REVIEW DERLEME

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Assessing the Reliability of the Zarit Caregiver Burden Interview: A Comprehensive Reliability Generalization Meta-Analysis

Zarit Bakım Veren Yükü Ölçeği'nin Güvenilirliğinin Değerlendirilmesi: Kapsamlı Bir Güvenilirlik Genelleme Meta-Analizi

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ABSTRACT Caregiving is a common role, and assessing caregiver burden requires culturally appropriate tools. The Zarit Caregiver Burden Interview (ZBI) is widely used and adapted across cultures. This study aimed to perform a reliability generalization meta-analysis of Cronbach's alpha for the ZBI. A systematic search was conducted in Elton Bryson Stephens Company, PubMed, Scopus, and Web of Science databases up to September 2023. Studies reporting Cronbach's alpha for the ZBI were included. A Random Effects Model with a Restricted Maximum Likelihood approach was used to estimate pooled Cronbach's alpha values. Heterogeneity was assessed using Tau^2, I^2, and Cochran's Q statistics. Publication bias was evaluated through Rosenthal's safe N, Egger regression test, Kendall's Tau, and a funnel plot. Moderator analysis was conducted using a mixed-effects model. A total of 41 studies with 7,818 participants were analyzed. The pooled Cronbach's alpha was 0.89 (95% confidence interval: 0.88-0.91), with high heterogeneity (I^2=94.52%). Moderator analysis showed that study location and sample type significantly influenced alpha values. Higher caregiver age and greater variability in ZBI scores were associated with higher alpha values. No publication bias was detected. The ZBI is a reliable tool across various cultures and caregiver groups. It can be effectively used in clinical and research settings to assess caregiver burden.

Keywords: Caregiver; caregiver burden; Zarit Caregiver Burden Interview; reliability; meta-analysis

ÖZET Bakım verme, yaygın bir rol olup, bakım verenlerin yükünü değerlendirmek için kültürel olarak uygun araçlara ihtiyaç vardır. Zarit Bakım Veren Yükü Ölçeği [Zarit Caregiver Burden Interview (ZBI)], dünya genelinde yaygın olarak kullanılan ve farklı kültürlere adapte edilen bir ölçektir. Bu çalışmada, ZBI'nin Cronbach alfa katsayısına dayalı bir güvenilirlik genelleme metaanalizi yapılması amaçlanmıştır. Bu amaç doğrultusunda Elton Bryson Stephens Company, PubMed, Scopus ve Web of Science veri tabanları Eylül 2023'e kadar sistematik olarak incelenmiştir. Cronbach alfa katsayısını raporlayan çalışmalar tüm çalışmalar metaanalize dâhil edilmiştir. Cronbach alfa değeri Rastgele Etkiler Modeli ve Kısıtlı Maksimum Olabilirlik yaklaşımı ile tahmin edilmiştir. Heterojenlik Tau^2, I^2 ve Cochran Q istatistikleriyle ve yayın yanlılığı, Rosenthal'ın güvenli N değeri, Egger regresyon testi, Kendall's Tau ve huni grafiğiyle incelenmiştir. Moderatör analizinde ise, karışık etkiler modeli kullanılmıştır. Toplam 7.818 katılımcının yer aldığı 41 çalışma analiz edilmiştir. Birleşik Cronbach alfa katsayısı 0,89 (%95 güven aralığı: 0,88-0,91) olarak bulunmuş ve çalışmalar arasında yüksek düzeyde heterojenlik gözlemlenmiştir (I^2=%94,52). Moderatör analizi, çalışmanın yapıldığı yer ve örneklem tipinin alfa değerlerini anlamlı bir şekilde etkilediğini göstermiştir. Bakım verenlerin yaş ortalamasının yüksek olması ve ZBI puanlarındaki değişkenliğin artması, yüksek alfa değerleriyle ilişkilendirilmiştir. Yayın yanlılığı tespit edilmemiştir. Sonuç olarak ZBI'nin, farklı kültürler ve bakım veren gruplar arasında güvenilir bir araç olduğu doğrulamıştır. ZBI hem klinik hem de araştırma ortamlarında bakım yükünü değerlendirmek için etkili bir şekilde kullanılabilir.

Anahtar Kelimeler: Bakım veren; bakım yükü; Zarit Bakım Veren Yük Ölçeği; güvenilirlik; metaanaliz

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Caregiving is a role many individuals assume at some point in their lives. Particularly, providing care and support for frail elderly individuals and those living with chronic and acute health conditions poses a significant global challenge.[1] Additionally, the shrinking of family units, increasing life expectancy, and rise in chronic illnesses place substantial expectations on formal caregivers, such as health policymakers and providers, and informal caregivers.[2]

Informal caregiving is commonly defined as caring for a relative or friend with a chronic illness, disability, or other long-term healthcare needs without payment.[1] Informal caregivers are primarily needed for supporting difficult nursing and medical tasks, mostly ensuring treatment adherence; they learn complex treatments, administer medications, provide symptom management, and accompany the patient to medical appointments.[3] While managing the financial and administrative responsibilities within the healthcare system, they cope with various challenges.[4] Simultaneously, caregivers implement practical care skills, meet the self-care needs of the patient, and support daily living activities. Additionally, caregivers address the emotional care needs of the patient, listen to their concerns, and provide companionship.[1]

