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Connor-Davidson Resilience Scale: a systematic review psychometrics properties using the COSMIN

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Background: Psychometrical evaluation of persons of diverse contexts and different populations, including general or clinical.
Objective: This review study aimed to evaluate the psychometrics quality of resilience scales.
Methods: International and Iranian databases were searched with MESH terms, including "psychometric", "validity", "reliability", "Connor-Davidson resilience scale", "Resilience scale", for published articles up to 1 February 2023. For each of the selected studies, the risk of bias was evaluated using the COSMIN Risk of Bias Checklist. Then the COSMIN checklist was used to evaluate the entire text of the article for methodological quality.
Results: Considering the inclusion criteria, 80 documents were evaluated. According to the COSMIN's criteria for evaluating the risk of bias, the current study findings revealed the included studies' limitations in assessing the three versions of CD-RISC cross-cultural and content validity as well as their stability (e.g. conducting test re-test), whereas the majority of psychometric studies of CD-RISC-25, and CD-RISC-2 rated as very good or adequate in terms of structural validity. In terms of quality assessment of the included studies, the current study indicated that investigating the structural validity of the CD-RISC was mainly done based on exploratory factor analysis (EFA), and confirmatory factor analysis was absent.
Conclusion: The general result indicates the acceptability of the quality of the studies. However, concerns for measurement properties such as responsiveness and criterion validity as well as the standard error of measurement have been neglected.

Keywords: Connor-Davidson Resilience Scale, COSMIN, psychometrics, resilience, systematic review

Introduction

Resilience is a multidimensional and complex concept that has achieved popularity in positive psychology as a significant human strength due to its impact on psycho-somatic and social health[1,2]. Facing stress (internal and external) is not avoidable in different stages of the human life course[3]. Thus, maintaining individual function or bio-psychological balance, and even reaching evolution or thriving after dealing with adversities and disturbances, has resulted in scientists' interest in resilience in different disciplines[4]. Based on various definitions, resilience is an adaptive response to stressful or threatening conditions[5]. Individuals can help themselves through different mechanisms, including enhancing their strength by relying on available resources and capacities or improving their flexibility and stamina by applying coping strategies efficiently[6]. As mentioned earlier, resilience is a complex concept, several scales, therefore, have been developed; among them, the Connor-Davidson scale of Resilience (CD-RISC) has achieved the highest rating and validation in different contexts[7,8]. However, psychometric properties or the number of factors and items vary in those studies.

Being cross-cultural and complicated conception, professionals in different disciplines have multi-criteria perspectives on resilience definition and debates regarding its determinants[6].

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Some researchers have focused on attitudes (internal capacity), but others believe in behaviours and relations (supportive resources) or a combination of both as aspects of resilience[9,10]. Since the items mentioned above, examples of adaptations in different countries should also be included, showing the diversity of existing versions of the CD-RISC: original 25 items, 10 items and 2 items[10].

Based on the evidence, resilience has a significant association with mental and social health as it significantly affects the process and outcome of developmental transitions in the life course[11–13]. Therefore, a valid and standard measure such as CD-RISC would be necessary for its assessment. Psychometric evaluation among diverse contexts and different populations, including general or clinical, and individuals under stressful situations such as life-threatening conditions, will require the development of psychosocial interventions. This review study aimed to evaluate the psychometrics quality of CD-RISC.

HIGHLIGHTS

- Connor-Davidson Resilience Scale is a popular scale in psychology.
- This was the first study that assessed the risk of bias and quality of methodological studies about the Connor-Davidson Resilience Scale.
- The majority of methodological studies were rated as very good or adequate in terms of the structural validity of this scale.

Methods

A systematic review was conducted in February 2023 on all psychometric adaptations of the CD-RISC using the PRISMA, Supplemental Digital Content 1, http://links.lww.com/MS9/A411 and AMSTAR 2, Supplemental Digital Content 2, http://links.lww.com/MS9/A412 (Assessing the methodological quality of systematic reviews) guidelines[14,15].

Search strategy and selection criteria

We used international databases, including PubMed, Scopus, Web of Science, and Iranian databases, including SID, and Magiran and evaluated studies published up to 1 February 2023. MESH terms included "psychometric", "validity", "reliability", "Connor-Davidson resilience scale", "Resilience scale", [with the use of 'OR' and 'AND' operators] and were used for assessment of the identified databases. Appendix 1 provides details about the search strategy, Supplemental Digital Content 3, http://links.lww.com/MS9/A413.

First, duplicate studies from the initial search were removed after selected studies were entered into the Endnote software. Two researchers with doctoral degrees (A.H.G. and S.H.) obtained original articles and then carefully evaluated them for inclusion. Studies needed to meet the following criteria for inclusion: (1) use of CD-RISC in study; and (2) Reliability assessment; (3) Validity assessment; (4) Evaluation of the diagnostic accuracy of CD-RISC. Studies that did not provide information regarding validity and/or reliability assessments (e.g. factor structure); (1) had an insufficient sample size (< 50 participants), (2) they used tools other than the CD-RISC to measure resilience, (3) unable to access full-text of the article, (4) only used Item Response Theory (IRT) for data analysis, (5) were written in languages other than English or Farsi were excluded. The phases of article selection were based on PRISMA guidelines are shown in Fig. 1.

Risk of bias assessment

For each of the selected studies, the risk of bias was evaluated using the COSMIN Risk of Bias Checklist (include reference(s) to this procedure here). This tool includes three parts with 10 boxes. Boxes 1 and 2 are in the first part, which deal with content validity. This section evaluates how well each item fits the target construct and population, as well as its relevance and comprehensibility. The internal structure is addressed in the box of the second part) (boxes 3, 4, and 5, which also include information on structural validity, internal consistency, and cross-cultural validity/measurement invariance. The third section is broken down into boxes 6, 7, 8, 9, and 10 and deals with the remaining measurement properties, such as responsiveness, criterion validity, reliability, measurement error, and reliability of hypotheses. Instead of emphasizing individual items, the third section concentrates on the overall quality of the (sub) scale[16]. This and the following procedures were carried out by researchers other than the above (L.H. and S.H.).

