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Validation of the Disaster Adaptation and Resilience Scale for Vulnerable Communities in Vietnam's Coastal Regions

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Objectives: This study validated the Vietnamese version of the Disaster Adaptation and Resilience Scale (DARS) for use in vulnerable communities in Vietnam.

Methods: This was a cross-sectional study involving 595 adults from 2 identified communities. The original DARS assessment tool was translated, and the validity and reliability of the Vietnamese version of DARS (V-DARS) were assessed. The internal consistency of the overall scale and its subscales was evaluated using Cronbach's alpha and McDonald's omega reliability coefficients. Confirmatory factor analysis (CFA) was employed to evaluate its construct validity, building upon the factor structure identified in exploratory factor analysis (EFA). Construct validity was assessed based on convergent and discriminant validity.

Results: Following the established criteria for EFA, 8 items were removed, resulting in a refined V-DARS structure comprising 35 items distributed across 5 distinct factors. Both alpha and omega reliability coefficients indicated strong internal consistency for the overall scale ($\alpha=0.963$, $\omega=0.963$) and for each of the 5 sub-scales (all >0.80). The CFA model also retained the 5-factor structure with 35 items. The model fit indices showed acceptable values (RMSEA: 0.072; CFI: 0.912; TLI: 0.904; chi-square test: <0.01). Additionally, the convergent and discriminant validity of the V-DARS were deemed appropriate and satisfactory for explaining the measurement structure.

Conclusions: Our findings suggest that the V-DARS is a valid and reliable scale for use within vulnerable communities in Vietnam to assess adaptive responses to natural disasters. It may also be considered for use in other populations.

Key words: Disaster Adaptation and Resilience Scale, Validity, Reliability, Vietnam

INTRODUCTION

With a coastline of more than 3200 km, Vietnam is among the most disaster-prone countries in the Asia-Pacific region, frequently experiencing natural disasters such as typhoons, floods, droughts, and landslides [1]. More than 70% of the Vietnamese population lives in regions vulnerable to these natural disasters, particularly the rural and urban poor [1]. The country ranks sixth among the 10 countries most affected by extreme climate events [2]. The coastal areas of central Vietnam are particularly vulnerable to natural disasters and the effects of climate change [3]. To mitigate the adverse impacts of catastrophic events, it is crucial to establish comprehensive disaster preparedness and response strategies. Therefore, promoting individual adaptation and resilience at all levels contributes significantly to reducing risks and enhancing preparedness.

The Sendai Framework for Disaster Risk Reduction 2015-2030 highlights the significance of promoting human adaptation to disaster resilience at both individual and community levels [4]. A literature review indicates that various methods

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for disaster adaptation have been proposed. A recent review highlighted 2 critical dimensions of disaster adaptation: the spatial scale of adaptation and the nature of adaptive behavior [5]. The concept of disaster adaptation also pertains to the recovery, balance, and management of adaptations to changes in the natural environment [6].

According to the Hyogo Framework for Action (United Nations Office for Disaster Risk Reduction, 2015), "disaster resilience is determined by the degree to which individuals, communities, and public and private organizations are capable of organizing themselves to learn from past disasters and reduce the risks of future ones, at international, national, regional, and local levels" [4]. Resilience plays a crucial role in mitigating the negative impacts of disasters and promoting sustainable development by preparing resident populations before disasters occur, particularly addressing vulnerabilities at the community and individual levels [7].

Valid tools for evaluating responses in disaster and resilience contexts are considered essential for effective disaster risk reduction efforts [8]. There is a need for well-tested assessment tools to explore how humans adapt and become resilient to such events. Recently, the Disaster Adaptation and Resilience Scale (DARS) was developed and validated for the United States population that experienced disasters in 2021. This scale concentrates on individual responses in post-disaster settings. Overall, DARS highlights the significance of personal, social, and environmental resources as fundamental processes in building and maintaining resilience against adverse outcomes [9].

