



Designing and Psychometric Evaluation of a Questionnaire for Assessing Society's Perception of Flash Flood Risk

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Abstract

Background: Public perception of risks associated with natural disasters like flash floods significantly influences disaster management effectiveness. Flash floods pose a major threat to life and property, and a lack of tools to evaluate societal risk perception creates a critical gap.

Objectives: This study aimed to design and evaluate the psychometric properties of a questionnaire specifically assessing society's perception of flash flood risk.

Methods: A two-stage approach was employed. The first stage involved collecting questionnaire items through a systematic literature review and a qualitative study. In the second stage, a comprehensive psychometric evaluation was conducted, including assessments of face validity, content validity, and construct validity. Reliability was established using Cronbach's alpha. Confirmatory factor analysis was further conducted with data collected from 136 community members who had experienced flash floods. Data analysis was performed using SPSS version 20 and AMOS software.

Results: A combination of qualitative data and systematic review findings facilitated the development of 36 initial questionnaire items. Applying quantitative and qualitative construct validity measures led to the refinement of the instrument, resulting in 29 final items categorized into three domains: Risk perception (12 items), awareness (10 items), and preparedness (7 items). The internal consistency of the instrument was confirmed by a Cronbach's alpha coefficient of 0.88. Factor analysis further supported the good fit of the hypothesized model to the data.

Conclusions: This study successfully developed and rigorously evaluated a questionnaire to assess society's perception of flash flood risk. This instrument offers valuable insights for informed decision-making and identification of factors influencing risk perception, ultimately contributing to improved disaster preparedness and management.

Keywords: Flash Flood, Risk Perception, Questionnaire, Psychometrics

1. Background

Floods, as a natural occurrence, can have serious effects on people and communities. Every year, many people die due to natural disasters like floods, and many others suffer physical and material injuries (1). Additionally, floods can result in the loss of homes and jobs, causing both material and psychological harm to affected individuals (2). Flash floods, which occur rapidly and cause extensive harm, are usually associated with short, high-intensity rainfall and impact local

areas. They typically affect watersheds of less than 1 000 km² and have response times of a few hours or less. Iran, situated in the geographical path of the Alpine-Himalayan orogeny belt, has a varied climate and has historically experienced natural disasters such as flash floods (3).

Identifying high-risk areas and preparing for disasters like flash floods requires thorough knowledge and preparation (4). Many governments have developed contingency plans for events such as flash floods to

minimize potential damage. Additionally, societal preparedness is crucial, as adequate knowledge and understanding of the risks can reduce potential damage and aid in planning and managing flash floods (5). However, without community support, even well-prepared organizations can fail in their disaster response efforts. Therefore, understanding how society perceives natural disasters like flash floods is essential for advancing national and local programs and leveraging the power of societal involvement in disaster management (6).

On the other hand, self-perception in social issues is important from the point of view that it helps people in society become aware of their own attitudes towards phenomena such as unknown feelings by observing their behavior (7).

Given that natural disasters such as floods occur annually in many disaster-prone countries, including Iran, it's vital for the government and responsible organizations to understand the increasing frequency of flash floods and the low-risk perception of society regarding this issue (8). Therefore, accurately gauging how people perceive floods is crucial for enhancing flood risk management, ensuring that appropriate and effective measures are taken to mitigate flood risks (9, 10). Various studies have been conducted to evaluate people's attitudes towards floods, using questionnaires or location-related software.

However, there is a limited number of tools available to evaluate society's perception of flash flood risk, and the present study aims to fill this gap by providing a new tool specifically tailored to evaluate the perception of flash flood risk in Iran (11-14).

2. Objectives

Due to the lack of reliable tools in Iran to measure societal self-perception regarding flash floods, this study aimed to validate and analyze the psychometric features and applicability of a questionnaire on flash flood risk perception in Iran.

3. Methods

The study comprised the design and psychometric evaluation of a questionnaire on society's perception of the risk of flash floods. The first phase involved a systematic review and qualitative studies to extract items of the initial tool. In the second phase, a

quantitative approach was adopted for psychometric assessment.

3.1. First Phase: Item Generation

In the initial stage, a systematic review of available studies related to flash flood risk perception was conducted. Web of Science, Scopus, PubMed, and Google Scholar databases were searched to find studies using the keywords "risk perception," "flash flood," "sudden flood," and "dam break" until September 2023. Specific inclusion and exclusion criteria were established for selecting relevant articles on flash flood risk perception. Inclusion criteria encompassed research articles and theses in English focusing on this topic, while exclusion criteria included studies in languages other than English and Persian, those not directly addressing flash floods, letters to the editor, and conference abstracts. The screening process involved eliminating duplicates using EndNote software and independently reviewing titles, abstracts, and full texts by two authors to ensure alignment with the criteria. Data extraction utilized a standardized form to record essential details such as author information, publication year, research methods, sample demographics, and key findings. Quality evaluation of studies was conducted using the Joanna Briggs Institute (JBI) critical appraisal checklist, assessing elements like study objectives, sample size, participant characteristics, statistical analysis, and result congruence. Discrepancies were resolved through discussion and, if necessary, consultation with a third researcher. Studies meeting predefined criteria were included in the final review compilation. The selection process involved sequentially reading titles, abstracts, and full texts of studies, resulting in the identification of 25 relevant articles out of 1025 titles. Most of these articles utilized cross-sectional descriptive studies to assess residents' risk perception in the relevant areas.