Informal caregivers assume the caregiving role without adequate knowledge, formal preparation, necessary skills, and resources to fulfill their duties before performing all these caregiving skills. It has been reported that the limited and irregular home visits of formal caregivers within the healthcare system of many countries also contribute to the increasing unmet needs of informal caregivers.[5] Caregivers' comprehensive care responsibilities and unmet needs are factors associated with adverse health outcomes and financial difficulties, exacerbating the burden of care.[6,7] Caregiver burden is a multidimensional concept linked to the caregiving experience, encompassing physical, psychological, emotional, social, and financial stresses, which may contribute to caregivers' physical and psychological distress.[8] Caregiver burden is categorized into objective and subjective caregiver burden. Objective caregiver burden stands for indicators measuring the intensity or magnitude of caregiving tasks. Subjective caregiver burden refers to personal perceptions related to caregiving. Numerous instruments in literature measure subjective caregiver burden outcomes.[1]

Among these, the primary and still widely employed scale is the "Zarit Burden Interview (ZBI)".[9] The ZBI is a tool that measures the physical, emotional, social, and financial burden of informal caregivers in their relationships with care recipients.[10] The ZBI, formed by Zarit, Reever, and Bach-Peterson in 1980, was originally composed of 29 items designed to assess the influence of caregiving on a person's life.[9] Then, it was reduced to 22 items. The original scale is unidimensional, using a Likert-type rating system where responses to each statement are scored as "never" (0), "rarely" (1), "sometimes" (2), "frequently" (3), and "almost always" (4). Higher scores on the scale indicate higher levels of stress and burden. While the maximum score that can be reached from this scale is 88, the minimum score is 0.[11] There are also shorter versions of the ZBI, including 12-item, 8-item and 4-item versions.[12] Additionally, the ZBI has been adapted into many different languages and cultural contexts, including specific populations.[13,14] In the literature, meta-analysis studies conducted on caregivers of individuals with dementia, cancer patients, dialysis patients, Chronic Obstructive Pulmonary Disease patients, and elderly individuals have shown that the frequency of ZBI usage ranges from 22% to 69%.[10,15,16] Furthermore, it has been reported that the ZBI is used to measure the caregiving burden of informal caregivers in many countries around the world, including Spain, the United States, Brazil, Portugal, China, Argentina, Belgium, European countries, Japan, Latin American countries, Nigeria, Singapore, Thailand, United Kingdom, and Türkiye.[14] It appears that the ZBI is widely used as a tool to measure caregiving burden among informal caregivers worldwide.

The contribution of informal caregivers to the sustainability of health and social care systems is of great importance.[17] Nurses are critical in intervening in sensitive areas for a healthy transition into the caregiver role. The challenges associated with becoming a caregiver are receptive to nursing interventions.[18] It is crucial for nurses to identify the challenges that caregivers face to help them manage these difficulties and prevent risks at other stages. The use of valid

and reliable instruments in clinical practice to assess the challenges experienced by caregivers can assist in evaluating their journey over time.[18,19] Furthermore, these instruments can facilitate the development of interventions and support mechanisms and allow for the evaluation of the effectiveness of supportive interventions. In this context, it is necessary to measure the burden of informal caregivers with instruments suitable for the culture and care conditions to identify their burden and effectively intervene in the problems.

Reliability Generalization (RG) studies allow the combining of reliability estimates of measurement instruments and a better understanding of their psychometric properties across different populations. In this regard RG studies are critical both scientifically and professionally because they provide objective data about the reliability of a particular scale, enabling the selection of the most appropriate test in research and assessments.[20] With this background, this study, which includes the generalization of the reliability of the Zarit Caregiver Burden Interview, aimed to achieve the following objectives: (I) Estimate the average reliability of the scale by utilizing empirical studies employing ZBI and reporting Cronbach's alpha reliability estimates, (II) to explore relationships between descriptive characteristics of studies (study design, country of study, sample, quality scores of studies, sex, mean age, and mean scale score) and reliability estimates.

MATERIAL AND METHODS

RESEARCH DESIGN

This meta-analysis is a RG study conducted following the recommended REGEMA reporting guidelines for reporting RG studies.[21]

SELECTION CRITERIA

Without any geographical and cultural restrictions, studies were included if they met the following criteria: (a) 22-item version of ZBI or an adaptation preserving the original structure of the scale was used, (b) the Cronbach's alpha value for the overall scale was reported based on the study-specific sample, (c) the publication language was English, and (d) the study involved at least 10 participants. Studies were excluded if they were (a) meta-analyses, systematic reviews, case reports, conference abstracts, editorials, and (b) studies using a version of the scale different from the original.

SEARCH STRATEGY

The literature search used the keywords "Zarit Caregiver Burden Interview", "Zarit Caregiver Burden Scale", or "ZBI". All studies published until September 2023 were searched in the PubMed, Scopus, Elton Bryson Stephens Company (EBSCO), and Web of Science databases without date restrictions.

DATA EXTRACTION

All studies obtained from the databases were transferred to the Mendeley® program (Elsevier, Amsterdam). The Joanna Briggs Institute (JBI) guide for evidence synthesis recommends involving at least 2 authors during article screening and data extraction to minimize bias in meta-analysis studies.[22] Therefore, the authors independently assessed the conformity of studies with the selection criteria and the data extraction. In case of inconsistencies in the selected studies and extracted data, the authors collaborated to discuss and resolve the issue. A standardized data collection form created by the researchers was used to extract study characteristics and potential moderator variables. This form included author(s), publication year, study design, country of study, scale language, sample, sample size, participant sex (%), participant age (mean±SD), scale scores (mean±SD), and Cronbach's alpha values in the selected studies.

QUALITY ASSESSMENT

Since the included studies did not contain a single study type, a quality assessment tool was created on the questionnaire developed by Zangaro and Soeken.[23] This tool includes elements essential for examining the reliability and validity of scores on a measurement instrument. The 7-item tool consists of the following items: research question(s) (0=not stated, 1=clearly stated), subjects in the sample (0=not described, 1=clearly described), setting (0=not described, 1=clearly described), method of data collection (0=not described, 1=clearly described), response rate (0=no, not provided, 1=yes, provided),

measurement instrument (0=not described, 1=partially described, 2=fully described), and reliability of the scale (0=no, not provided, 1=yes, provided). The total quality score obtained from the tool was between 0-8. Studies scoring between 0-2 were considered low quality, those scoring between 3-5 were considered moderate quality, and those scoring between 6-8 were considered high quality. The quality of the included studies was assessed independently by each author using this tool. Inconsistencies between assessments were clarified by discussion.