The impact of natural disasters on Vietnam is severe, and it is crucial to establish comprehensive disaster preparedness and response strategies for upcoming hazard events [1]. The literature indicates that developing measures of resilience applicable across diverse geographical and socioeconomic contexts remains a challenge [8]. Therefore, reliable and valid tools specifically designed to measure disaster adaptation and resilience in Vietnamese contexts are necessary. This study aimed to validate the Vietnamese version of the DARS (V-DARS) for vulnerable communities in the central coastal region of Vietnam.

METHODS

Study Design

This cross-sectional study was conducted in 2 vulnerable communities in the rural coastal region of Vietnam to investigate how residents adapt and remain resilient in the face of disasters. The original DARS was translated into Vietnamese, and its validity and reliability were assessed.

Setting

Thua Thien Hue Province, situated in the North Central Coast region of Central Vietnam, lies approximately at the country's center. It is highly susceptible to natural disasters, particularly flooding and storms [1]. According to Decision No. 353/QD-TTg of the Prime Minister of Vietnam, 7 communes in the province were identified as facing special difficulties in coastal and island areas for the period 2021-2025 [10]. Two of these communities were randomly selected to participate in this study, and data collection was performed from October 2022 to February 2023.

Sample Size

A total of 595 adults living in the selected communities were recruited. The inclusion criteria included being 18 years or older, having a permanent residence in the selected sites that had experienced a flood or typhoon disaster in the past year, and a willingness to participate. Participants were interviewed directly in their households using a structured questionnaire administered by the research team. The recruitment strategy relied on the involvement and coordination of local stakeholders, such as community health centers and people's committees.

Disaster Adaptation and Resilience Scale for the Vietnamese Population

Upon initial review, a literature search confirmed that the DARS demonstrates robust psychometric properties for assessing adaptive responses in adults affected by disasters. Developed and validated by First et al. [9], the DARS consists of 43 items spread across five dimensions. This scale has proven crucial in evaluating preparedness responses, encompassing physical and social resources, problem-solving, distress regulation, and optimism [9]. Each item is assessed based on the respondent's level of agreement with statements about their disaster experiences over the past year, using a Likert scale (0=not true at all; 1=rarely true; 2=sometimes true; 3=often true; 4=true nearly all of the time) (Supplemental Material 1).

Study Procedure

In this study, 2 independent experts with backgrounds in environmental health risk assessment and public health were

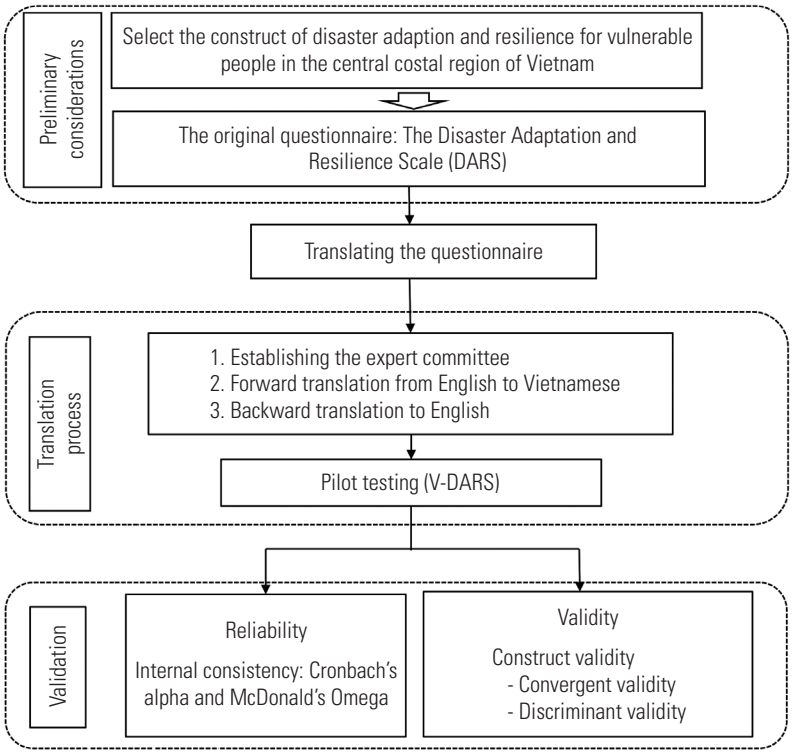

Figure 1. Validation procedure for Vietnamese version of the DARS (V-DARS).