Quality assessment

The COSMIN checklist was used (by L.H. and S.H.) to evaluate the entire text of the article for methodological quality. A variety of psychometric properties are evaluated by the COSMIN checklist, including (i) structural validity, (ii) internal consistency, (iii) reliability, (iv) measurement error, (v) hypotheses testing for construct validity, (vi) Cross-cultural validity\measurement invariance, (vii) criterion validity, and (viii) responsiveness. The result of every single study on a measurement property is rated against the updated criteria for good measurement properties as either sufficient (+), insufficient (–), or indeterminate[17]. The quality criteria of the measured properties were then analyzed using Terwee's study criteria[18,19]. In updated criteria for good measurement properties, the assessment of cross-cultural validity involves determining whether a scale remains consistent in its measurement across different cultures or if there are variations in how specific items are responded to. This is evaluated through measurement invariance (MI) and differential item functioning (DIF) analyses. MI and non-DIF investigate whether individuals from diverse groups while accounting for group differences, respond similarly to a given item at the same underlying level of the trait being measured. Regression analyses or confirmatory factor analysis (CFA) are effective methods for adequately evaluating cross-cultural validity using Classical Test Theory (CTT). In the present study, decisions were made to remove the criteria for determining the suitability of a gold standard. Instead, the review team first identifies which outcome measurement instrument can be considered a reasonable gold standard before assessing the methodological quality of the studies. If a study included in the review utilizes this designated gold standard instrument to evaluate validity, it can be categorized as a study on criterion validity. The COSMIN panel has reached a consensus that there are no established gold standards for PROMs, with the

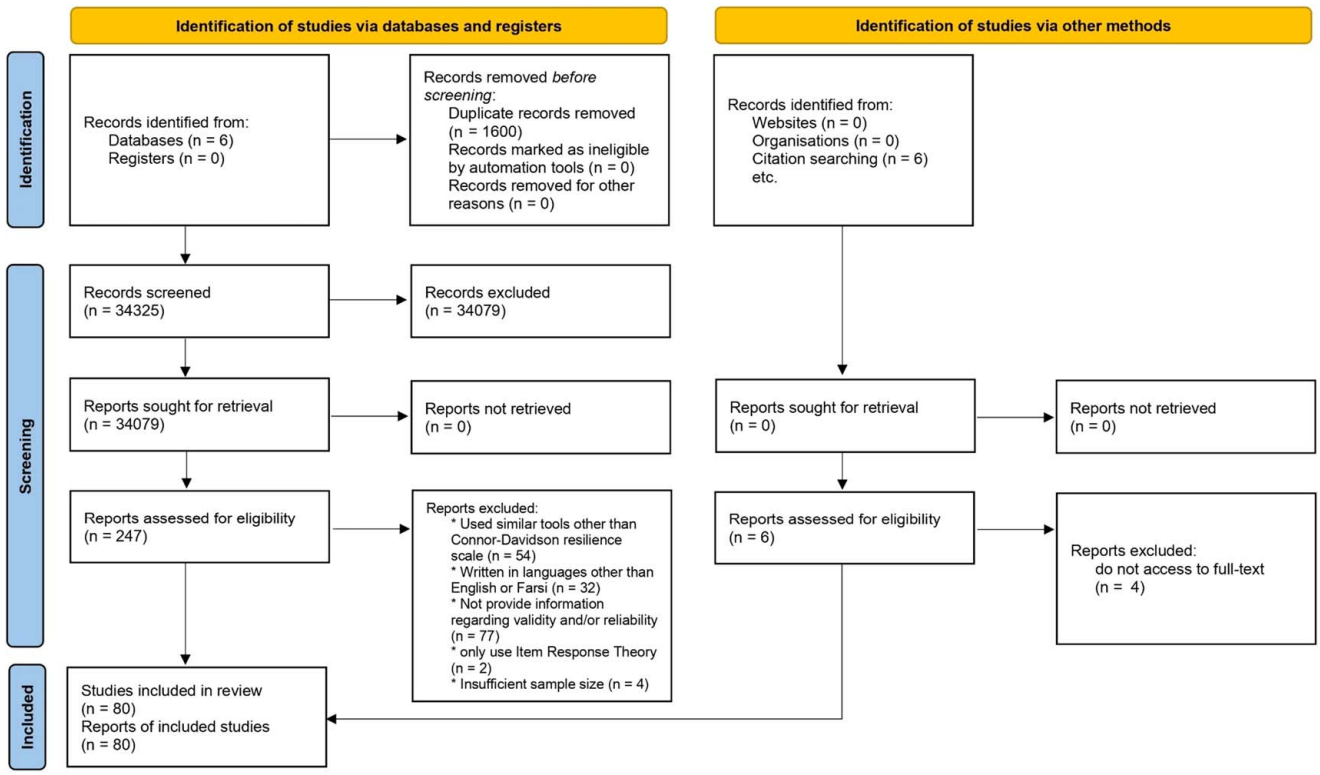

Figure 1. PRISMA flow chart.

exception being when a shortened version of an instrument is compared to its original long version. In such cases, the original long version can be considered the gold standard[19]. Any disagreements were settled by discussion and arbitration. The Cohen's Kappa value was used to evaluate the inter-reviewer reliability. Any disagreements were settled by discussion and arbitration.

Data collection and construct validity assessment

For each study, the following details were considered: authors, publication year, country, average age of participants (or range), type of sample, sample size, sampling method, number of factors, total variance explained and variance of each factor, and reliability outcomes. Principal Component Analysis (PCA) and Exploratory Factor Analysis (EFA), were two methods used to extract factors, have differences, but many researchers have used them interchangeably, and PCA is frequently used when EFA would be more appropriate[20]. As a result, PCA will have a higher percentage of the extracted variance than EFA because it concentrates on the total variation among the variables rather than the shared variance of the variables[21]. Around 60% of the total extracted variance is typically explained by factor analysis models in the social and behavioural sciences[22].

Results

Study characteristics

Considering the inclusion criteria, 80 documents were evaluated[7,8,23–99]. All of the documents were original articles. Out of these three articles, 3.75% used Item Response Theory methods in addition to the Classic Test Method for validating the tool. Different versions of the CD-RISC were evaluated in the studies. In 10 articles, 12.5% evaluated more than one version of the scale. The 25-item version of the CD-RISC was psychometrically assessed in 44 studies, the 10-item version in 40 studies, and the 2-item version in 7 studies. For the 25-item version, a minimum of one factor and a maximum of five factors were extracted[42]. For the 10-item version, one and eventually two[26,62,74,83,100] factors were identified.

The majority of studies took place in the United States (15 studies, 18.75%), followed by China (12 studies, 15.00%). The publication period of the articles included in the current study ranged from 2003 to 2023, with the highest number of articles (13 articles, 16.25%) published in 2016. A diverse spectrum of individuals was examined as the research population, with the majority being the general population (13 studies), students (12 studies), adolescents and youth (12 studies). Patients, adults with autism and psychiatric disorders, employees, firefighters, family caregivers, nurses and healthcare personnel, earthquake survivors, veterans, and older adults were other populations who were assessed by researchers. Further details regarding the characteristics of the studies are provided in Appendix 2, Supplemental Digital Content 3, http://links.lww.com/MS9/A413.