DATA ANALYSIS

The Cronbach α value, which evaluates the internal consistency reliability of the scale, was considered to assess the reliability coefficient in the study. The Cronbach α values were normalized using the Bonett transformation, and the coefficients obtained after the transformation were used in the analyses.[24] The Random Effects Model was used to calculate the variance-weighted alpha, and the Restricted Maximum Likelihood approach was employed in the meta-analysis to obtain a combined estimate of Cronbach alpha and 95% confidence intervals (CI). Heterogeneity was assessed using Tau^2, I^2, and Cochran's Q statistics. The Q statistic tests the null hypothesis of homogeneous reliability coefficients, assuming a chi-square distribution with (k-1) degrees of freedom for k studies. A significant Q statistic ($p<0.05$) shows the presence of heterogeneity among the studies. The I^2 statistic measures the heterogeneity degree displayed by reliability coefficients as a percentage. I^2 values between 0-25% indicate no heterogeneity, 25-50% low, 50-75% moderate, and 75-100% high heterogeneity.[25] Outliers that could affect the study results were checked using the odd-man out procedure.[26] The leave-one-out procedure assesses the impact of individual studies on the overall results and is used to identify and isolate any potentially influential studies. Additionally, to evaluate the reliability of the meta-analysis results, the leave-one-out analysis was applied as a sensitivity analysis. This test allows for assessing the effect of each individual study on the overall results and the robustness of the analysis outcomes.[27] During the analysis process, each study was sequentially removed from the meta-analysis, and the analysis was repeated with the remaining studies. The results obtained after the analysis was interpreted by converting them back to Cronbach α coefficients. Publication bias was assessed using Rosenthal's fail-safe n value, Egger regression test, Kendall's Tau rank correlation test, and a funnel plot.[28] Moderator analyses were conducted due to the high heterogeneity among the reliability coefficients obtained from the studies. Categorical moderators were study design (1=descriptive, 2=experimental, 3=methodological), the location where the study was conducted (1=East and Southeast Asia, 2=Türkiye, 3=others), sample (1=cancer caregivers, 2=dementia caregivers, 3=pediatric caregivers, 4=others) and methodological quality (1=moderate, 2=high). Continuous moderators were sample size (n), sex (%), age (mean, SD), and ZBI scores (mean, SD). A mixed-effects model was used to assess the role of moderators on Cronbach alpha estimates. The proportion of variance explained by the moderator variables was estimated with R^2. METAFOR package in the R Studio (R Foundation for Statistical Computing, Vienna, Austria) software was used for all statistical analyses.[29]

RESULTS

STUDY SELECTION

The REGAMA flow chart is shown in Figure 1. A total of 1,089 publications were retrieved from the Web of Science (n=232), Scopus (n=284), PubMed (n=228), and EBSCO (n=345) databases. After removing duplicates, the remaining 339 studies were screened based on titles and abstracts. Out of these, 166 studies were excluded for using short or extended versions of ZBI (n=43), unavailability of full text (n=22), including other scales measuring caregiver burden outside ZBI (n=28), being published in a language other than English (n=42), and not meeting inclusion criteria for publication types (n=31). After excluding studies that did not report Cronbach alpha values (n=132), the remaining 41 studies were selected to be included in the meta-analysis.

CHARACTERISTICS OF THE SELECTED STUDIES

The characteristics of the included studies in the meta-analysis are presented in Table 1. The included

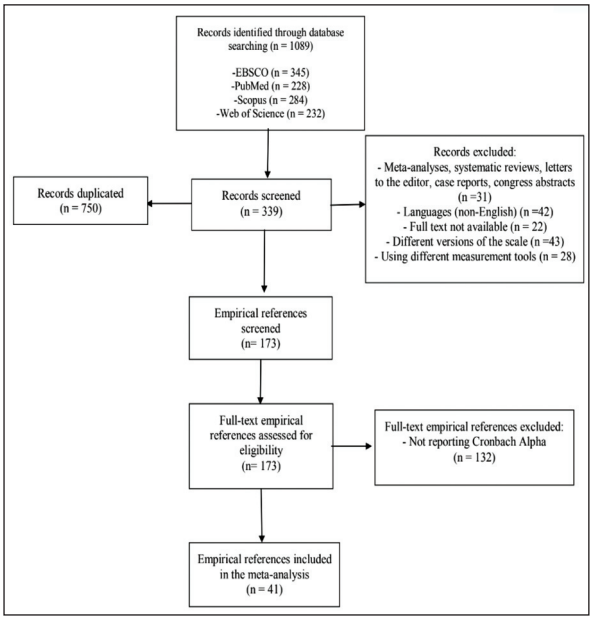

FIGURE 1: REGEMA flow chart

studies were conducted between 1997-2023; 28 were descriptive, 7 were methodological, and 6 had an experimental design. Türkiye (n=16) and China (n=13) had the highest number of publications. The studies used Turkish, Chinese, English, Italian, Japanese, Vietnamese, Spanish, Mongolian and Portuguese scale versions. The sample sizes among the included studies ranged from 16-1,144. The studies included caregivers of individuals with cancer (n=6), schizophrenia (n=6), dementia (n=7), other chronic diseases or conditions (n=15) and pediatric patients (n=7). Twenty-six studies reported the average age of participants, with the mean age ranging from 32 to 66. Only 3 studies were conducted with women, and 2 did not report sex distribution. In the remaining studies, most participants were women. Cronbach's alpha values ranged from 0.72 to 0.96. All studies reported alpha values of 0.70 and above, with nineteen reporting alpha values of 0.90 and above.