invited to translate the English version of the DARS into Vietnamese simultaneously and independently. To ensure both the accuracy and cultural appropriateness of the translation, a team of translators then back-translated the V-DARS into English.

Pilot testing of the V-DARS was conducted with a sample of 30 adults who had experienced a natural disaster at least one year prior to participating in the same community study. The participants were stratified by age, sex, occupation, and socioeconomic status. The final version of the V-DARS was reviewed and finalized before being used in the main survey.

The validation procedure for V-DARS followed the steps outlined in Figure 1.

Statistical Methodology

The characteristics of the participants are presented using observed numbers and percentages for categorical data, and means with standard deviations (SDs) for continuous data.

Prior to conducting exploratory factor analysis (EFA), the Kaiser-Meyer-Olkin (KMO) coefficient was used to assess the adequacy of the sampling. Values between 0.80 and 1.00 indicate that the sampling is adequate for factor analysis [11]. Bartlett [12]'s test of sphericity was used to determine the suitability of the respondents' data for factor analysis.

EFA was employed to identify the latent factors underlying the questionnaire items. The maximum likelihood method was utilized for data extraction, and orthogonal rotation was applied [13].

The initial eligibility value was utilized to determine the number of factor loadings, which were then illustrated using a scree plot. The subsequent strategies for item removal were implemented during the EFA [14,15]:

(1) Factor loading: Items with factor loadings below 0.5 were removed to ensure that each item significantly contributed to its respective factor.

(2) Number of items per factor: At least 3 items were required for each item to establish an adequate measurement of the underlying construct.

(3) Cross-factor loadings: Items exhibiting high cross-loadings (greater than 0.3 on multiple factors) and minimal differences in factor loading (<0.1) were removed to reduce ambiguity and improve the distinction between factors.

Validation procedures were conducted to assess the reliability and construct validity of V-DARS. To evaluate reliability, the internal consistency of both the overall scale and its subscales

was measured using Cronbach's alpha and McDonald's omega reliability coefficients [16,17]. These statistics were deemed to indicate good internal consistency if they exceeded 0.70 [18,19]. For construct validity, the convergent and discriminant validity of the V-DARS structure were assessed through confirmatory factor analysis (CFA), which built upon the factor structure identified in the EFA. Model fit was evaluated using statistical parameters and thresholds outlined in the literature [11,20]. To ensure convergent and discriminant validity, the following parameters were calculated: composite reliability (CR), average variance extracted (AVE), maximum shared variance, average shared variance, and square root of average variance extracted (SQRTAVE).

Ethics Statement

The study received approval from the Ethics Committee in Biomedical Research at the University of Medicine and Pharmacy, Hue University (code: H2022/486, dated June 30, 2022), as well as from local authorities in the regions where the research was conducted. All participants in the study provided informed consent.

RESULTS

Participant Characteristics

Participants' general characteristics are presented in Table 1. In total, 595 adults residing in 2 vulnerable coastal communities in Vietnam participated in this study. The mean age was 52.23 years (SD, 16.71), with a range of 18-89 years. Most of the participants were married (90.4%) and worked as farmers or fishermen (41.7%). Only 4.5% of the participants had a bachelor's degree or higher, and 16.5% self-evaluated their household economic status as poor.

Exploratory Factor Analysis

EFA was applied to the original V-DARS, which included 43 items (Supplemental Material 2). Following the established criteria for item removal in the EFA, 8 items were excluded. This resulted in a refined V-DARS structure comprising 35 items distributed across 5 distinct factors. Before performing the EFA, the KMO statistic was calculated to be 0.947, indicating good sampling adequacy for the factor analysis. Additionally, Bartlett's test of sphericity was statistically significant ($p<0.001$), further supporting the suitability of the data for EFA (Supplemental Material 3).