Risk of Bias

After selecting the documents based on inclusion criteria, the first step in evaluating the articles was to assess the potential risk of bias using the COSMIN risk of bias checklist[16]. The results of

the risk of bias assessment for different versions of the CD-RISC are provided below:

CD-RISC-25

The method used in the PROM Development dimension of the 25-item version in 26 studies (59.1%) received a very good score in terms of parameters related to bias risk. Out of 44 studies, 39 studies (88.6%) did not evaluate the content validity of the 25-item version of the scale. Overall, more than two-thirds of the studies received a very good (26 studies, 59.1%) or adequate (9 studies, 20.5%) score in terms of structural validity, which is notable. Based on the COSMIN criterion, three studies were classified as inadequate or doubtful for assessing structural validity. Six studies (13.6%) did not evaluate the structural validity. In terms of internal consistency, 20 studies (45.5%) received a very good score in terms of the risk of bias. Out of the 44 reviewed studies, 32 studies (72.7%) did not evaluate cross-cultural validity or measurement invariance overall, and only one study (2.3%) received a very good score on these criteria. The majority of studies (28 studies, 63.8%) did not assess the reliability of the CD-RISC-25-item version, and only 3 studies (6.8%) received a very good score in terms of the risk of bias rating in the reliability dimension. Out of 44 studies, in 43 studies (97.7%), the measurement error was not assessed, and one study that evaluated this property received an inadequate score based on COSMIN's criteria. According to the definition used in this study for criterion validity, which was based on COSMIN's definition of criterion validity, none of the 44 reviewed studies evaluated the criterion validity of the 25-item version, so there was no possibility of assessing bias risk in this domain. In the hypothesis testing for the construct validity domain, the method and results of the reviewed articles were in an acceptable state, and a total of 29 articles (65.9%) received a very good or adequate score in this aspect. Only one study evaluated the responsiveness of the 25-item version of the CD-RISC, which received a doubtful score according to the COSMIN risk of bias checklist (Table 1).

CD-RISC-10

In the first domain examined, 18 studies (45%) received a very good score for the 10-item version. Similar to the 25-item version, the majority of studies (34 studies, 80%) did not evaluate the content validity of the 10-item version; as a result, there was no possibility to assess the risk of bias in the results of studies in this domain.

In terms of structural validity, the 10-item version was deemed acceptable, with 27 studies (67%) receiving a very good score in this domain. Similarly, in the domain of internal consistency, the studies' status for the 10-item version was acceptable, with 32 studies (80%) receiving a very good score from COSMIN's risk of bias checklist. Out of 40 studies, 21 studies examined the cross-cultural validity or measurement invariance of the 10-item version, and 8 studies received an insufficient score in this domain. Additionally, only 18 studies out of 40 evaluated the reliability of the 10-item version, and out of these, 9 studies received an inadequate score on the risk of bias checklist. Moreover, only five studies out of 40 addressed the measurement error evaluation of the 10-item version, and out of these five studies, three received a doubtful or inadequate score on the checklist. Only three studies out of 40 evaluated the criterion validity of the 10-item version according to COSMIN's definition, and all three studies received an inadequate score. In the Hypothesis Testing for Construct Validity domain, 23 studies out of 40 evaluated this property, and similar to the 25-item version, the 10-item version's status was acceptable, with 22 studies receiving a very good score. Out of 40 studies, only one study evaluated the responsiveness of the 10-item version and allocated an adequate score to itself on the checklist (Table 2).

CD-RISC-2

Four out of seven studies did not evaluate the parameters related to the PROM Development dimension in the risk of bias Assessment Checklist for the 2-item version. Among the three studies that evaluated these parameters, two studies obtained a very good score, and one study obtained a doubtful score. None of the studies examined the content and structural validity of the 2-item version, so it was not possible to evaluate this aspect using the checklist. Out of the seven studies, five studies examined the internal consistency of the scale, with four studies receiving a very good score and one study receiving an inadequate score. Only one study examined the cross-cultural validity or measurement invariance of the 2-item version, which had a doubtful score. Three studies (49.2%) received an inadequate score in the assessment of reliability, and one study (14.3%) received an adequate score, while the remaining studies (3 studies, 42.9%) did not assess reliability. Only one study examined the measurement error of the 2-item version and received an adequate score, while the other six studies did not measure this parameter, so it was not possible to evaluate them using the checklist. Out of the seven studies, only two studies (28.6%) assigned a very good score to the criterion validity assessment based on COSMIN's definition. Similar to the other two versions, the 2-item version had good status in terms of hypothesis testing for construct validity, with five studies (74.4%) receiving a very good score and two studies (28.6%) receiving an adequate score. Only one study (14.3%) examined the responsiveness of the 2-item version of CD-RISC and received an inadequate score from the risk of bias Checklist (Table 3).

Quality assessment

After evaluating the risk of bias, the quality of the studies was assessed based on criteria for good measurement properties (quality criteria) introduced by COSMIN[101]. The results, categorized by psychometric parameters and different versions of the scale, are as follows. Additional information is provided in Tables 4 to 6.

Structural validity

Only 22 studies (50.00%) out of the 44 reviewed articles provided "sufficient" evidence for the structural validity of the 25-item version. In terms of the quality assessment of the evidence provided regarding the psychometric properties of the 10-item version, 24 studies (60%) out of 40 studies reported sufficient evidence for structural validity. Many studies only conducted Exploratory Factor Analysis (EFA) and, therefore, failed to provide high-quality evidence for structural validity according to the COSMIN criteria. For the 2-item version, no study succeeded in producing high-quality evidence for structural validity. However, since conducting CFA is necessary to obtain a sufficient score according to the COSMIN criteria, it seems that conducting CFA

Table 1

The COSMIN risk of bias checklist (CD-RISC-25-items).

