, leading to a much higher ZBI cutoff score. The cutoff score is much lower than the reported 59 for predicting caregiver psychiatric cases in Martin-Carrasco et al.'s study [20]. The most obvious explanation for this result is the use of rapid screening tool of PHQ and GAD for assessment of depression and anxiety in the current study, instead of much more rigid and standard GHQ-28 for precise measurement of psychiatric disorders in Martin-Carrasco et al.'s study. As a result, it is more likely to detect positive result on PHQ and GAD than GHQ-28 by ZBI scale, leading to a lower cutoff score in the current study. The ZBI cutoff score of 48 for predicting caregiver depression and anxiety in the current study is similar to the reported 46 for predicting caregiver collapse in Gort et al.'s study [19]. The finding may suggest that the

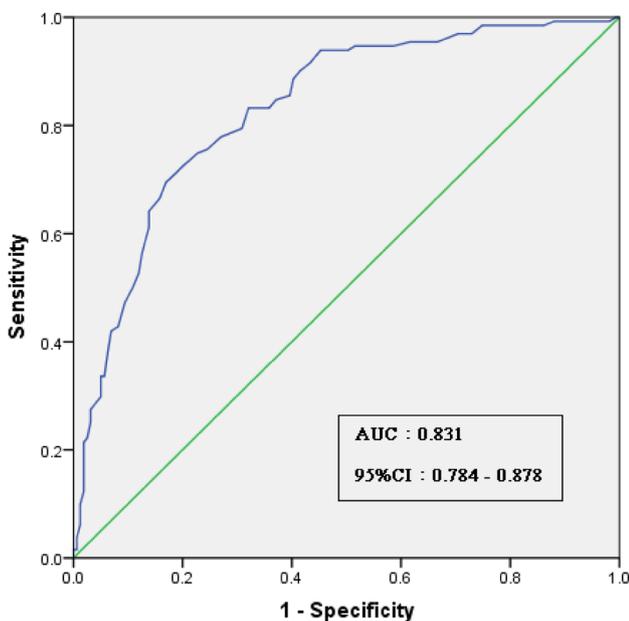
concepts of caregiver depression and anxiety may overlap with the concept of caregiver collapse, which is a much more complex concept with no adequate scales to measure. Our research could add another possibility of assessing caregiver collapse by the use of PHQ and GAD.

Several limitations need to be acknowledged and addressed regarding the current study. First of all, we use brief screening scales such as PHQ and GAD to assess depression and anxiety, instead of standard psychometric scales such as the Beck Depression Inventory (BDI) and the Beck Anxiety Inventory (BAI), or the Hamilton Rating Scale for Depression (HRSD) and the Hamilton Rating Scale for Anxiety (HRSA), which may compromise the accuracy of our measurement and thus leading to bias. However, the aim of the present study was to use the ZBI to predict the risk of depression and anxiety rather than to accurately measure these concepts, the results may not be affected by the use of scales. Moreover, the use of ZBI cutoff may generate an added benefit where physicians only need to use one ZBI scale alone to both directly measure caregiver burden, as well as indirectly estimate psychological distress, instead of using a battery of different scales, which is cost-effective in busy clinical settings. Future study may consider using

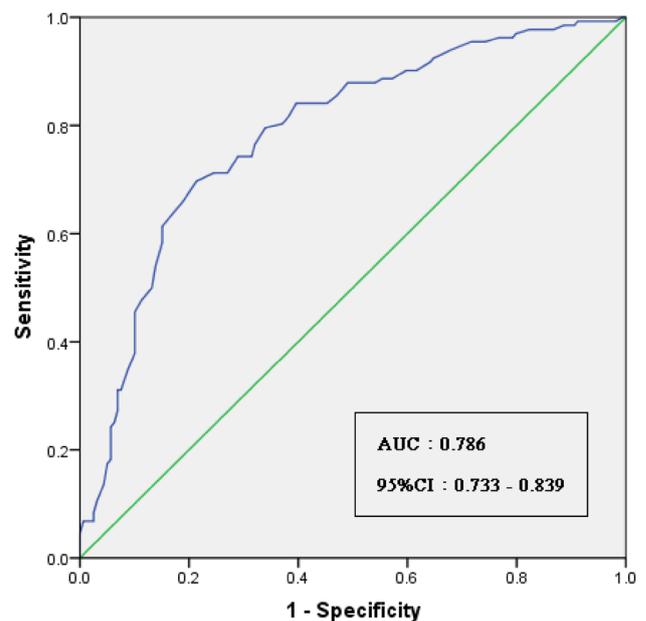
**Table 4** Contingency analysis of caregivers by anxiety and burden groups

