Development and Verification of a Model for Assessment of Risk Factors of Death in Floods

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Abstract

Background: Determination of the causes of flood-related deaths is the precondition for effective interventions aimed at the reduction of such deaths. There is a gap in the design and the development of a valid and reliable tool for measuring underlying factors of death in the flood.

Methods: A complete set of causes of flood deaths was collected. After forming the pool of items, an initial questionnaire was designed and divided into two parts of objective and subjective factors. The questionnaire's psychometric evaluation was performed for the subjective part.

Results: At the design stage, the objective and subjective sections were designed. During the psychometric evaluation, the number of items was reduced. While measuring the content validity 13 questions were excluded. Finally, a 33-item questionnaire was developed in seven categories. In the confirmatory factor analysis, the KMO coefficient was higher than .05 for all constructs. The internal consistency of the instrument using Cronbach's alpha coefficient was 0.92. Finally, in order to perform the stability test, the Pearson correlation coefficient was calculated for all questions. This was above .05 and acceptable.

Conclusions: FAFDQ can be used to make decisions, identify groups at risk of flood-related deaths, and implement flood-related death-reduction interventions. Indeed, these measures have led to the development of a comprehensive and reliable questionnaire for measuring the factors affecting flood deaths: a comprehensive set of factors that can be scientifically and accurately classified as flood-related deaths, appropriately categorizing the subjective and objective factors, psychometric assessment of the SFAFDQ, confirmatory factor analysis and questionnaire testing in a case-control Study.

Background

Floods are the most frequent and destructive natural disasters in the world [1, 2], that affect a large proportion of the global population [3]. Compared to other continents, Asia has been most severely affected by flood [4, 5]. Iran is located in the eastern Mediterranean region of Asia [5]. This country is one the flood-prone areas of the world [6]. The frequency of floods is increasing worldwide [7] and in Asia continent [4]. Flood events in Iran have also increased [7]. Recent floods of Iran were devastating and severe and have affected people dramatically [8]. Climate change is one of the reasons for the increment in the intensity and frequency of floods [3]. also, According to Intergovernmental Panel on Climate Change (IPCC), the trend of floods' frequency and severity is worsening due to seasonal rainfalls in Asia and climate change [4].

Among different type of natural disaster, floods cause to greatest damage in the world (flood risk manag-1). property damages, population displacement, social impact [3], economic losses, human casualties [7] and Human death [2] have been listed as the main adverse effects of floods. Deaths are a serious and irreversible impact of floods [9]. Indeed, in public understanding of disasters, loss of life is the most important type of flood damage [10]. Floods are one of the major causes of death from natural disasters in the world [11–13], They account for around half of all deaths from natural hazards [14–16]. In addition, floods' frequency and flood deaths have increased in recent years [17–19]. In the United States, on average, every flash flood has caused thirty-seven deaths [20]. floods have caused more than 5,39811 deaths in a 30-year period (1980–2009) [1] and resulted in 50092 deaths in the world between 2005 and 2014 [21]. From 2002 to 2018 in Iran, the number of registered deaths due to floods was 706 deaths [22]. In the 2019 floods in this country, 82 deaths occurred [23].

Flood-related deaths or flood deaths are deaths that would not occur without a specific flood [24]. In addition to flood hazards, attitudes, behaviors, decision-making and community actions in the long run also affect flood deaths [25]. As a result, the trend of flood deaths is not the same in different parts of the world [14, 24]. The number of deaths from floods is far much higher in less developed countries [14, 26, 27]. In fact, the proportion of deaths caused by floods in developing countries compared to developed countries is about 23 to 1 [28].

Reduction of underlying risk factors was one of the key priorities for action of the World Conference on DRR in Kobe, Hyogo, Japan 2005. In addition, one of the main goals of the Sendai framework to disaster risk reduction during the years 2015–2030 is: "Reduce death in populations affected by natural hazards"[29]. Therefore, one of the main consequences of floods that must to studied is the loss of lives [30]. The information available in the academic literature on the loss of life due to the causes of floods is almost limited [14]. Some studies have only referred to the causes of flood deaths [8, 14, 31–33]and some have categorized these causes [2, 34]. Also in a study by Elizabeth Pradhan et al. In Nepal on the risk of death from floods, the odds ratio of some of the causes of flood death was measured [35]. Nevertheless, we have little information on the likelihood of loss of life in floods or damage reduction measures to save lives [18]. Further, there is relatively little knowledge about the determinants of flood deaths [31, 32, 36, 37] and little research has been conducted in this regard [37]. Although the determinants of flood deaths have been examined but the effect of these factors has not been measured [7].