	BOX 1	BOX 2	BOX 3	BOX 4	BOX 5	BOX 6	BOX 7	BOX 8	BOX 9	BOX 10
Author (year)	PROM development	Content validity	Structural validity	Internal consistency	Cross-cultural validity \measurement invariance	Reliability (stability with test re-test)	Measurement error	Criterion validity	Hypotheses testing for construct validity	Responsiveness
Abdi *et al.* (2019)[23]	Very good	—	Very good	Very good	—	—	—	—	—	—
Tsigkaropoulou *et al.* (2018)[87]	Very good	—	Adequate	Very good	—	Very good	—	—	Very good	—
Bakhshayesh Eghbali *et al.* (2022)[29]	Very good	Adequate	Very good	Very good	—	—	—	—	—	—
Bezdjian *et al.* (2017)[30]	Very good	—	—	Inadequate	—	—	—	—	Very good	—
Campbell-Sills and Stein (2007)[33]	Very good	—	Very good	Inadequate	—	Inadequate	—	—	Very good	—
Connor and Davidson (2003)[4]	Very good	—	Adequate	Doubtful	—	Adequate	—	—	Very good	Doubtful
Solano *et al.* (2016)[84]	Very good	Doubtful	Adequate	Very good	—	Very good	—	—	Very good	—
Derakhshanrad *et al.* (2014)[37]	Very good	—	—	Doubtful	—	—	—	—	—	—
Kuiper *et al.* (2019)[59]	Very good	—	—	Very good	—	Inadequate	—	—	Very good	—
Dominguez-Cancino *et al.* (2022)[38]	Very good	Adequate	Very good	Doubtful	—	—	—	—	—	—
Anjos *et al.* (2019)[27]	Very good	—	Very good	Doubtful	—	—	—	—	Very good	—
Fujikawa *et al.* (2013)[40]	Very good	—	Very good	Doubtful	Doubtful	Inadequate	—	—	Very good	—
Gao *et al.* (2021)[41]	Very good	—	Very good	Doubtful	Doubtful	Inadequate	—	—	—	—
García León *et al.* (2019)[42]	Very good	—	Adequate	Doubtful	Doubtful	—	—	—	Very good	—
Goins *et al.* (2013)[43]	Very good	—	Doubtful	Very good	Inadequate	—	—	—	Very good	—
Gonzalez *et al.* (2016)[44]	Very good	—	Very good	Very good	Doubtful	—	Inadequate	—	Very good	—
Gouda *et al.* (2022)[46]	Very good	—	Inadequate	Inadequate	—	Inadequate	—	—	—	—
Guihard *et al.* (2018)[50]	Very good	Inadequate	Very good	Inadequate	—	Very good	—	—	—	—
Guarnizo Guzmán *et al.* (2019)[49]	Very good	—	Very good	Very good	Very good	—	—	—	—	—
Baek *et al.* (2010)[28]	Very good	—	Adequate	Doubtful	—	Doubtful	—	—	Very good	—
Jorgensen and Seedat (2008)[53]	Very good	—	Very good	Inadequate	Doubtful	—	—	—	—	—
Jung *et al.* (2012)[54]	Very good	—	Very good	Inadequate	—	Inadequate	—	—	Very good	—
Karaırmak (2010)[55]	Very good	—	Very good	Very good	—	Inadequate	—	—	Very good	—
Khoshouei (2009)[57]	Very good	—	Adequate	Doubtful	—	Doubtful	—	—	—	—
Kidd *et al.* (2019)[58]	Very good	—	Adequate	Very good	—	—	—	—	Very good	—
Wu *et al.* (2017)[93]	—	—	Very good	—	—	—	—	—	Very good	—
Madewell *et al.* (2016)[64]	—	—	Very good	Very good	—	—	—	—	Adequate	—
Manzano García and Ayala Calvo (2013)[65]	—	—	Very good	Inadequate	—	—	—	—	—	—
Martinez *et al.* (2021)[66]	—	—	Very good	Very good	Inadequate	—	—	—	Adequate	—
Bizri *et al.* (2022)[31]	—	—	—	Inadequate	—	—	—	—	Adequate	—
McGillivray and Ho (2016)[67]	—	—	Adequate	Very good	—	—	—	—	Adequate	—

Mealer *et al.* (2016)[68]	—	—	Very good	Very good	—	—	—	—	Adequate	—
Miller *et al.* (2021)[70]	—	—	—	Inadequate	—	—	—	—	Very good	—
Nagle *et al.* (2021)[72]	Doubtful	—	Very good	Inadequate	Inadequate	Inadequate	—	—	Adequate	—
Sexton *et al.* (2016)[78]	—	—	Adequate	Inadequate	—	—	—	—	Adequate	—
Sharif-Nia *et al.*, (2021)[99]	—	Inadequate	Very good	Very good	—	—	—	—	—	—
Sharif Nia *et al.* (2023)[8]	—	—	Very good	Very good	Doubtful	—	—	—	—	—
Singh and Yu (2010)[82]	—	—	Doubtful	Very good	Inadequate	—	—	—	Adequate	—
Velickovic *et al.* (2020)[89]	—	—	Very good	—	—	—	—	—	Adequate	—
Yu and Zhang (2007)[96]	—	—	Very good	Very good	—	—	—	—	Adequate	—
Yu *et al.* (2011)[97]	Doubtful	—	Very good	Very good	Doubtful	—	—	—	Adequate	—
Xie *et al.* (2016)[94]	—	—	Very good	Very good	—	Inadequate	—	—	Adequate	—

CD-RISC, Connor-Davidson Resilience Scale.

for the 2-item version was not feasible. Therefore, in this domain, acceptable evidence from a quality perspective has not been provided.

Internal consistency

From the perspective of internal consistency for the 25-item version, only half of the studies, specifically 23 articles (52.3%), were able to provide "sufficient" evidence based on the quality criteria introduced by COSMIN. As for the internal consistency of the 10-item version, the situation was relatively acceptable, with 36 studies (90%) out of 40 studies providing high-quality (sufficient) evidence for internal consistency. For the 2-item version, four studies (57.1%) out of seven studies succeeded in producing sufficient evidence.

Reliability

For the 25-item version, the results indicated an unacceptable situation in terms of reliability, and the majority of studies (39 articles, 88.6%) were unable to provide conclusive results in this regard and were in an "indeterminate" state. Most studies that evaluated the 10-item version (36 studies, 87.5%) were also in an "indeterminate" state in this domain. The majority of studies had not evaluated this aspect. Similarly, for the 2-item version, almost the majority of studies (6 studies, 85.7%) have not provided evidence in this area, and the studies were in an "indeterminate" state.

Measurement error

For the 25-item version, almost no results were available in terms of measurement error, and consequently, this dimension was in an "indeterminate" state for all studies. In terms of the evidence produced regarding measurement error for the 10-item version, the majority of studies (39 studies, 97.5%) were unable to provide sufficient quality evidence for this property and were in an "indeterminate" state. Additionally, for the 2-item version, almost all the studies did not provide evidence regarding the assessment of measurement error, and all of them (seven studies) were in an "indeterminate" state.

Hypotheses testing for construct validity

More than half of the studies (30 studies, 68.2%) that examined this feature in the 25-item version were able to provide "sufficient" evidence. In this domain, the evidence quality generated for the 10-item version was "sufficient" according to 27 studies (67.5%). For the 2-item version, all studies provided "sufficient" evidence for the hypothesis testing for the construct validity domain.

Cross-cultural validity/measurement invariance

For the 25-item version, the majority of studies (36 articles, 81.8%) were in an "indeterminate" state in terms of quality for cross-cultural validity and measurement invariance. For the 10-item version, only 13 studies (32.5%) were able to provide "sufficient" evidence for cross-cultural validity of measurement invariance. Out of the seven studies that conducted psychometric analysis on the 2-item version, six studies did not produce evidence regarding examining cross-cultural validity or

Table 2

The COSMIN risk of bias checklist (CD-RISC-10-items).