Evaluations regarding the methodological quality of the included studies are included in Table 2. Accordingly, 26 of the 41 studies were evaluated as high quality and 15 as moderate. No study had a score lower than 4.

RELIABILITY AND HETEROGENEITY

Cumulative estimates of Cronbach's alpha and CIs were calculated for raw Cronbach alpha values using the restricted maximum likelihood method with a random-effects model. Figure 2 presents the Forest plot for Cronbach alpha coefficients. Accordingly, the cumulative Cronbach alpha coefficient calculated for the 41 studies, representing a combined sample size of 7,818 individuals, was 0.89 (CI: 0.88, 0.91). Tau^2, I^2, and Cochran's Q statistics indicated high heterogeneity (Tau^2=0.19, I^2=94.52%, df=40, Q=957.529, p<0.001).

PUBLICATION BIAS

The funnel plot for publication bias is presented in Figure 3. According to this plot, the included studies were distributed almost symmetrically around the vertical line, representing the combined effect size. Rosenthal's fail-safe n value ($p < 0.001$), Egger regression test (t=1.021, p=0.307), and Kendall's Tau coefficient (Tau=0.024, p=0.822) indicated no publication bias in the included studies.

SENSITIVITY ANALYSES

Sensitivity analyses were conducted to examine the effect of including or excluding reliability coefficients from studies. Each study was deleted one by one, and the analyses were repeated each time. Accordingly, the mean Cronbach's alpha coefficient for ZBI ranged from 0.89 (95% CI: 0.87, 0.90) to 0.90 (95% CI: 0.88, 0.91). These results indicate that the mean reliability estimate is quite robust.

ANALYSIS OF MODERATOR VARIABLES

Table 3 summarizes the findings from the analog analysis of variance examining categorical moderators for the ZBI results. Study design did not show a statistically significant relationship with alpha coefficients (p=0.406). However, the locations where the studies were carried out exhibited a significant relationship with alpha coefficients (p=0.036), explaining 9.3% of the variance. The average alpha coefficient was found to be 0.87 for studies conducted in Türkiye, 0.90 for studies conducted in East and Southeast Asia, and 0.92 for studies conducted in other countries. The relationship between the sample type and alpha coefficients was significant (p=0.029). Reliability estimates were found to be 0.83 for cancer caregivers, 0.91 for dementia caregivers, 0.90 for pediatric caregivers, and 0.88 for