Identifying the effective factors in flood deaths is essential for implementing risk management policies and interventions to reduce flood deaths [38]. Increasing awareness on flood casualties and understanding the causes of flood-related deaths constitute the basis of preventive measures [39, 40]. This contributes in developing methods for estimating flood mortalities [40]. This is important because understanding these factors will clarify where and how we are more likely at risk of losing our lives and how we can implement effective interventions [18]. In addition, it's important to provide evidence based on scientific methods to convince politicians and policy makers to design and implement appropriate measures to reduce flood deaths.

Methods

This study involved two basic steps of designing and psychometrically assessing the questionnaire of factors influencing flood death according to systematic review and qualitative studies. These studies were conducted prior to the study design and psychometric evaluation of the questionnaire employed to identify the factors affecting flood deaths [2,7].

The literature used for this study had already been collected during a systematic review in which most relevant literature published from 1990 to 2017 on factors affecting flood deaths were extracted and analyzed [2]. International databases of PubMed, Scopus, Web of Science, and Google Scholar and Iranian electronic databases IranMedex, Irandoc, Magiran, and Scientific Information Database (SID) were searched for articles related to flood deaths. we used appropriate search strategy and key terms including Flood, factor, characteristic, vulnerable, cause, element, agent, variable, mortality, fatal, death, loss of life, kill, lethal, dead and die. These key words were searched in different combinations using either OR/AND. The studies were selected regardless of their methods but based on their inclusion and exclusion criteria. The data were extracted, coded and analyzed. A descriptive and thematic analysis was performed. A total of 114 risk factors were identified in systematic review and were classified into 5 categories of hazard characteristics, individual, environmental, socio-economic, and managerial or capacities (Figure 1).

In the qualitative study using the content analysis method via a conventional approach, the underlying factors influencing flood deaths in different groups were identified including: ordinary flood-affected people, academic groups, and disaster management authorities in different parts of Iran who have experienced flood death [7]. In this study, 7 categories of factors were identified including: hazard-related features, cultural, economic, social, demographic, management, and physical factors. These seven categories of factors had 27 sub-categories and 167 factors (Figure 1).

Consequently, to design the questionnaire, based on systematic and qualitative studies, a complete set of objective and subjective factors affecting flood deaths was collected and categorized. After editing and finalizing items that measured objective factors, the items of subjective factors were assessed and their validity and reliability were assessed. Finally, a reliable questionnaire was developed to measure these factors.

Then, the design and psychometric evaluation of the questionnaire was performed as follows:

Designing a Questionnaire to Measure the Causes of Flood Death

The design of the questionnaire consisted of three stages (Figure 1):

Item Organization (Generation, Reduction, and Classification): At this stage, first the pools of the items were formed using the items extracted in the systematic review and qualitative study. Next, after investigating each item by the research team, duplicate items were eliminated or one or more items with the same meaning were merged, with the number of items in the pool decreasing while non-repetitive items were used. Then, the items that were measuring the same scope or concept were merged together. Eventually, the sub-domains and domains were formed with each measuring a particular sub-domains and domain. Indeed, the items were classified in such a way that the related items could fit into their appropriate sub-domains and domain.

The production and finalization of questions: At this stage, the questions related to each item were designed based on the items produced and categorized in the previous step. Then, the duplicate questions were removed again and similar questions merged. Once the questions were merged, each question was finalized in terms of the writing structure, simplicity, and comprehensibility.

Categorization of questions: Once the questions were finalized, the questions were divided into two general categories of objective and subjective questions where each category was subdivided into other categories: Objective Questions: Once the objective questions were made, they were reviewed, edited, and categorized several times by the research team. Objective questions were edited and finalized three times by the research team. Subjective Questions: Once the subjective questions were made, they were reviewed, edited, and categorized by the research team. Finally, subjective questions were reviewed and edited five times by the research team.