	BOX 1	BOX 2	BOX 3	BOX 4	BOX 5	BOX 6	BOX 7	BOX 8	BOX 9	BOX 10
Author (year)	**PROM development**	**Content validity**	**Structural validity**	**Internal consistency**	**Cross-cultural validity \measurement invariance**	**Reliability**	**Measurement error**	**Criterion validity**	**Hypotheses testing for construct validity**	**Responsiveness**
Alarcón *et al.* (2020)[24]	Very good	—	Very good	Very good	—	—	—	—	Very good	—
Aloba *et al.* (2016A)[26]	Very good	—	Very good	Very good	—	—	—	—	Very good	—
Aloba *et al.* (2016B)[25]	Very good	—	Adequate	Very good	—	Inadequate	—	—	Very good	—
Blanco *et al.* (2019)[32]	Very good	—	Very good	Very good	—	Inadequate	—	—	Very good	—
Cheng *et al.* (2020)[34]	Very good	—	Very good	Very good	Very good	Inadequate	—	Inadequate	Very good	—
Coates *et al.* (2013)[35]	Very good	—	Very good	Very good	—	—	—	—	Very good	—
Daniel-González *et al.* (2020)[36]	Very good	Inadequate	Very good	Inadequate	Very good	Inadequate	—	—	Very good	—
Kuiper *et al.* (2019)[59]	Very good	—	—	Very good	—	Inadequate	—	—	Very good	—
Duong and Hurst (2016)[39]	Very good	Inadequate	Very good	Doubtful	Doubtful	Inadequate	—	—	Very good	—
Goins *et al.* (2013)[43]	Very good	—	Doubtful	Very good	Inadequate	—	—	—	Very good	—
Gonzalez *et al.* (2016)[44]	Very good	—	Very good	Very good	Doubtful	—	Inadequate	—	Very good	—
Gorman *et al.* (2021)[45]	Very good	—	Very good	—	—	Inadequate	—	—	—	—
Gras *et al.* (2019)[47]	Very good	—	Very good	—	Doubtful	—	—	—	—	—
Guarnizo Guzmán *et al.* (2019)[49]	Very good	—	Very good	Very good	Very good	—	—	—	—	—
Kwan *et al.* (2019)[60]	Very good	Adequate	Very good	Doubtful	—	Very good	Very good	—	Very good	—
Hwang *et al.* (2020)[51]	Very good	—	Very good	Inadequate	Inadequate	Inadequate	—	—	Very good	—
Keyhani *et al.* (2015)[56]	Very good	—	Doubtful	Inadequate	—	—	—	—	Very good	—
Lauridsen *et al.* (2017)[62]	—	Inadequate	Doubtful	Very good	—	—	—	—	Adequate	Adequate
Levey *et al.* (2021)[63]	—	—	Adequate	Very good	—	—	—	—	Very good	—
Madewell *et al.* (2016)[64]	—	—	Very good	Very good	—	—	—	Inadequate	Adequate	—
Meng *et al.* (2019)[69]	—	—	Very good	Very good	Very good	Doubtful	—	—	—	—
Miller *et al.* (2021)[70]	—	—	—	Very good	—	—	—	Inadequate	Very good	—
Minh-Uyen and Im (2021)[71]	—	—	Very good	Very good	—	—	—	—	—	—
Nartova-Bochaver *et al.* (2021)[73]	Doubtful	—	Very good	Very good	Doubtful	—	—	—	Adequate	—
Nguyen and Dinh (2022)[74]	Doubtful	—	Very good	Very good	Inadequate	—	—	—	Very good	—
Notario-Pacheco *et al.* (2011)[76]	—	—	Doubtful	Very good	Inadequate	Doubtful	—	—	Doubtful	-
Pretorius and Padmanabhanunni (2022)[77]	—	—	Doubtful	Very good	Inadequate	—	Inadequate	—	Adequate	—
Rezaeipandari *et al.* (2022)[7]	Doubtful	Doubtful	Very good	Doubtful	Inadequate	Doubtful	—	—	—	—
She *et al.* (2020)[80]	—	—	Very good	Very good	very good	—	—	—	Very good	—
Sharma *et al.* (2018)[79]	Doubtful		Very good	Very good	—	Adequate	Adequate	—	Very good	—
Shin *et al.* (2018)[81]	—	—	Doubtful	Very good	—	—	—	—	Adequate	—
Smith *et al.* (2019)[83]	—	—	Very good	Very good	Adequate	—	—	—	Adequate	—
Tourunen *et al.* (2021)[86]	—	—	Very good	Very good	Inadequate	Doubtful	—	—	Adequate	—
Vongsirimas *et al.* (2017)[90]	—	—	Doubtful	Very good	—	—	—	—	—	—
Waddimba *et al.* (2022)[91]	—	—	Very good	Very good	Very good	Inadequate	—	—	Adequate	—
Wang *et al.* (2010)[92]	—	—	Doubtful	Very good	—	Doubtful	—	—	9a: Very good 9b: Adequate	—
Ye *et al.* (2017)[95]	—	Very good	Very good	Very good	—	Doubtful	—	—	Adequate	—
Zhang *et al.* (2021)[98]	—	—	Very good	Very good	Doubtful	—	—	—	Very good	—

CD-RISC, Connor-Davidson Resilience Scale.

Table 3

The COSMIN risk of bias checklist (CD-RISC-2-items).

	BOX 1	BOX 2	BOX 3	BOX 4	BOX 5	BOX 6	BOX 7	BOX 8	BOX 9	BOX 10
Author (year)	PROM development	Content validity	Structural validity	Internal consistency	Cross-cultural validity \measurement invariance	Reliability	Measurement error	Criterion validity	Hypotheses testing for construct validity	Responsiveness
Kuiper *et al.* (2019)[59]	Very good	—	—	Very good	—	Inadequate	—	—	Very good	—
Jeong *et al.* (2015)[52]	Very good	—	—	Inadequate	Doubtful	—	—	—	Very good	—
Ni *et al.* (2016)[75]	—	—	—	Very good	—	—	—	Very good	Very good	—
Shamna *et al.* (2018)[79]	Doubtful	—	—	—	—	Adequate	Adequate	Very good	Very good	—
Vaishnavi *et al.* (2007)[88]	—	—	—	—	—	Inadequate	—	—	9a: Adequate 9b: Doubtful	Inadequate
Waddimba *et al.* (2022)[91]	—	—	—	Very good	—	Inadequate	—	Inadequate	Adequate	—
Zhang *et al.* (2021)[98]	—	—	—	Very good	—	—	—	Inadequate	Very good	—

CD-RISC, Connor-Davidson Resilience Scale.

measurement invariance, and one study provided "insufficient" evidence in this domain.