TABLE 1: Characteristics of the included studies

Author(s), years	Study design	Country	Language	Sample	n	Sex Female %	Age X̄±SD	Score X̄±SD	Cronbach's alpha
Akkuş et al.[30]	Descriptive	Türkiye	Turkish	Caregivers of cancer patients	250	56	40.2±12.4	21.0±14.6	0.95
Aksu et al.[31]	Descriptive	Türkiye	Turkish	Caregivers of gynecological cancer patients	227	79.3	42.5±12.6	44.5±20.1	0.90
Ari et al.[32]	Methodological	Japan	Japanese	Caregivers of the elderly people	66	83.3	62.0±13.4	38.7±18.4	0.93
Ata and Doğan[33]	Experimental	Türkiye	Turkish	Caregivers of patients with schizophrenia	71	70.4	NA	NA	0.89
Bademli et al.[34]	Experimental	Türkiye	Turkish	Caregivers of patients with schizophrenia	62	59.6	NA	NA	0.81
Bahadır Yılmaz and Ata[35]	Descriptive	Türkiye	Turkish	Caregivers of patients with neurological diseases	64	68.8	50.4±11.6	31.9±15.56	0.89
Bekar et al.[36]	Descriptive	Türkiye	Turkish	Caregivers of cancer patients	136	76.5	36.2±7.5	31.2±9.4	0.78
Bozkurt Zincir et al.[37]	Descriptive	Türkiye	Turkish	Caregivers of adults and children with heart failure	138	65.2	37.1±11.6	37.4±7.8	0.83
Dikmen et al.[38]	Descriptive	Türkiye	Turkish	Caregivers of hemodialysis patients	107	53.3	NA	47.5±13.8	0.86
Dou et al.[39]	Descriptive	Chinese	Chinese	Caregiver of acute ischemic stroke patient	271	59.8	48.4±14.7	NA	0.82
Durmaz and Okanlı[40]	Descriptive	Türkiye	Turkish	Caregivers of schizophrenia patients	62	45.2	41.5±13.0	68.6±18.6	0.93
Ferreira et al.[41]	Descriptive	Portugal	Portuguese	Parents of children with Angelman syndrome	24	75	NA	63.8±16.4	0.91
Fu et al.[42]	Descriptive	Chinese	Chinese	Caregivers of critically ill patients	554	50.9	NA	30.3±19.0	0.94
Hoang and Bonner[43]	Descriptive	Vietnamese	Vietnamese	Caregivers of patients undergoing hemodialysis	178	55.6	45.4±14.1	40.1±10.4	0.87
Kamalzadeh et al.[44]	Descriptive	Iranian	Persian	Primary caregivers of patients with dementia	60	75	47.2±12.2	46.1±21.6	0.94
Ko et al.[45]	Methodological	Chinese	Chinese	Caregivers of patients with dementia	168	78.6	54.0±13.3	35.5±14.4	0.89
Koto et al.[46]	Descriptive	Japan	Japanese	Caregivers of non-neuronopathic gaucher patients	25	92.2	45.7±13.8	20.6±16.3	0.93
Liu et al.[47]	Descriptive	Chinese	Chinese	Caregivers of hemodialysis patients	173	NA	NA	23.5±15.8	0.94
Liu, et al.[48]	Descriptive	Chinese	Chinese	Caregivers of breast cancer patients	108	100	49.0±9.0	24.8±12.5	0.89
Lok et al.[49]	Experimental	Türkiye	Turkish	Caregivers of patients with schizophrenia	60	51.6	NA	73.4±4.3	0.81
Lu et al.[50]	Methodological	Chinese	Chinese	Caregivers of hospitalized patients	523	59.3	44.2±12.4	NA	0.87
Luchsinger et al.[51]	Experimental	USA	English/Spanish	Caregivers of patients with dementia	221	82.8	58.2±11.2	NA	0.93
Ma et al.[52]	Descriptive	Chinese	Chinese	Caregivers of children with epilepsy	173	55.5	NA	22.1±14.2	0.89
Martin-Carrasco et al.[53]	Methodological	Spain	Spanish	Caregivers of Alzheimer's patients	115	68.7	62.7±13.5	60.7±15.8	0.92
McConaghy and Caltabiano[54]	Descriptive	Australia	English	Caregivers of patients with dementia	42	76.19	62.0±13.2	NA	0.91
Menekli and Şentürk[55]	Descriptive	Türkiye	Turkish	Caregivers of patients awaiting bone marrow transplantation	451	55.4	32.5±2.7	50.1±9.8	0.72
Özmen and Yurttaş[56]	Descriptive	Türkiye	Turkish	Caregivers of multiple sclerosis patients	380	65.2	NA	NA	0.85
Purpura et al.[57]	Descriptive	Italy	Italian	Caregivers of children with neurodevelopmental disorders	105	84.7	41.9±5.1	24.9±17.4	0.93
Rodriguez et al.[58]	Descriptive	Mexico/Spain	Spanish	Caregivers of children with muscular dystrophy	74	86.5	NA	NA	0.90
Seng et al.[59]	Methodological	Singapore	English	Caregivers of patients with dementia	238	68.1	50.1±10.5	35.4±15.5	0.93
Suluhan et al.[60]	Experimental	Türkiye	Turkish	Mothers feeding their children through gastrostomy	78	100	NA	47.5±14.8	0.84
Tanrıverdi and Ekinci[61]	Experimental	Türkiye	Turkish	Caregivers of patients with schizophrenia	31	58.1	46.3±14.6	57.2±9.9	0.88
Tuncay and Sarman[62]	Descriptive	Türkiye	Turkish	Mothers of children with cerebral palsy	181	100	35.7±5.9	NA	0.92
Wang et al.[63]	Methodological	Chinese	Chinese	Caregivers of patients with dementia	42	50	66.0±12.6	NA	0.89
Yamaguchi et al.[64]	Methodological	Mongolian	Mongolian	Caregivers of physical therapy recipients	16	75	48.6 ±12.9	34.1±15.7	0.92
Yang et al.[65]	Descriptive	Chinese	Chinese	Caregivers of the elderly with chronic diseases	1144	60	44.3±11.5	27.3±15.0	0.83
Yıldız et al.[66]	Descriptive	Türkiye	Turkish	Caregivers of cancer patients	101	NA	NA	56.4±14.2	0.87
Yu et al.[67]	Descriptive	Chinese	Chinese	Caregivers of patients with schizophrenia	327	53.8	NA	NA	0.89
Zhang J et al.[68]	Descriptive	Chinese	Chinese	Caregivers of people with craniocerebral injuries	214	56.1	NA	NA	0.96
Zhang Q et al.[69]	Descriptive	Chinese	Chinese	Caregivers of children with epilepsy	173	55.5	36.6±10.8	28.7±8.2	0.90
Zhu et al.[70]	Descriptive	Chinese	Chinese	Caregivers of early-stage lung cancer patients	385	49.4	NA	29.1±11.4	0.72

SD: Standard deviation

TABLE 2: Methodological quality of included studies

Study	Research question(s)	Subjects in sample	Setting described	Method of data collection	Response rate provided	Measurement instrument described	Reliability for scale provided	Total
Akkuş et al.[30]	1	1	0	1	0	2	1	6
Aksu et al.[31]	1	1	1	1	0	2	1	7
Ari et al.[32]	1	1	0	0	0	2	1	5
Ata, Doğan[33]	1	1	0	1	1	2	1	7
Bademli et al.[34]	1	1	0	0	0	2	1	5
Yılmaz, Ata[35]	1	1	1	1	0	2	1	7
Bekar et al.[36]	1	1	1	1	1	2	1	8
Bozkurt Zincir et al.[37]	0	1	1	1	0	2	1	6
Dikmen et al.[38]	0	1	1	1	1	2	1	7
Dou et al.[39]	0	1	1	0	0	1	1	4
Durmaz, Okanlı[40]	0	1	1	0	0	1	1	4
Ferreira et al.[41]	1	1	0	1	0	1	1	5
Fu et al.[42]	0	1	1	1	0	2	1	6
Hoang, Bonner[43]	0	1	0	0	0	2	1	4
Kamalzadeh et al.[44]	1	1	1	0	0	2	1	6
Ko et al.[45]	0	1	0	0	0	2	1	4
Koto et al.[46]	0	1	1	1	0	2	1	6
Liu et al.[47]	1	1	1	1	0	2	1	7
Liu, et al.[48]	0	1	0	1	1	2	1	6
Lok et al.[49]	1	1	0	0	0	2	1	5
Lu et al.[50]	0	1	1	1	1	2	1	7
Luchsinger et al.[51]	1	1	1	1	1	1	1	7
Ma et al.[52]	0	1	0	0	1	1	1	4
Martin-Carrasco et al.[53]	0	1	0	1	0	2	1	5
McConaghy, Caltabiano[54]	1	1	1	1	1	2	1	8
Menekli, Şentürk[55]	0	1	1	1	0	2	1	6
Özmen, Yurttaş[56]	1	1	1	1	0	2	1	7
Purpura et al.[57]	0	1	1	0	1	2	1	6
Rodriguez et al.[58]	0	1	0	1	0	1	1	4
Seng et al.[59]	0	1	1	1	1	2	1	7
Suluhan et al.[60]	1	1	1	1	0	2	1	7
Tanrıverdi, Ekinci[61]	0	1	1	1	0	2	1	6
Tuncay, Sarman[62]	0	1	0	1	0	2	1	5
Wang et al.[63]	0	1	1	1	0	2	1	6
Yamaguchi et al.[64]	0	1	0	0	0	2	1	4
Yang et al.[65]	0	1	1	1	1	2	1	7
Yıldız et al.[66]	1	1	0	1	0	2	1	6
Yu et al.[67]	0	1	1	1	1	2	1	6
Zhang J et al.[68]	0	1	1	1	0	1	1	5
Zhang Q et al.[69]	0	1	1	0	1	1	1	5
Zhu et al.[70]	0	1	0	1	1	2	1	6