Psychometric Assessment of the Subjective Factors Affecting Flood Death Questionnaire (SFAFDQ):

Psychometric validation of subjective factors of the questionnaire was essential and performed whereas there was no need for psychometric validation of objective factors. Subjective factors were categorized as 7 categories of factors and 55 questions. The psychometric evaluation of Subjective Factors Affecting Flood Death Questionnaire (SFAFDQ) included two main stages of validity and reliability (Figure 2):

Validity Assessment of SFAFDQ: Validity of the questionnaire consisted of three stages:

Assessment of Face Validity: Face validity is the simplest and weakest form of validation which shows the appropriateness of the questionnaire for the purpose of the study and the content of the domain [41]. The face validity of the questionnaire was measured qualitatively and quantitatively. Face-to-face interviews are conducted with some of the target group to assess the face validity qualitatively [42]. Accordingly, qualitative face-to-face interviews were conducted with 10 people affected by floods (a community with flood deaths) in one of Iran's flood-hit provinces on April 14, 2017. At this point, the participants were asked to give a comment about the apparent suitability of the items, readability, and difficulty level of items, the clarity of the wording, ambiguity and misinterpretations of items, the layout, style, acceptability and feeling comfortable with the items. In order to quantify the face validity quantitatively, the items' impact scores were measured. In this step, 10 flood crisis and disaster managers and those with academic background in health and disasters who had sufficient experience or knowledge of flood were employed. The 10 participants were asked to rate the importance of each item on a 5-point Likert scale from 1 (not at all important) to 5 (very important). Impact scores of the items were measured using the following formula: The percentage of participants who gave each item scores as 4 or 5 times mean of importance for each item. For the formal acceptance of each item, an impact score ≥1.5 was considered [43].

Assessment of Content Validity: Assessment of the content validity of the tool was qualitatively and quantitatively assisted by 15 disaster management professionals with sufficient knowledge and experience of flood death or at least knowledge and experience of flood disaster. A total of 46% of the participants in this phase had a master's or doctoral degree while the rest had at least a bachelor's degree. Also, more than 72% of the participants in this phase had more than 10 years of experience in disaster management. In the qualitative method, the instrument was emailed to the participants to express their views on grammar, use of appropriate words, item placement and their ordering from simple to complex, categorizing and matching the items with relevant content domains, adequacy of items for relevant dimensions and appropriate scoring. The questionnaire was edited based on participants' comments.

Content Validity Index and Content Validity Ratio (CVI and CVR) were used to examine the content validity of the instrument. In order to measure the content validity ratio (CVR), experts' opinions were used, explaining the objectives of the questionnaire and asking them to rate each item on a 3-point range of " 1: It is not necessary ", "2: useful but not necessary" and "3: essential" to classify. The questions were removed from the questionnaire. The CVR index was then calculated using the following formula, followed by the Lawshe table, which scored less than 0.49 [44].

$$\mathrm{CVR} = \frac{nE - N/2}{N/2}$$

nE: The number of professionals choosing the "essential" option.

N: Total number of specialists

In this research, four criteria of simplicity, specificity, clarity, and relevance were used to calculate the content validity index. These criteria were individually rated by 15 experts on a four-part Likert scale (1: Irrelevant, 2: Somehow relevant, 3: Acceptably relevant, and 4: Completely relevant). CVI score was calculated by summing the percentages of agree scores for each item scored as 3 and 4 (highest score) according to the following formula [45]:

$$CVI = \frac{Number\ of\ rates\ giving\ a\ rating\ of\ 3\ or\ 4}{total\ number\ of\ rates}$$

Questions with a score above 0.79 have a good content validity index. Thus, the questions with a content validity index (CVI) score of less than 0.79 were removed from the questionnaire.