Criterion validity

For the 25-item version of the scale, all studies were in an "indeterminate" state in terms of quality for criterion validity assessment. Similarly, for the 10-item version of the scale, the majority of studies (25 studies, 62.5%) were in an "indeterminate" state. For the 2-item version, three studies (42.9%) successfully provided "sufficient" evidence, three studies (42.9%) were in a state of "indeterminate" evidence, and the evidence produced by one study was "insufficient".

Responsiveness

In the responsiveness domain, only one study (2.3%) for the 25-item version was able to provide "sufficient" results according to the criteria of quality assessment. For the 10-item version, no study successfully produced evidence of "sufficient" quality for responsiveness, and all 40 studies were in an "indeterminate" state. Similarly, in the 2-item version, the majority of studies (six studies, 85.7%) did not produce evidence in the domain of responsiveness, so they were in an "indeterminate" state.

Discussion

The CD-RISC stands as a robust and widely utilized tool for assessing resilience across various populations and contexts. Through its carefully crafted items, the scale captures individual differences in the ability to bounce back from adversity, adapt to challenging circumstances, and maintain psychological well-being. Its psychometric properties have been extensively studied and validated, demonstrating high levels of reliability and validity across different demographic groups, including diverse cultural backgrounds and clinical populations. Moreover, the CD-RISC has proven to be a valuable instrument in both research and clinical practice, providing insights into individuals' resilience levels and predicting outcomes related to mental health, functioning, and overall adjustment. Its versatility and effectiveness make it a valuable asset for researchers, clinicians, and practitioners alike, offering a standardized means of assessing resilience that can inform interventions and support strategies tailored to individuals' needs.

Among the various measures developed to assess psychological resilience, the CD-RISC has been used in a large-scale study population and settings and has exhibited different but mostly good psychometric evaluation results. The current systematic review sought to investigate the psychometric properties of three versions of CD-RISC by summarizing and analyzing the existing literature in this field. The current study revealed that the maximum number of published papers in the field of psychological resilience originated in the United States and China in 2016. According to Scimago Journal & Country Rank (SJR), the United States published more than 707 000 scientific documents about Resilience, and China, with more than 502 000 published documents were the top-rank countries in the world in 2016. Furthermore, the United States was the first-rank country with the highest scientific publication in applied psychology (n = 3717 documents) and clinical psychology (n = 5910) in 2016[102]. Although these statistics can support the current study

Table 4

Quality assessment (CD-RISC-25-items).

	Criteria for good measurement properties							
Author (year)	**Structural validity**	**Internal consistency**	**Reliability**	**Measurement error**	**Hypotheses testing for construct validity**	**Cross-cultural validity\measurement invariance**	**Criterion validity**	**Responsiveness**
Abdi *et al.* (2019)[23]	+	+	?	?	?	?	?	?
Tsigkaropoulou *et al.* (2018)[87]	?	+	+	?	+	?	?	?
Bakhshayesh Eghbali *et al.* (2022)[29]	+	+	?	?	?	?	?	?
Bezdjian *et al.* (2017)[30]	?	?	?	?	+	?	?	?
Campbell-Sills and Stein (2007)[33]	+	?	?	?	+	?	?	?
Connor and Davidson (2003)[4]	?	+	+	?	+	?	?	+
Solano *et al.* (2016)[84]	?	+	+	?	+	?	?	?
Derakhshanrad *et al.* (2014)[37]	?	+	?	?	?	?	?	?
Kuiper *et al.* (2019)[59]	?	+	?	?	+	?	?	?
Dominguez-Cancino *et al.* (2022)[38]	+	–	?	?	?	?	?	?
Anjos *et al.* (2019)[27]	+	–	?	?	+	?	?	?
Fujikawa *et al.* (2013)[40]	+	+	?	?	+	+	?	?
Gao *et al.* (2021)[41]	+	+	?	?	?	+	?	?
García León *et al.* (2019)[41]	–	+	?	?	+	+	?	?
Goins *et al.* (2013)[43]	+	+	?	?	+	?	?	?
Gouda *et al.* (2022)[46]	?	–	?	?	?	?	?	?
Green *et al.* (2014)[48]	+	+	?	?	+	?	?	?
Guihard *et al.* (2018)[50]	+	–	+	?	?	?	?	?
Guarnizo Guzmán *et al.* (2019)[49]	+	+	?	?	?	+	?	?
Baek *et al.* (2010)[28]	+	–	?	?	+	?	?	?
Jorgensen and Seedat (2008)[53]	+	–	?	?	?	?	?	?
Jung *et al.* (2012)[54]	+	–	?	?	+	?	?	?
Karaırmak (2010)[55]	+	+	?	?	+	?	?	?
Khoshouei (2009)[57]	?	+	?	?	?	?	?	?
Kidd *et al.* (2019)[58]	?	+	?	?	+	?	?	?
Wu *et al.* (2017)[93]	+	–	?	?	+	?	?	?
Madewell *et al.* (2016)[64]	–	+	?	?	+	?	?	?
Manzano García and Ayala Calvo (2013)[65]	?	–	?	?	?	?	?	?
Martinez *et al.* (2021)[66]	+	+	?	?	+	+	?	?
Bizri *et al.* (2022)[31]	?	?	?	?	+	?	?	?
Mealer *et al.* (2016)[68]	–	+	?	?	+	?	?	?
Ni *et al.* (2016[75]	?	?	?	?	+	?	?	?
Miller *et al.* (2021)[70]	?	?	?	?	+	?	?	?
Nagle *et al.* (2021)[72]	+	?	?	?	+	?	?	?
Sexton *et al.* (2016)[78]	?	?	?	?	+	?	?	?
Sharif-Nia *et al.*, (2021)[99]	+	+	?	?	?	?	?	?
Sharif Nia *et al.* (2023)[8]	+	–	?	?	?	+	?	?
Singh and Yu (2010)[82]	–	–	?	?	+	?	?	?
Velickovic *et al.* (2020)[89]	–	?	?	?	?	–	?	?
Yu and Zhang (2007)[96]	–	–	?	?	+	?	?	?
Yu *et al.* (2011)[97]	+	–	?	?	+	?	?	?
Xie *et al.* (2016)[96]	–	+	+	?	+	?	?	?

CD-RISC, Connor-Davidson Resilience Scale.

Table 5

Quality assessment (CD-RISC-10-items).