To ensure comprehensive item coverage and to identify Iranian context-based items, a qualitative content analysis was conducted. Through content analysis, codes were extracted from interviews with the target group, meticulously examining interview content to identify patterns, important topics, and differing perspectives. In the qualitative study, 23 residents of Bakhtegan city, Fars province, Iran, were interviewed from December 2022 to February. People living in the city who had experienced flash floods and volunteered to participate in the study, and at the same time had information about flash floods, were included in the

study using purposive sampling method. The main question included "Please describe your flash flood experience," and the interview was continued based on the participants' answers with probing questions. The duration of each interview varied from 30 to 55 minutes. Data collection employed the Graneheim and Lundman approach, and data categorization was carried out using MAXQDA 18 software. Trustworthiness was ensured through Guba and Lincoln criteria, including researcher rapport, data diversity, continuous comparison, and participant validation of findings (15). Detailed documentation of analysis stages and participant feedback enhanced validity and reliability. Detailed contextual descriptions aimed to increase the transferability of findings.

The study extracted factors such as environmental variables (residential location, proximity to the river), economic and social variables (education level, income, marital status, family size), knowledge, trust in the media and aid organizations, and flood experience. Subsequently, the initial questionnaire was designed using items derived from both qualitative methods and systematic review. By scrutinizing and eliminating redundant items from the two extraction methods, a total of 36 items were confirmed for inclusion in the designed questionnaire, encompassing both objective and subjective factors influencing risk perception.

3.2. Second Phase: Psychometric Evaluation of the Questionnaire

The second phase of this study involved the psychometric evaluation of the risk perception questionnaire for flash floods, including testing its validity and reliability, encompassing face validity, content validity, and construct validity (16).

Face validity assesses whether the questionnaire appears valid to subjects, patients, or observers, a criterion that can often be enhanced through appropriate wording alterations (17). To ensure face validity in this study, 10 experts including Ph.D. students, researchers, and subjective experts were asked to comment on the questionnaire's ease of completion, grammar and spelling, writing clarity, and appropriateness. They rated each item on a 5-level scale, and items with an impact score of one and a half or higher were retained (18).

Content validity was evaluated qualitatively and quantitatively. Thirteen experts were asked to provide

detailed corrective feedback after studying the questionnaire, drawing from their expertise in disaster health, crisis management, and health education and promotion. Quantitative content validity entailed assessing the importance and appropriateness of the selected content. Content validity ratio (CVR) and Content Validity Index (CVI) were computed to ensure the selection of critical content and the appropriate design of measurement items. The numerical values of CVR were determined using a predefined table, and items scoring higher than 0.59 were considered significant and retained. For CVI, simplicity, relevance, and clarity were evaluated on a Likert Scale, and items with a resulting value exceeding 0.79 were deemed acceptable (19).

Regarding reliability, internal consistency was assessed using Cronbach's alpha coefficient for the entire questionnaire (20). At this stage, all residents of Bakhtegan city were eligible to participate in the study, regardless of whether they were directly exposed to flash floods or not.

Before conducting confirmatory factor analysis, assumptions of univariate normality, estimates of squared values, multivariate normal deviation, and outliers were evaluated using the Mahalanobis distance method. Missing data were handled using the maximum likelihood method. Subsequently, common dispersion between observed variables was examined to confirm linearity and address multicollinearity, enabling the use of parametric tests for confirmatory factor analysis.

4. Results

Quantitative validation of the risk perception measurement tool was conducted on 36 items. Minor corrections were made based on the participants' comments in the face validity stage in the wording and grammar of some items. The Impact Score results indicated that 35 questions scored equal to or greater than 1.5, prompting a check of CVI and CVR for these questions. Following review by thirteen panelists, questions with a CVR lower than 0.42 and a CVI lower than 0.79 were excluded. Consequently, after recalculating CVI and CVR for all questions, 6 items were removed, resulting in respective scores of 0.65 for CVI and 0.88 for CVR for the entire questionnaire.

Subsequently, 29 questions were confirmed, and internal reliability analysis indicated a satisfactory

Cronbach's alpha coefficient of 0.89, signifying adequate internal stability of the questionnaire.