Assessment of construct validity: Based on the observations, data, and results of systematic and qualitative review studies, there were predetermined hypotheses regarding the structure and relationships between questions and categories of questions. At this stage, the confirmatory factor analysis was used to investigate these assumptions. In other words, confirmatory factor analysis was performed to evaluate the validity of questionnaire constructs. In order to conduct this analysis and check construct validity, a case-control study was performed in 2018. The participants included 369 people in a flood affected community in different parts of Iran, who experienced flood death. The sample size required for analytical factor analysis varies from three to ten samples per item [46,47]. In this study, 10 samples were considered for each item. Since the construct validity was measured for the items of subjective factor assessment and the number of items in this section was 33 items, the sample size was estimated as 330 subjects. The research team completed a questionnaire on 369 people in the flood affected community who experienced flood death through attending the doorstep of the participants. Then, the collected data were introduced into SPSS software and confirmatory factor analysis was performed by separating the structures and the entire structure in the last step of the instrument psychometric evaluation. This step was performed after reviewing other validity and reliability steps.

Reliability Assessment of the SFAFDQ

reliability assessment of the questionnaire consisted of two stages:

Internal consistency test: this test was conducted through participation of 15 persons in the flood affected communities in one of the provinces of Iran (in Chenar village and Azarshahr city in East Azerbaijan) in 2017 flood. To measure internal consistency, Cronbach's alpha coefficient was calculated for the total questionnaire and its constructs. Based on the direct relationship between the correlation coefficient and the reliability of the instrument [45,47], the Cronbach's alpha coefficient above 2 was considered as the desired internal consistency [48,49].

Stability evaluation: For stability evolution via test-retest method, SFAFDQ was completed twice with a two-week interval in one of the floods affected communities in Iran. Then, the Pearson Correlation Coefficient (PCC) was measured. PCC of 0.5 or greater indicated sufficient stability [50]. This coefficient was calculated separately for all questions.

Additional Statistical Analyses: in the construct validity stage, before performing confirmatory analysis, first, Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's Test of Sphericity were measured. These two tests were performed to determine the adequacy of the sampling for conducting the factor analysis. The KMO index is especially recommended when the ratio between items to variables is less than 5: 1. The value of this index is within 0 and 1, while if it is above 0.5 it is suitable for factor analysis. Also, to check the suitability for factor analysis, it is necessary to have a significant Bartlett test ($p<.05$)[51]. Also, in order to identify the questions that played the most important role in each structure, the initial factor loadings of the questions and the factor loadings of the questions after being placed in the structures were measured.

Results

Item Organization (Generation, Reduction, and Classification)

At the initial designing of FAFDQ and the formation of the item pools stages, 281 items were extracted; of these items, 114 were related to the systematic review study and 167 to the qualitative study. In the reduction phase, 200 items remained after removing duplicate items and merging similar items. At the final stage of designing the questions and designing the questions for each item, the questions were re-examined; after eliminating duplicate questions and merging similar questions at this stage too, there were 115 questions left (Figure 1). After classifying the questions into two categories of objective and subjective questions, 60 items were classified as objective and 55 were subjective (Figure 1). The objective section of the questionnaire (AFAFDQ) consisted of 5 domains: Hazard Characteristics, Geographic Hazard Characteristics, Infrastructure Characteristics, Demographic Characteristics, Information about Government Services and the subjective section of the questionnaire (SFAFDQ), which was psychometrically assessed, consisted of 7 domains: cognition, general knowledge, general beliefs, risk perception, attitude, prevention, social norms (Figure 1).

Psychometric of SFAFDQ

Validity

Face Validity: In the qualitative phase, 4 questions were eliminated and three questions changed, with the number of questions decreasing from 55 to 51. In the quantitative face validity phase, five questions received an impact score of less than 1.5; thus, the number of questions dropped from 51 to 46.

Content Validity: according to the Content Validity Ratio index, there were 10 questions with a CVR of less than 0.49. Thus, at this stage, 10 questions were removed from the remaining 46 questions where the number of questions reached 36 questions. Also, in the content validity index determination phase, 3 questions scored less than 0.79 and were eliminated. Finally, the number of questions was reduced to 33 questions.

construct validity: The results of Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's test showed that the number of questions in all constructs was sufficient and suitable for confirmatory factor analysis (KMO> 0.5 and Bartlett's Test of Sphericity were significant). Thus, it was possible to measure confirmatory factor analysis for all domains. Confirmatory factor analysis was then performed for all constructs, with its results indicating that the questions in all constructs had a good correlation (Table 1).