	Criteria for good measurement properties							
Author (year)	Structural validity	Internal consistency	Reliability	Measurement error	Hypotheses testing for construct validity	Cross-cultural validity\measurement invariance	Criterion validity	Responsiveness
Alarcón *et al.* (2020)[24]	+	+	?	?	+	?	?	?
Aloba *et al.* (2016A)[26]	+	+	?	?	+	?	?	?
Aloba *et al.* (2016B)[25]	?	+	?	?	+	?	?	?
Blanco *et al.* (2019)[32]	+	+	?	?	+	?	?	?
Cheng *et al.* (2020)[34]	+	+	?	?	+	+	?	?
Coates *et al.* (2013)[35]	+	+	?	?	+	?	?	?
Daniel-González *et al.* (2020)[36]	+	+	?	?	+	+	?	?
Kuiper *et al.* (2019)[59]	?	+	?	?	+	?	?	?
Duong and Hurst (2016)[39]	+	+	?	?	+	+	?	?
Goins *et al.* (2013)[43]	+	+	?	?	+	?	?	?
Gonzalez *et al.* (2016)[44]	+	+	?	?	+	+	?	?
Gorman *et al.* (2021)[45]	+	?	?	?	?	?	?	?
Gras *et al.* (2019)[47]	+	?	?	?	?	+	?	?
Guarnizo Guzmán *et al.* (2019)[49]	+	+	?	?	?	+	?	?
Kwan *et al.* (2019)[60]	+	+	+	+	+	?	?	?
Keyhani *et al.* (2015)[56]	–	–	?	?	+	?	?	?
Kyriazos and Stalikas (2021)	+	+	?	?	+	+	?	?
Lauridsen *et al.* (2017)[62]	?	+	?	?	+	?	?	?
Levey *et al.* (2021)[63]	?	+	?	?	+	?	?	?
Madewell *et al.* (2016)[64]	–	+	?	?	+	?	+	?
Meng *et al.* (2019)[69]	?	+	?	?	?	+	?	?
Miller *et al.* (2021)[70]	?	+	?	?	+	?	+	?
Minh-Uyen and Im (2021)[71]	–	+	?	?	?	?	?	?
Nartova-Bochaver *et al.* (2021)[73]	+	+	?	?	+	?	?	?
Nguyen and Dinh (2022)[74]	+	+	?	?	+	?	?	?
Notario-Pacheco *et al.* (2011)[76]	?	+	+	?	+	?	?	?
Pretorius and Padmanabhanunni (2022)[77]	+	+	?	?	+	+	?	?
Rezaeipandari *et al.* (2022)[7]	+	+	+	?	?	?	?	?
Sharma *et al.* (2018)[79]	+	+	+	?	+	?	?	?
Shin *et al.* (2018)[81]	?	+	?	?	+	?	?	?
Smith *et al.* (2019)[83]	+	–	?	?	+	+	?	?
Tomyn and Weinberg (2018)	?	+	?	?	+	–	?	?
Tourunen *et al.* (2021)[86]	?	+	–	?	+	–	?	?
Vongsirimas *et al.* (2017)[90]	–	+	?	?	?	?	?	?
Waddimba *et al.* (2022)[92]	+	+	?	?	One hypothesis (fear of COVID-19): -Others: +	+	?	?
Wang *et al.* (2010)[92]	?	+	?	?	hypothesis: + Known group: +	?	?	?
Ye *et al.* (2017)[95]	+	+	?	?	One hypothesis (MCMQ): -Others: +	?	?	?
Zhang *et al.* (2021)[99]	+	+	?	?	+	+	?	?

CD-RISC, Connor-Davidson Resilience Scale.

Table 6

Quality assessment (CD-RISC-2-items)

	Criteria for good measurement properties							
Author (year)	Structural validity	Internal consistency	Reliability	Measurement error	Hypotheses testing for construct validity	Cross-cultural validity\measurement invariance	Criterion validity	Responsiveness
Kulper *et al.* (2019)[59]	?	+	?	?	+	?	?	?
Jeong *et al.* (2015)[52]	?	–	?	?	+	–	?	?
Ni *et al.* (2016)[75]	?	+	?	?	+	?	+	?
Sharma *et al.* (2018)[79]	?	?	+	?	+	?	+	?
Vaishnavi *et al.* (2007)[88]	?	?	?	?	One hypothesis (ASEX): -Others: + Known group: +	?	?	+
Waddimba *et al.* (2022)[91]	?	+	?	?	One hypothesis (fear of COVID-19): -Others: +	?	–	?
Zhang *et al.* (2021)[98]	?	+	?	?	+	?	+	?

CD-RISC, Connor-Davidson Resilience Scale.

findings, further investigations are needed to determine why psychological resilience grasped the researchers' or journals' attention during 2016. Studies show that many countries were affected by the economic crisis before and during 2015 which significantly affected population health indicators[103,104]. This may be one reason why resilience drew the attention of the scientific community. The findings of a systematic review study revealed that a higher prevalence of mental health problems was the outcome of periods of economic crisis. In this regard, unemployed people or those who had a precarious work situation, as well as people who faced debts and economic strain and those who had a pre-existing mental illness, were identified as vulnerable victims of economic hardship[104]. In such a situation, it becomes important to improve people's resilience to bounce back from the adversity they face. The CD-RISC-2 is an abbreviated version of the scale that has good psychometric properties but may not capture the full range of resilience-related constructs[88]. Here are some differences between the CD-RISC and the Brief Resilience Scale (BRS); for example, CD-RISC focuses on resources that can help individuals recover from and adapt to disruptions or stressful events, but BRS Directly measures one's ability to bounce back or be resilient. The choice of which version of the scale to use may depend on the specific research question and the available resources.

The current study findings indicated that the CD-RISC versions were assessed psychometrically among a diversity of populations, including those people who were experiencing traumatic conditions, such as patients with autism[51], earthquake victims[92], persons with psychological disorders[34], as well as the general population[87]. Considering the existing definitions of psychological resilience, it is clearly stated that resilience is people's capacity derived from individual and social assets and resources for 'bouncing back' and adapting to adversities across the lifespan[105]. This indicated that both healthy and ill people, whether children or elderly, need resilience to improve their resistance to the challenges of life[106]. On the other hand, the development and vast testing of the CD-RISC was conducted in response to the lack of generalizability of the other existing resilience scales[4]. The current study findings indicated that both 25 and 10-item versions of CD-RISC were tested psychometrically almost the same; while the 25-item CD-RISC version was assessed in 44 papers, the other versions were used in 40 studies. Due to the comprehensiveness of the 25-item CD-RISC ,including more aspects of resilience and considering that the CD-RISC-10 is economically and psychometrically sounder, both versions of this scale have been used in the studies in different settings[107].