One hundred and fifty questionnaires were distributed to residents of Bakhtegan city, Fars's province, Iran, yielding a 90.1% response rate. Participants responded to questions on a 5-point Likert Scale from completely agree to completely disagree. The study's Mean participant age was 35.23 years, with a mean work experience of 9.82 years. Of the participants, 57.4% were male and 42.6% were female. Distribution among educational levels showed that 25% had less than a diploma, 17.6% had a diploma, 29.4% had a bachelor's degree, and 17.6% had a master's degree or higher.

The mean question response scores and standard deviations for each question are presented in Table 1. The goodness-of-fit indices for the confirmatory factor analysis are detailed in Table 2, confirming the assumed model's strong fit with the observed data. Furthermore, the general model of the risk perception questionnaire, illustrating the relationships between items and their respective structures, is depicted in Figure 1.

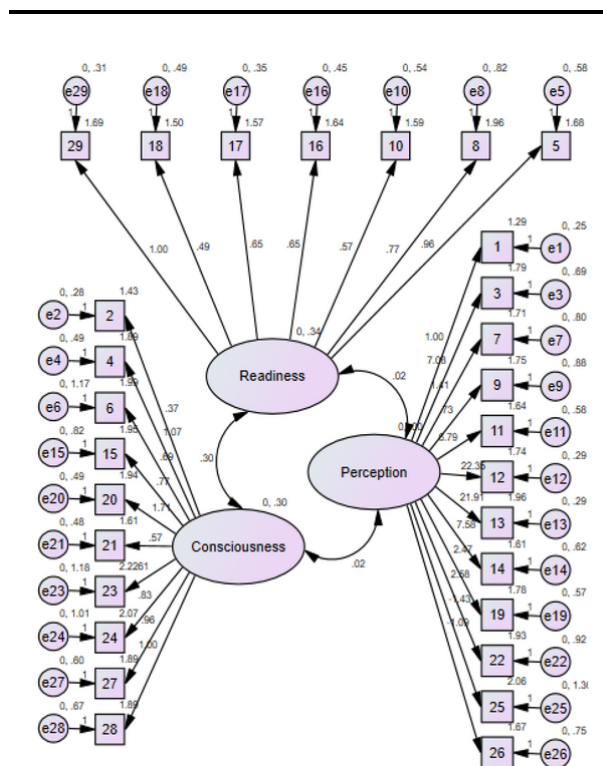


Figure 1. The results of confirmatory factor analysis of the final questionnaire

5. Discussion

Understanding public perception of flash flood risk is crucial. Identifying the key factors influencing this perception requires accurate tools. Measuring objective factors like knowledge is straightforward, but capturing subjective ones like personal beliefs is more challenging. Until now, no reliable tool existed in Iran to measure these subjective factors, especially as they relate to flash floods.

Our new questionnaire addresses this gap. It incorporates both objective and subjective factors, allowing us to measure various dimensions of flash flood risk perception. We used a rigorous approach, combining qualitative research and a systematic review, to design the questionnaire, making it applicable to understanding risk perception in other societies as well.

The questionnaire contains three sections: Awareness, risk perception, and preparedness. The awareness section (10 items) assesses people's knowledge and understanding of flash floods. Recognizing risk is crucial for taking action. As research shows, individuals with accurate information are more likely to prepare for emergencies (21, 22). This recognition acts as a catalyst for other emergency response measures (23) and influences decision-making, especially in uncertain situations (24). Accurate risk assessments also help evaluate preparedness levels (25). Understanding people's awareness of flash floods allows us to identify areas for improvement and develop targeted risk management strategies.

The risk perception section (12 items) explores people's feelings, concerns, and beliefs about flash floods. Risk perception is influenced by social factors, exposure levels, and potential consequences. It's generally measured by sensitivity to the risk and perceived severity. Knowledge, past experiences, and individual vulnerability also play a role (26). People who find a risk significant and potentially harmful tend to have higher risk perception. The health belief model highlights this link between perceived risk and preventative behavior (27). Additionally, risk perception is a key component of social vulnerability during flood disasters, with higher perception leading to lower vulnerability (28).

Finally, the preparedness section (7 items) examines people's actions and readiness for flash floods. Effective preparedness plans help individuals and communities recover quickly from crises. This includes training,