Reliability

Internal consistency: Cronbach's alpha coefficient of the entire questionnaire was 0.92. This number indicates that the internal consistency or internal correlation of the whole instrument is appropriate. Also, Cronbach's alpha coefficient for all constructs was greater than 0.7. The results of the Cronbach's alpha coefficient in the constructs and the whole questionnaire suggested that the questionnaire have a high internal consistency (Table 1).

Stability: The results of stability test with Pearson correlation coefficient showed that all questions have acceptable and significant stability (above 0.5) (Table 1).

Additional Statistical Analyses: The results of factor loadings analysis revealed that all questions in all structures had a significant role in constructing structures, where some questions with more factor loadings had a more important role in structures (Table 1).

Table 1										
Reliability Assessment and Confirmatory Factor Analysis Results of Subjective Factors Affecting Flood Death Questionnaire (SFAFDQ)										
Categories	Internal consistency test (Cronbach's alpha coefficients)	KMO (Kaiser-Meyer-Olkin)	Bartlett tests (Chi-square)	df	sig	Questions	Stability test		Factor load measurement	
							Pearson correlation coefficient	level of significance	Initial value	Factor load extracted
Cognition of the Flood	0.73	0.734	384.323	6	P<0.001	How much do you agree that the risk of flood deaths will increase in the future?	0.86	0.000	1.000	0.528
						How much do you agree that we need training in flood prevention?	0.83	0.002	1.000	0.681
						How much do you agree that flooding is a dangerous hazard and you should be aware of it?	0.67	0.022	1.000	0.656
						How much do you agree that your place of residence is always exposed to flooding?	0.79	0.000	1.000	0.492
General Knowledge	0.81	0.749	350.359	6	P<0.001	How much do you agree that in terms of frequency of disasters, more floods would occur in Iran?	0.86	0.000	1.000	0.553
						How much do you agree that flood-to-knee can also take the car?	0.70	0.003	1.000	0.650
						How much do you agree that at the time of the flood the best place to seek refuge is the high places?	0.69	0.004	1.000	0.411
						How much do you agree that low water levels, even down to the submarine, can be dangerous?	0.64	0.017	1.000	0.689

Public beliefs	0.74	0.599	273.382	6	P<0.001	How much do you agree that praying in the event of a flood can save us from death?	0.64	0.017	1.000	0.803
						How much do you agree that in the event of a flood if a person is flooded you have a duty to save him?	0.60	0.031	1.000	0.627
						How much do you agree that flood deaths can be prevented?	0.78	0.002	1.000	0.804
						How much do you agree that people and society have a very important role to play in preventing and controlling flood deaths?	0.76	0.022	1.000	0.762
Risk Perception	0.79	0.759	862.715	36	P<0.001	How much do you adhere to the laws of prevention during construction?	0.67	0.022	1.000	0.498
						How worried were you at the time of the flood?	0.74	0.001	1.000	0.375
						How much do you consider flood risk when buying or renting a home?	0.71	0.003	1.000	0.546
						How much is your participation in neighborhood problem solving meetings?	0.66	0.007	1.000	0.454
						How much do you know about safety rules and regulations to prevent flooding and death?	0.61	0.014	1.000	0.507
						How much do you know about the floods and flood hazards?	0.75	0.042	1.000	0.534

						If they had problems with the authorities, how much would they accompany them?	0.89	0.031	1.000	0.512
						How much is planned by your local authorities to prevent severe flooding of the roads?	0.95	0.012	1.000	0.727
						How responsive are the authorities responsible (such as the municipality or the water and wastewater organization) for preventing flood events?	0.96	0.009	1.000	0.675
Attitude	0.83	0.748	660.519	10	P<0.001	How much did you think about the flood hazards before the flood?	0.71	0.007	1.000	0.636
						How much did you think of the flood before the flood?	0.87	0.030	1.000	0.651
						How much did you believe in preventive measures before the flood?	0.76	0.001	1.000	0.656
						How much did you believe in safety principles before the flood?	0.84	0.000	1.000	0.564
Prevention	0.91	0.810	614.188	10	P<0.001	How much did you feel about flood prevention before the flood?	0.60	0.016	1.000	0.616
						How much did you feel about flood safety training prior to the flood?	0.84	0.018	1.000	0.644
						How much did you feel the need for	0.93	0.013	1.000	0.617