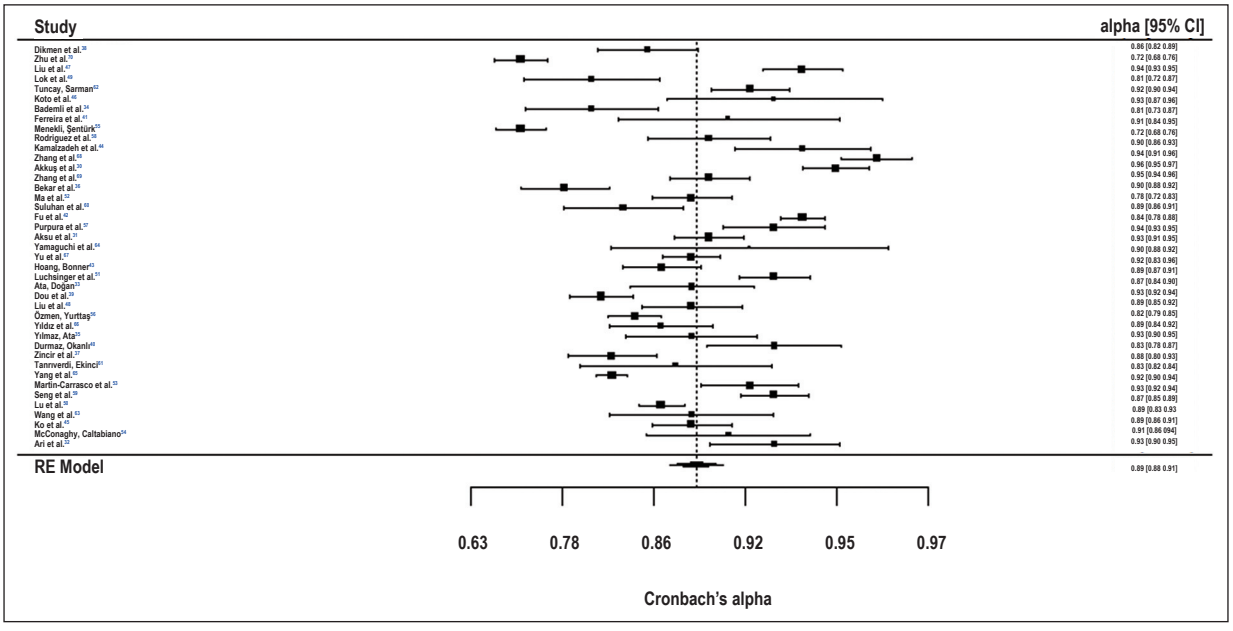

FIGURE 2: Forest plot of the internal consistency of the ZBI
Tau^2: 0.19; I^2: 94.52%; Q: 957.52; df: 40; p<0.001. CI: Confidence internal; RE: Random effects model

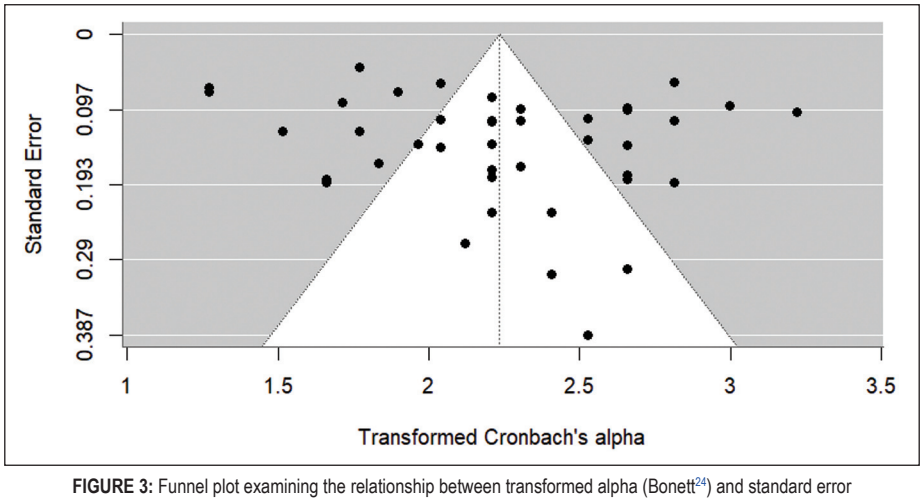

FIGURE 3: Funnel plot examining the relationship between transformed alpha (Bonett[24]) and standard error

other caregivers. The differences between groups explained approximately 12.8% of the variance in the model. The quality of the studies did not show a statistically significant relationship with alpha coefficients (p=0.376) (Table 3).