Table 1. Participants' baseline characteristics (n=595)

Characteristics	n (%)
Sex	
Male	274 (46.1)
Female	321 (53.9)
Age, mean±SD [range], (y)	52.23±16.71 [18-89]
Community	
Giang Hai	230 (38.7)
Phu Gia	365 (61.3)
Marital status	
Single	48 (8.1)
Married	538 (90.4)
Others	9 (1.5)
Occupation	
Farmer/Fisherman	248 (41.7)
Small business	63 (10.6)
Officers	27 (4.5)
Workers	69 (11.6)
Others	188 (31.6)
Educational level	
Primary or lower	197 (32.8)
Secondary school	187 (31.4)
High school	80 (13.4)
Bachelor's or higher	27 (4.5)
Household economic status	
Poor	98 (16.5)
Not poor	497 (83.5)

SD, standard deviation.

The final EFA was conducted with 5 factors using maximum likelihood extraction and orthogonal rotation, as shown in Supplemental Material 4. It extracted a total of 35 items, categorized into social resources (8 items), distress regulation (9 items), problem-solving (8 items), factor optimism (6 items), and physical resources (4 items). Additionally, the scree plot identified five factors that met the eigenvalue criteria (>1) (Figure 2).

Reliability and Validity Estimates

Table 2 presents the reliability and validity estimates for the structural measures of the scale. Cronbach's alpha and McDonald's omega were calculated for the overall scale and its 5 dimensions to assess the internal consistency reliability of the extracted factors of the V-DARS scale. The results for both alpha and omega reliability indicated good internal consistency for the overall scale ($\alpha=0.963$, $\omega=0.963$) and for all 5 sub-scales, with reliability coefficients exceeding 0.80 in all sub-scales us-

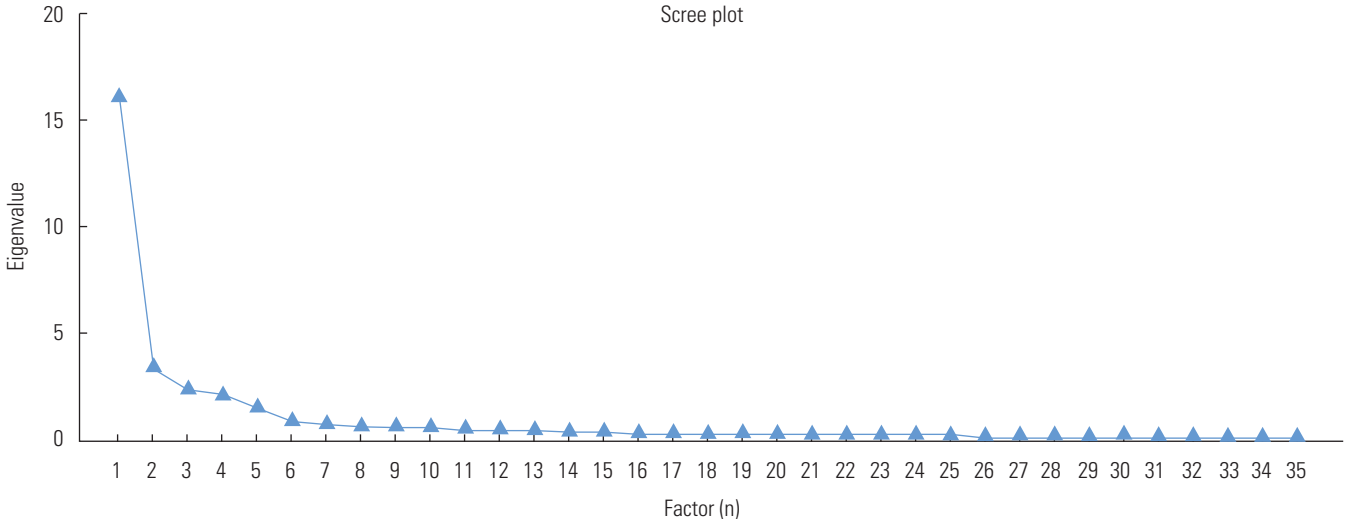

Figure 2. Scree plot for exploratory factor analysis extraction loading factors.