						action by government agencies or institutions before the flood?				
						How much did you feel the need for neighborhood involvement to prevent flood events prior to the flood?	0.85	0.016	1.000	0.663
						How much did you find it necessary to adhere to the principles of safety and risk reduction prior to the flood?	0.76	0.001	1.000	0.366
Social Norms	0.72	0.584	78.278	1	P<0.001	How much do you think the impact of local customs on flood deaths?	0.62	0.001	1.000	0.719
						How much do you think the impact of religious values on flood deaths?	0.88	0.000	1.000	`0.719
Sum of Questions	0.92									

Discussion

Given the importance of identifying the underlying causes of flood-related deaths in preventing flood-related deaths, these causes should be measured correctly with a valid and reliable instrument. Measuring the objective causes of flood deaths is very different from measuring the subjective causes; It is very difficult to measure subjective causes. According to our studies, to date, no reliable instrument has been developed to measure the set of causes of flood deaths, especially subjective causes. Since the final instrument consisted of two parts, a section measuring objective factors and a section for subjective factors, it was able to measure the various dimensions of objective and subjective factors affecting flood deaths. Using FAFDQ, we can measure the complete set of factors that affect flood deaths in different communities. By measuring mental causes, FAFDQ will be able to measure the impact of many hidden and influential factors in flood deaths. Planning in line with the identified risk factors can be done by measuring the causes of flood death in at-risk communities and has made effective interventions to reduce flood-related deaths in communities. Since this questionnaire was first developed, it has to be measured in other studies and in other communities.

The cognitive structure had four questions that could be used to assess the extent to which local people were aware of flood hazard. Cognition has been denoted as human capacity to recognize the extent of emergent risk which may affect community and to act on that information. Indeed, cognition is one of the essential components of an emergency response. Other response components remain inactive without cognition [52]. Decision-making theorists have emphasized the important role of cognition in decision-making, especially under conditions of uncertainty [53]. Indeed, emotional and cognitive processes affect communities' flood preparedness behaviors. Cognitive assessments of flood risk play an important role in assessing individuals' readiness [54]. People's cognition of risk determines the type of information required to manage risk, so providing information on hazard cognition is essential [55]. In SFAFDQ, by designing the cognition section, we can measure the extent of people's knowledge of flood hazard and ultimately measure its impact on flood-related deaths.

The **General Knowledge Structure** had 4 questions which could be used to measure the extent of public knowledge of local people about the risk of flood death. new research shows that the success and durability of community-based interventions depend on a number of factors, including the combination of new knowledge with the culture of the region and the knowledge of local people that lead to the creation of new ideas. The link between local knowledge and natural disasters has received much attention in recent years [56]. Local, indigenous, and informal knowledge plays a vital role in the science and management of flood risk and community resilience; Thus, the integration of local and specialized knowledge is essential for the proper management of floods in a world which is both environmentally and socially changing [57]. Given the importance of engaging communities at all stages of disasters, in line with the Hugo Framework for Action, indigenous knowledge is crucial to contribute to practical and policy disaster risk reduction policies. Indeed, the prerequisite for integrating local knowledge and disaster risk reduction programs is understanding the local knowledge and practice [56]. Indeed, the knowledge of flood risk increases the level of protection against floods and facilitates the implementation of emergency measures [58].

The **general belief structure** consisted of 4 questions which could assess some of the public beliefs about flood hazard. Public beliefs through strong social networks influence the perception of risk and ultimately the behavior of people at hazard and risk [59]. The changes in community beliefs, along with other factors, lead to modification in traditional flood risk management. The most significant modifications include changes in flood protection structures, early warning systems and increased public awareness, land-use planning, and the development of controls in flood-prone areas [60]. In personal risk management, people's beliefs about their own level or level of responsibility for protection against the risk or hazard is an important variable. This variable is very helpful in understanding why people protect themselves against environmental hazards, whether successfully or unsuccessfully [61].