Table 4 summarizes the findings from the meta-regression analysis of continuous moderator variables for the alpha estimate. The analysis found no significant relationship between sample size and alpha coefficients (p=0.056). The analysis for mean age showed a positive and statistically significant effect on alpha coefficients (p=0.036). This finding indicates that an increase in the participants' mean age leads to an increase in alpha coefficients. The mean age variable explained 11.6% of the variance in the model. The standard deviation of mean age also showed no significant relationship with alpha coefficients (p=0.061). The sex (% female) moderator did not show a significant relationship (p=0.113). No significant relationship was found between mean ZBI

TABLE 3: Analog analysis of variance results of categorical moderators for ZBI

Variable	Category	k	α	95% CI	ANOVA results
Study design	Descriptive	28	0.88	[0.86, 0.90]	F (2, 38)=1.800, p=0.406, R^2=0.00, QE (38)=798.649, p<0.0001
	Experimental	6	0.86	[0.81, 0.91]	
	Methodological	7	0.90	[0.86, 0.94]	
Location	East and Southeast Asia	18	0.90	[0.88, 0.92]	F (2,38)=6.634, **p=0.043**, **R^2=0.093**, QE (38)=796.046, p<0.0001
	Türkiye	16	0.87	[0.84, 0.90]	
	Others	7	0.92	[0.89, 0.94]	
Sample	Cancer caregivers	7	0.83	[0.79, 0.87]	F (3,37)=8.967, **p=0.029**, **R^2=0.128**, QE (37)=800.639, p<0.0001
	Dementia caregivers	7	0.91	[0.87, 0.95]	
	Pediatric caregivers	7	0.90	[0.86, 0.93]	
	Others	20	0.88	[0.86, 0.90]	
Quality	Moderate	15	0.87	[0.85,0.90]	F (1,39)=0.782, p=0.376, R^2=0.00, QE (39)=787.519, p<0.0001
	High	26	0.89	[0.86, 0.92]	

K: Number of Cronbach's alpha coefficients; α: Mean coefficient alpha; 95%CI: 95% confidence interval around the Cronbach's alpha; ANOVA: Analysis of variance; F: Knapp-Hartung's statistic for testing the significance of the predictor; QE: Statistic to test for residual heterogeneity; df: Degrees of freedom; R^2: Proportion of variance accounted for by the predictor

TABLE 4: Meta-regression results for continuous moderators for ZBI

				%95 CI					
Predictor variable	**k**	**b_j**	**SE**	**LL**	**UL**	**F**	**p value**	**QE**	**R^2**
n	41	-0.0001	0.000	-0.0002	0.000	3.653	0.056	722.060***	0.073
Mean age (years)	26	0.0023	0.0011	0.0001	0.0045	4.354	**0.036**	434.312***	**0.116**
Mean age SD (years)	26	0.0063	0.0034	-0.0003	0.0130	3.492	0.061	434.966***	0.078
Sex (%female)	39	1.427	0.0006	-0.0002	0.0021	2.511	0.113	780.947***	0.036
Mean ZBI score	29	-0.0005	0.0008	-0.0021	0.0010	0.487	0.485	528.519***	0.00
Mean ZBI score SD	29	0.010	0.0023	0.0054	0.0146	18.238	**<0.001**	424.214***	**0.412**

***p<0.0001. k: Number of studies; b_j: Unstandardized regression coefficient; SE: Standard Error for b_j; LL and UL: lower and upper limits of the 95% confidence interval for b_j; F: Knapp-Hartung's statistic for testing the significance of the predictor; p value: Probability level for the F statistic; QE: Statistic to test for residual heterogeneity; R^2: Proportion of variance accounted for by the predictor; SD: Standard deviation; ZBI: Zarit Caregiver Burden Interview

scores and alpha coefficients (p=0.485). However, a strong positive relationship was found between the standard deviation of mean ZBI scores and alpha coefficients (p<0.001). This finding suggests that variation in ZBI scores has a significant effect on alpha coefficients, explaining 41.2% of the variance in the model (Table 4).

DISCUSSION

This study conducted a RG meta-analysis of Cronbach's alpha, a measure of internal consistency of the ZBI obtained from studies performed to evaluate the caregiver burden of informal caregivers. The main objectives were to obtain an average estimate of Cronbach's alpha for the ZBI and to observe whether potential moderator variables could influence the heterogeneity. The ZBI demonstrates a high level of consistency. With a total sample obtained from 41 studies (n=7,818), the estimated internal consistency for ZBI is 0.89, with a 95% confidence interval of (0.88; 0.91). The highest Cronbach's alpha value was obtained from the study with 0.96, while the lowest value was from the studies with 0.72.[55,68,70] Cronbach's alpha values above 0.70 are adequate in exploratory research.[71] Cronbach's alpha is an appropriate measure to evaluate the reliability of single-dimensional scales.[72] Considering the inherently single-dimensional nature of the ZBI, it is believed that using Cronbach's alpha value is sufficient to evaluate its internal consistency. The Cronbach's alpha results of this RG meta-analysis indicate that the ZBI exhibits excellent reliability and supports its use in measuring caregiver burden among informal caregivers.