Cutoff scores	High GAD	Low GAD	Total N	Chi square	<i>p</i>	Sensitivity (%)	Specificity (%)	Youden index (%)	PPV (%)	NPV (%)
High burden ≥ 40	108	61	169	55.933	<0.001	81.82	61.64	43.45	63.91	80.33
Low burden < 40	24	98	122							
High burden ≥ 41	106	59	165	54.815	<0.001	80.30	62.89	43.20	64.24	79.37
Low burden < 41	26	100	126							
High burden ≥ 42	105	54	159	60.465	<0.001	79.55	66.04	45.58	66.04	79.55
Low burden < 42	27	105	132							
High burden ≥ 43	101	51	152	57.088	<0.001	76.52	67.92	44.44	66.45	77.70
Low burden < 43	31	108	139							
High burden ≥ 44	98	50	148	52.853	<0.001	74.24	68.55	42.80	66.22	76.22
Low burden < 44	34	109	143							
High burden ≥ 45	98	46	144	59.238	<0.001	74.24	71.07	45.31	68.06	76.87
Low burden < 45	34	113	147							
High burden ≥ 46	94	43	137	56.473	<0.001	71.21	72.96	44.17	68.61	75.32
Low burden < 46	38	116	154							
High burden ≥ 47	94	39	133	63.341	<0.001	71.21	75.47	46.68	70.68	75.95
Low burden < 47	38	120	158							
High burden ≥ 48	92	34	126	68.571	<0.001	69.70	78.62	48.31	73.02	75.76
Low burden < 48	40	125	165							
High burden ≥ 49	87	30	117	66.387	<0.001	65.91	81.13	47.04	74.36	74.14
Low burden < 49	45	129	174							
High burden ≥ 50	84	27	111	66.538	<0.001	63.64	83.02	46.66	75.68	73.33
Low burden < 50	48	132	180							

*PHQ* the 9-item Patient Health Questionnaire, *GAD* the 7-item Generalized Anxiety Disorder Scale, *PPV* positive predictive value, *NPV* negative predictive value



**Fig. 3** Receiver operating characteristic curve for the Zarit Burden Interview (ZBI) and areas under the curve (AUC, 95% confidence interval [CI]). A total score of 10 on the PHQ as the cutoff value between low and high depression



**Fig. 4** Receiver operating characteristic curve for the Zarit Burden Interview (ZBI) and areas under the curve (AUC, 95% confidence interval [CI]). A total score of 10 on the GAD as the cutoff value between low and high anxiety

standard psychometric scales and test whether brief screening scales are comparable to them in measuring depression and anxiety. Also, they may benefit from using the suggested cutoff to test whether it is sensitive in the diagnosis rather than the depression or anxiety scales. Secondly, the cross-sectional design of the study makes it impossible to establish causal relationship between burden and psychological distress, the current study was conducted based on the underlying assumption that burden is the cause and psychological distress is the outcome, which is yet to be confirmed in the future longitudinal study. Thirdly, the results of the current study are intended to serve only as a guideline for practitioners to use to assess their family caregivers and encourage them for further assessment and future intervention. Fourthly, the cutoff scores in this study warrant further test and validation in caregivers of other mental disorders.

## Conclusions

In short, the present study provides implications for the use of ZBI to predict the risk of both depression and anxiety among caregivers of schizophrenia individuals in a Chinese rural community. The findings suggest that a ZBI cutoff score of 48 may help identify potential caregivers at risk for depression and anxiety for further assessment and future intervention.

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**Author contributions** YY, ZWL, and SYX contributed to the conception and design of the study, YY, ZWL, WZ, MZ, DQ, YLL, and SYX contributed to the research conduction and data collection, YY, ZWL, and WZ contributed to data analyses and interpretation. YY and ZWL drafted the article while WZ, MZ, DQ, YLL, and SYX critically appraised it and revised it. All authors approved the final version of manuscript for submission and publication and agreed to be accountable for all aspects of the work.

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

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no competing interests.

**Ethical approval** Ethical approval was obtained from the Institutional Review Committee of the Xiangya School of Public Health of Central South University. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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