Table 1. Descriptive Indices of Final Items

Variables	Items	Average	Standard Deviation	Skewness	Kurtosis
Awareness	1 I pay attention to the warnings issued about the possibility of flash floods.	1.29	0.5	1.84	1.87
	2 I am aware of the life and financial consequences of flash floods.	1.43	0.56	0.88	- 0.2
	3 Having accident insurance has not made me careless about flood risks.	1.79	0.91	1.27	0.95
	4 I am aware of how to take measures to reduce flood damage.	1.83	0.91	0.92	0.4
	5 A flood can affect my life.	1.68	0.94	1.36	0.87
	6 A flood can harm me materially.	1.99	1.1	1.11	0.67
	7 My physical condition does not make me vulnerable to hazards.	1.71	0.9	1.44	0.98
	8 The area where I live is vulnerable to flooding.	1.96	0.94	1.65	0.92
	9 Considering my economic situation, I am worried about the consequences of the flood.	1.71	0.81	1.29	1.81
	10 The presence of deterrent laws reduces my concern about the consequences of flooding.	1.96	0.84	1.80	1.95
Preparation	1 My previous experience with flash floods has increased my caution.	1.75	1.26	1.38	1.46
	2 I have the ability to adapt to the conditions caused by the flood.	1.59	1.24	1.7	1.99
	3 I take seriously the warnings issued regarding the possibility of flooding.	1.64	0.87	1.03	0.95
	4 I secure my place of residence before heavy rains.	1.74	0.99	1.21	1.45
	5 I warn my family members and people around me before the flood.	1.96	0.77	1.1	0.66
	6 I follow flood safety recommendations.	1.61	0.7	1.4	1.23
	7 The methods of receiving flood warning messages are effective in taking preventive measures against floods.	1.94	1.17	0.8	1.3
Perception of risk	1 Seeing the deaths and injuries of people exposed to flash floods makes me more careful when flash floods occur.	1.64	0.76	1.3	0.33
	2 I trust flash flood warning sources.	1.57	0.97	1.34	1.17
	3 I trust the high accuracy of weather forecasts.	1.50	1.12	1.3	1.8
	4 I feel threatened by the flood.	1.78	1.1	1.1	- 0.029
	5 I believe in preventive measures.	1.63	1.14	1.14	- 0.11
	6 Preventive behaviors reduce harm to me and my family.	1.93	1.1	1.1	0.8
	7 My preventive behaviors reduce the damage to the environment.	2.22	1.14	1.14	0.18
	8 My preventive behaviors reduce the financial losses caused by floods.	2.07	0.87	0.87	1.7
	9 I am afraid of the flood.	2.05	0.94	0.94	0.13
	10 When I hear the flood warning messages, I get scared.	1.67	0.98	0.98	1.22
	11 Due to the protective measures taken, I am not worried about the possibility of flooding.	1.89	0.87	0.87	1.29
	12 The preparedness of the relief forces eases my worries about flooding.	1.89	0.74	0.74	0.59

Table 2. Goodness of Fit Indices of the Final Questionnaire

Indices	Observed	Acceptable Value
Chi-square ratio to degrees of freedom	2.62	< 0.05
Normed Fit Index (NFI)	1	Less than 3
Comparative Fit Index (CFI)	1	More than 0.9
RMSEA	0.105	Less than 0.1: Excellent model fit
		Between 0.1 and 0.5: Good model fit
		Between 0.5 and 0.8: The fitness of the average model
CFI	1	0.9 ≤
PRATIO	0.860	0.5 ≤

drills, risk planning, and infrastructure upgrades (29). Preparedness plays a crucial role in reducing potential damage (30-32). Our research used confirmatory factor

analysis to assess the questionnaire's psychometric properties, confirming its good fit and validity (33).

5.1. Conclusions

The flash flood risk perception questionnaire, comprising objective and subjective components across three key areas—preparation, awareness, and perception—demonstrates robust validity and reliability. It serves as a valuable tool for informing policy-making, planning, prevention, promotion, preparedness, and response strategies in flood management. Additionally, it facilitates the analysis of flash flood prevention training efficacy and the assessment of relevant measures.

5.2. Limitations and Strengths of the Study

This study benefits from item extraction conducted through both qualitative and systematic review phases, enhancing the comprehensiveness of the items. Furthermore, all necessary steps for psychometric evaluation of the instruments were meticulously followed. However, due to the domains of items being derived from the qualitative study, exploratory factor analysis was not undertaken. Additionally, participants for face validity, internal consistency, and confirmatory factor analysis were exclusively selected from residents of a single city in Fars province, limiting the generalizability of findings. Future studies would benefit from including a more diverse range of participants to enhance the study's external validity.

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Footnotes

Authors' Contribution: SFA, AH, AV, and AR designed the study. AR and AV were involved in collecting qualitative data. SFA, AH, and AR contributed to the systematic review. Additionally, AR and SFA were responsible for assessing the validity and reliability of the questionnaire.

Conflict of Interests Statement: The authors declared no conflicts of interest.

Data Availability: The dataset presented in the study is available upon request from the corresponding author during submission or following publication. The data are not publicly accessible to ensure privacy and confidentiality.

Ethical Approval: Ethical permission to conduct the present research was obtained from the Regional Research Ethics Committee of Shahid Sadoughi University of Medical Sciences ([IR.SSU.SPH.REC.1401.115](https://doi.org/10.1007/s11069-011-9934-1)).

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