Table 2. Reliability and validity estimates for Vietnamese version of the Disaster Adaptation and Resilience Scale

Reliability estimates	Factors								
	No. of items			Cronbach's alpha (α)			McDonald's omega (ω)		
Global scale	35			0.963			0.963		
Distress regulation	9			0.936			0.937		
Problem-solving	8			0.957			0.958		
Social resources	8			0.929			0.930		
Optimism	6			0.932			0.934		
Physical resources	4			0.875			0.878		
Construct validity	**CR**	**AVE**	**MSV**	**MaxR(H)**	**PR**	**DR**	**PS**	**SR**	**O**
PR	0.886	0.662	0.245	0.903	0.813	-	-	-	-
DR	0.931	0.602	0.378	0.941	0.261	0.776	-	-	-
PS	0.955	0.728	0.497	0.960	0.376	0.615	0.853	-	-
SR	0.930	0.625	0.497	0.936	0.470	0.492	0.705	0.791	-
O	0.929	0.687	0.464	0.935	0.495	0.575	0.681	0.614	0.829

CR, composite reliability; AVE, average variance extracted; MSV, maximum shared variance; MaxR(H), maximum reliability; PR, physical resources; DR, distress regulation; PS, problem solving; SR, social resources; O, optimism.

ing both measures.

Convergent and discriminant validity were both acceptable and appropriate for explaining the measurement structure of the questionnaire. Convergent validity was assessed by calculating the AVE and comparing it with the CR. The CR values for the five dimensions exceeded the AVE values, with the AVE values being greater than 0.5 (AVE=0.53). Discriminant validity of the measurement models was evaluated using the Fornell and Larcker [21,22] criterion. SQRTAVE values indicated that the scale's discriminant validity was acceptable (Table 2).

Confirmatory Factor Analysis

CFA was conducted to confirm the factor structures suggested by the EFA and to examine the relationships between the latent variables (factors) and their corresponding indicators (items). Figure 3 illustrates the CFA results for the V-DARS, utilizing the factor structure identified in the EFA. The CFA model retained 5 factors with 35 items, extracted from the initial 43-item V-DARS. The model fit indices fell within acceptable ranges, supporting the suitability of the five-factor structure (RMSEA: 0.072; CFI: 0.912; TLI: 0.904; chi-square test: <0.01).