In this study, the heterogeneity of Cronbach's alpha coefficients was found to be quite high. Significant variability was observed among the reliability

coefficients reported by the studies evaluated. Based on this observed heterogeneity, potential moderators that could explain the variability in reliability coefficients across studies were investigated. Moderation analyses in the study considered factors such as location, sample, study design, methodological quality, sample size, sex, age, and mean ZBI scores. The analyses showed that alpha coefficients were related to location, sample, participants' average age, and the standard deviation of mean ZBI scores. This indicates that the reliability of the ZBI varies depending on the country, sample, and age group in which it is applied. Caregiver burden may be a culturally sensitive issue and could be perceived differently across cultures. Specifically, the average alpha coefficient for studies in Türkiye was 0.87, which is slightly lower compared to studies in other regions. In contrast, studies conducted in East and Southeast Asia had an average alpha coefficient of 0.90, and studies in other countries had an average of 0.92. The relatively lower reliability coefficients in Türkiye may be due to the different ways in which caregiver burden is interpreted in this culture. This difference suggests that cultural norms play an important role in the perception and evaluation of caregiver burden.

Although the original scale was first developed to measure caregiver burden in caregivers of elderly individuals, it was later used in caregivers of individuals with different chronic conditions.[9] In this study, the alpha coefficient of the scale showed the lowest value of 0.83 for cancer caregivers, while it was found to be 0.91 for dementia caregivers, 0.90 for pediatric caregivers, and 0.88 for other caregivers. This finding indicates that the reliability of the ZBI may vary depending on the type of condition being cared for. The lower reliability coefficient observed among cancer caregivers might suggest that this group may perceive caregiver burden differently or that measurements within this group are more variable. Overall, the type of condition being cared for is an important factor affecting the reliability of the ZBI. These differences may help us better understand how the scale performs in different situations. Additionally, the study designs and research quality are observed not to affect Cronbach's alpha coefficient, indicating that the ZBI can be considered a good measurement tool for use in different study designs.

The moderator's analysis found that the sample size had a very small and negative effect on reliability, but this effect was not statistically significant. This result indicates that an increase in sample size did not significantly impact the reliability of the ZBI. It was also found that the average age of participants affected the reliability of the ZBI, explaining 11.6% of the variance in alpha coefficients. The increase in age was associated with a slight increase in ZBI reliability, which could be attributed to older individuals having a better understanding of caregiver burden issues and evaluating the scale more consistently. This result supports the notion that the scale provides more consistent results among older caregivers compared to younger ones. Since the ZBI was developed to assess caregiver burden regardless of the sex of the caregiver, it is expected to exhibit good consistency across genders.[1] The moderator analyses in this study revealed that participants' sex did not affect the reliability estimate. However, this result should be interpreted cautiously, considering that some studies did not report these variables. Additionally, the mean ZBI score did not have a significant effect on reliability, indicating that overall ZBI scores, whether high or low, did not change reliability. However, the standard deviation of the mean ZBI scores had a strong and significant effect on reliability. Studies with higher standard deviations in mean ZBI scores also showed higher alpha coefficients. The variation in ZBI scores explained 41.2% of the variance in alpha coefficients. It is expected that variability in test scores is related to test reliability. Variability in scores may be influenced by different sampling schemes as well as measurement errors.[73] Therefore, the relationship between observed scores and reliability coefficients can be complex.

The 22-item version of the ZBI is a reliable scale that can be used to assess caregiver burden. However, conducting RG meta-analysis for other versions of the ZBI is also recommended. This way, the RG meta-analysis results of other versions can be compared with the results of this study. The analysis did not include some studies because Cronbach's alpha value was not reported. Therefore, encouraging the

reporting of Cronbach's alpha value in studies could contribute to future RG meta-analysis studies. Furthermore, researchers should pay particular attention to reporting the sociodemographic characteristics of study participants that may be of interest due to their potential effects on the reliability levels of scores in terms of alpha. This will facilitate the evaluation of moderator analyses in further RG meta-analytic studies. Finally, there is a need for more research examining the reliability of scores of self-report instruments assessing caregiver burden.

STRENGTHS AND LIMITATIONS

This RG meta-analysis study addresses a significant gap in the literature by evaluating caregiver burden scales for formal caregivers, thus filling an important void. One of the strengths of this research is that it tests the RG meta-analyses of the ZBI for the first time. Additionally, another strength of the study is the adherence to the REGEMA checklist in planning, conducting, and reporting the study. Despite these strengths, there are also limitations to the study. Because the ZBI is a scale developed in 1980, its validity and reliability across different cultures and languages have been tested in studies from the past. In the last 10 years, the inclusion of studies evaluating the ZBI has resulted in a limitation due to the lack of test-retest values. The ZBI currently has versions ranging from 1 to 22 items in the literature. This study tested only the 22-item version of the ZBI, which is the most used form, and studies reported in English. This is another limitation of the study. Additionally, the high number of studies that did not report alpha values is another limitation. Studies that did not report alpha values might have withheld their results due to low alpha values. Low alpha values indicate that the scale's internal consistency is low and, therefore, the measurement's reliability is weak. This situation might have led to the representation of only studies with high reliability values in the meta-analysis.

CONCLUSION

This RG meta-analysis provides valuable information on the reliability of the ZBI. The results of this study showed that the 22-item version of the ZBI is a reliable tool with internal consistency for assessing caregiver burden among informal caregivers. The analysis of data from a total of 41 studies revealed that the mean Cronbach's alpha for the ZBI was 0.89 and varied by country/region, sample group, and mean age of the sample. The high heterogeneity of the study findings and the fact that some of the included studies did not report moderators that could affect Cronbach's alpha values necessitate careful interpretation of the findings.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Gülyeter Erdoğan Yüce;* ***Design:*** *Gülyeter Erdoğan Yüce;* ***Control/Supervision:*** *Gülyeter Erdoğan Yüce;* ***Data Collection and/or Processing:*** *Nuray Caner;* ***Analysis and/or Interpretation:*** *Gülyeter Erdoğan Yüce;* ***Literature Review:*** *Nuray Caner;* ***Writing the Article:*** *Gülyeter Erdoğan Yüce, Nuray Caner;* ***Critical Review:*** *Gülyeter Erdoğan Yüce, Nuray Caner.*

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