According to the COSMIN's criteria for evaluating the risk of bias, the current research findings showed limitations of included studies in assessing the three versions of CD-RISC cross-cultural and content validity as well as their stability (e.g. conducting test re-test), whereas the majority of psychometric studies of CD-RISC-25, and CD-RISC-2 rated as very good or adequate in terms of structural validity. Our findings also indicated that the included papers were qualified in term of assessing internal consistency but were weak in assessing measurement error. Assessing the methodological quality of studies included in a systematic review is crucial because ignoring it can negatively affect the trustworthiness of the results[16,101]. As an accepted strategy, the COSMIN checklist is increasingly grasping the researchers' attention to evaluating the systematic reviews'

quality. Being aware of this consideration when assessing the studies' eligibility, the COSMIN provides evidence that determines the quality of a PROM. In terms of our findings that indicated the psychometric studies' limitations in conducting or reporting the cross-cultural validity, an insufficient explanation of the scale translation/back translation process and the pretesting of the scale among the target population may result in low-quality evidence. The failure of the cross-cultural validity of scales may lead to misleading findings and inaccuracies that are a reflection of the constructs in each study setting[108]. Regarding the lack of assessment of measurement error, it may lead to failure in estimating the influences of different sources of scores on variation. In other words, assessing the measurement error in each psychometric study can guide the researchers to decide about the level of trust they can place in the study findings and whether the parameters that where estimated are systematically not over- or underestimated[101]. As a result, considering the COSMIN criteria while designing and conducting a psychometric study can be suggested to the researcher in order to improve the study's quality.

In terms of quality assessment of the included studies, the current study indicated that investigating the structural validity of the CD-RISC by researchers was mainly done based on EFA, and a lack of evaluating confirmatory factor analysis was evident. It should be mentioned that measurement is the process by which a concept relates to one or more latent variables, and the latent variables link to the observed variables, which are usually items in a questionnaire[109]. During the development and psychometrically testing of a questionnaire to explore the underlying factors or dimensions (subscales) that explain the relationships between the items, that is called construct validity, to simplify a set of complex items (variables) using statistical techniques. Factor analysis (FA) is used as the most common method for construct validity[110]. In fact, factor analysis is used to assess the construct validity as the heart of the design and development of a scale, questionnaire, instrument, and or tool[111]. Construct validity by EFA provides evidence based on test content and internal structure that it tells us what the questionnaire, scale, or instrument really measures as an abstract concept[112]. EFA is a data reduction statistical technique that reflects the theoretical structure of phenomena and summarizes its underlying variables[113,114]. The emphasis of EFA is on the relationships among the items that use "shared covariance" to identify factors[115,116]. It is important to mention that the extracted factors in EFA should be interpreted as explanatory and not causality. Following EFA, confirmatory factor analysis (CFA) usually applies to verifying the emerged factor structure of a set of observed variables and helps to test the hypothesis regarding how the variables are related to each other[117]. In addition to assessing the model fit and the residual error variances of the observed variables, CFA estimates the factor loadings, variances, and covariances of the factors[118]. Due to the requirements of conducting CFA (e.g. existing the number of factors), the COSMIN checklist guides the researchers to consider whether CFA is more appropriate[18]. Accordingly, conducting CFA is not feasible for CD-RISC-2.

From the point of view of the quality of the available evidence, in terms of hypotheses testing for construct validity, the CD-RISC-2 was rated sufficient, and more than half of the included studies were rated as sufficient for the 25-item and 2-item versions. Hypothesis testing roughly determines whether the relationship's direction and magnitude or difference is comparable to what can be predicted based on the structure(s) being measured. The more hypotheses that are being tried on whether the information compares to previously formulated hypotheses, the more proof is assembled to build construct validity[120]. It has been recommended to provide clear data regarding the missing items, the sample size, the previously estimated mean differences, and correlations, as well as describe convergent validity to improve the study's quality in this aspect[119,120].

In almost all of the studies (except three studies), the responsiveness of the CD-RISC versions was not investigated. Detecting the construct changes over time is the aim of responsiveness, and it is usually needed to use another instrument for the study samples in the same situation and time. Due to its difficulty in terms of methodology as well as the restricted introduction of responsiveness based on COSMIN, many researchers, especially clinicians, don't assess it, and reporting it remains a challenge in many studies[121].

In the case of CD-RISC factor structure, the included studies assessed the 25-item version indicated that the factor structures have differed from the original five-factor version[4]. It was different from 1-factor structure[42], two-factor version[48], three-factor version[67], and 4-factor structure[78]. Similarly, the CD-RISC-10-item exhibited this difference from the original version. Considering the complex nature of resilience, the mentioned variety may suggest that the process or the way this construct was understood by the study population of different ages, genders, cultures, and religious groups was somehow different. The samples of the studies were in different situations, faced various challenges, and had diverse individual capacities or environmental/social support systems[122].

A range of different factors can influence the psychometric properties of the CD-RISC versions in the studies. The lack of a universally agreed-upon definition of resilience can make it difficult to develop relevant measurement tools and evaluate the impact of interventions and policy changes[123]. In addition, the cultural and semantic differences between study populations can affect the validity and reliability of resilience scales[124]. Furthermore, the psychometric properties of resilience scales may correlate with the study population's age[125,126], and their socioeconomic status[123].

Limitations and Strengths

The main limitation is that we included only studies that were either in Farsi or English and did not search databases such as PsychInfo, as well as searching only three international databases. The evaluation of the quality of the studies using three tools is one of the strengths of this study.

Conclusion

In this systematic review, 80 studies were evaluated for quality and risk of bias. The general result indicates the acceptability of the quality of the studies. Measurement properties such as responsiveness and criterion validity, as well as the standard error of measurement have been neglected in most studies. The evaluation of these properties in future studies can help to create more accurate evidence about the psychometric properties of the CD-RISC versions. The findings of the present study provide an image of the psychometric status of the CD-RISC versions for

researchers and clinicians in this field and can guide them in their decision to select a study tool or conduct additional psychometric studies or adopt this tool in new populations.

Ethics approval

This study was approved in ethic committee of Mazandaran University of Medical Sciences (code: IR.MAZUMS.REC.1402.264).

Consent

Informed consent was not required for this systematic review.

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Author contribution

H.S.N. and A.H.G. contributed in study design. A.B. and A.H.G. contributed in searching of databases. Evaluation of the quality of the studies has done by L.H. and S.H. Also, H.S.N., A.H.G., S.H., L.H., F.K.F., M.M., and F.M. wrote the manuscript. D.S.T., E.S.F., and H.S.H. critically revised the manuscript. All of the authors proved the final version of manuscript.

Conflicts of interest disclosure

The authors declare no conflict of interests.

Research registration unique identifying number (UIN)

This study wasn't submitted in Prospero. So, just the proposal of this study was approved by student research committee of Mazandaran University of medical sciences.

Guarantor

Amir Hossein Goudarzian.

Data availability

This article was derived from secondary sources (published research articles) which are cited in the reference list. No primary data are included. All data generated or analyzed during this study are included in this published article.

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