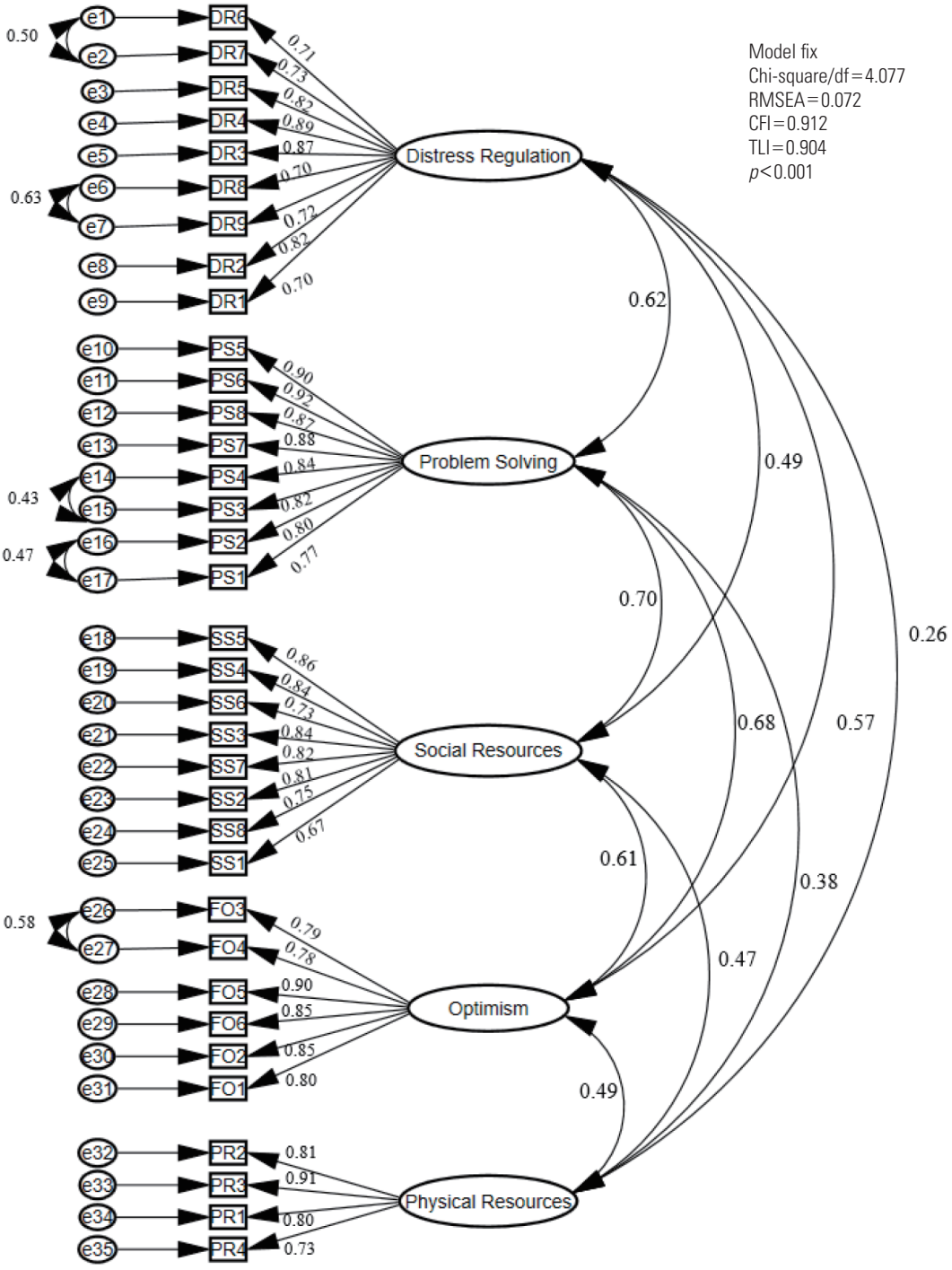

Figure 3. Factor structure and model fit indices of Vietnamese version of the Disaster Adaptation and Resilience Scale. df, degrees of freedom; RMSEA, root mean square error of approximation; CFI, comparative fit index; TLI, Tucker-Lewis index.

DISCUSSION

Given Vietnam's geographical location and extensive coastline, natural disasters significantly threaten the livelihoods and lives of millions of Vietnamese households. Effective tools for evaluating disaster response and climate resilience are essential for successful disaster risk reduction and climate adaptation. Accordingly, the current study addressed the specific needs of Vietnam, particularly in the most vulnerable communities. Since a larger sample size results in lower measurement

errors, greater accuracy, stable factor loadings, robust validity results, and better model fit [23,24], our sample size is considered adequate according to Comrey and Lee [25]. Additionally, the statistical indicators suggest that the current data are suitable for factor analysis [26].

Structural Measures of Vietnamese Version of the Disaster Adaptation and Resilience Scale

Structural measures for DARS were investigated using EFA. The process for selecting the final V-DARS, based on item removal strategies, is presented in Supplemental Material 5. The analysis was conducted iteratively, with each item being removed sequentially. The initial strategy involved eliminating items individually, starting with those exhibiting the lowest factor loadings. According to model 2, 5 items were removed because their factor loadings fell below the 0.5 threshold (F1, F6-9). The subsequent strategy concentrated on the number of items contributing to each factor. Model 3 showed only 2 items, F10 and F19, contributing to factor loading, leading to their exclusion in subsequent steps. The third strategy addressed cross-factor loading. Model 4 identified item F37 as having cross-loadings in both the distress regulation (0.472) and optimism (0.482) factors, with a negligible difference of less than 0.1.

According to the criteria for item removal, the modified structural measure excluded 8 items, including: "having insurance to cover disaster-related damages," "having enough money to pay my rent or mortgage when it is due," "having access to clean water," "having access to medical professionals and services (e.g., doctors, hospitals, pharmacies)," "having a plan for safety in the event of a disaster," "having friends during difficult times," "being able to talk with my friends about my problems," and "believing in my ability to make it through difficult times" (Supplemental Material 4).

Several possible reasons may explain why 8 items were dropped during the EFA. Disaster adaptation and resilience is a relatively new concept for the overall Vietnamese population, particularly in vulnerable communities. Therefore, they may not fully perceive disaster adaptation and resilience. The designed items might lack the intrinsic ability to capture perceptions of the issue due to bias or unclear wording. Additionally, variations in perceptions of adaptation and resilience could be attributed to differences in regions, socioeconomic status, contextual and cultural factors, and disaster patterns.

The current results suggest that the final V-DARS is not limited to the original version with 43 items; however, the structural measures were consistent with the initial findings reported by First et al. [9].

The CFA results identified 5 factor loadings: distress regulation, problem-solving, social resources, optimism, and physical resources (Figure 3).

Confirming the factor structures identified in the EFA, these findings provide strong evidence of model fit (Figure 3). Previous studies have shown that the model fit falls within an acceptable range [26,27]. Supplemental Material 4 lists the item loadings for the five dimensions, along with the total extraction and the percentage of variance explained. The results demonstrate that all items had loadings greater than 0.5 for their respective loading factors.

Reliability Estimates and Construct Validity

The Cronbach's alpha coefficient is widely used to assess reliability, but it relies on the assumption of tau equivalence, which may not always hold [16]. Therefore, the omega coefficient was calculated as an alternative reliability measure for the V-DARS [19,28]. In this study, both coefficients demonstrated good internal consistency for the V-DARS, with values exceeding 0.8 for both the overall scale and the subscales. These findings align with those from the original DARS by First et al. [9], where both alpha and omega coefficients showed high reliability for the subscales (e.g., alpha $>$ 0.86) and the overall scale (0.96).

Strengths and Limitations

The current study is one of the few that addresses the need to develop valid and reliable tools for disaster adaptation and resilience, particularly in the poorest and most vulnerable communities affected by natural events. These findings provide evidence supporting the development of community-based interventions for disaster preparedness and response. The study design and statistical methods were appropriate, and larger samples improved the reliability and accuracy of the results.

However, the study has several limitations that need to be considered for further research. This is a cross-sectional design, and responses to disasters can change over time following a disaster. Longitudinal studies should be employed to investigate these issues. Natural disasters have huge impacts on various areas, and further studies need to explore adaptation and resilience in other fields, among healthcare providers, and at community and national policy levels.

NOTES

Data Availability

Data will be made available on request to the corresponding author.

Supplemental Materials

Supplemental materials are available at https://doi.org/10.3961/jpmph.24.110.

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

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Author Contributions

Conceptualization: Nguyen TG, Le DD. Data curation: Tran BT, Nguyen MT. Formal analysis: Tran BT, Le DD. Funding acquisition: Nguyen TG. Methodology: Tran BT, Nguyen MT, Le DD. Project administration: Tran BT, Le DD. Visualization: Le DD. Writing – original draft: Nguyen TG, Tran BT, Nguyen MT, Le DD. Writing – review & editing: Nguyen TG, Tran BT, Nguyen MT, Le DD.

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