The **risk perception structure** has 15 questions which assess the extent to which people perceive the risk of flood death. Perception is a process in which information obtained from sensory observations is organized and used [62]. Perceiving and accepting risks depends on the underlying social culture, risk characteristics (e.g. man-made or natural risk), exposure rate, risk control rate and its consequences, and the answer to this question: how much personal interest is at stake [59]. Risk perception is one of the components of social vulnerability in the response phase and flood disaster reduction which has an inverse relationship with the vulnerability [63].

The **attitude construct** has 6 questions which can be used to evaluate the attitude of people towards flood death. According to conventional attitude theory attitude is a function of beliefs and values and is one of the factors that influence the perception of risk [64]. Viglion et al. in 2014 also suggested that risk-taking attitude is one of the key components of a risk-coping culture in communities controlling the balance between risk perception and action [65]. Attitudes and beliefs about change, such as the ability to learn from past mistakes and flood events, play a role in reducing disaster risk [66]. On the other hand, the type of disaster, prior experience of disaster, and gender are good predictors of victims' attitudes toward disasters [67]. Regarding this issue, it is necessary to assess the impact of attitude on flood deaths, which can be achieved by designing this section of the questionnaire.

The **prevention structure** has 6 questions. This structure can measure the extent of preventive measures against deaths from floods. Many flood-related deaths are not due to chance, so flood prevention measures in accordance with local conditions can reduce flood-related deaths. Thus, prevention or warning messages should address specific vulnerabilities of at-risk people [68]. Further insight into the causes of flood death constitutes the basis of preventive measures [39, 40] and the development of methods for estimating flood mortality [40].

The **social norms structure** has 7 questions which can measure the impact of social norms on deaths from floods. Unfortunately, although many disaster-related injuries can be prevented or mitigated by some measures [69], cultural misconceptions and misconceptions and attitudes can lead to inadequate preparation and response [70]. Some studies have pointed to the negative effects of religious beliefs and attitudes on disaster risk reduction and preparedness promotion [71]. On the other hand, other studies have pointed to the positive effects of religion and religious beliefs on reducing disaster risk and promoting disaster preparedness [72, 73]. Thus, by designing questions about social norms, one can measure the effects of religious beliefs and customs (as social components) on flood-related deaths.

Conclusion

The results of a systematic review study suggested that there is no comprehensive instrument for assessing the factors influencing flood deaths. Although some of the factors affecting flood-related death have been measured in some studies, their numbers are very limited and not comprehensive. FAFDQ can be used to study the causes of flood death in the world and Iran, for policy making, planning, prevention, upgrading, preparedness, and responding to floods to reduce flood deaths, as well as for analyzing flood prevention training and measures. Analyzing the evidence for decision-making and identifying groups at risk of flood death have a valuable contribution. Thus, the FAFDQ designed has the potential to be used in death risk assessment in organizations dealing with flood disaster management.

Abbreviations

IPCC: Intergovernmental Panel on Climate Change

FAFDQ: Factors Affecting Flood Death Questionnaire

SFAFDQ: Subjective Factors Affecting Flood Death Questionnaire

CVI: Content Validity Index

CVR: Content Validity Ratio

PCC: Pearson Correlation Coefficient

KMO: Kaiser-Meyer-Olkin

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committees of the Tehran Universities of Medical Sciences (Iran) IR.TUMS.VCR.REC.1397.204. The participants were previously informed about the characteristics of the study. Informed consent form was obtained from all participants. They were all asked to complete a questionnaire and to provide signed consent to confirm the participation in the study.

Availability of Data and Materials

The datasets used and/or analyzed in the study are available from the corresponding author on reasonable request.

Consent for publish

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contribution

A.Y., Y.Z., and A.A. researched the background for the project and were the primary writers of the manuscript with the guidance of A.OT., and A.RF., A.Y., M.SB. and F.B. analyzed and interpreted the data. A.OT., A.Y., and Y.Z. edited the manuscript. All the authors read and approved the final manuscript.

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Figures

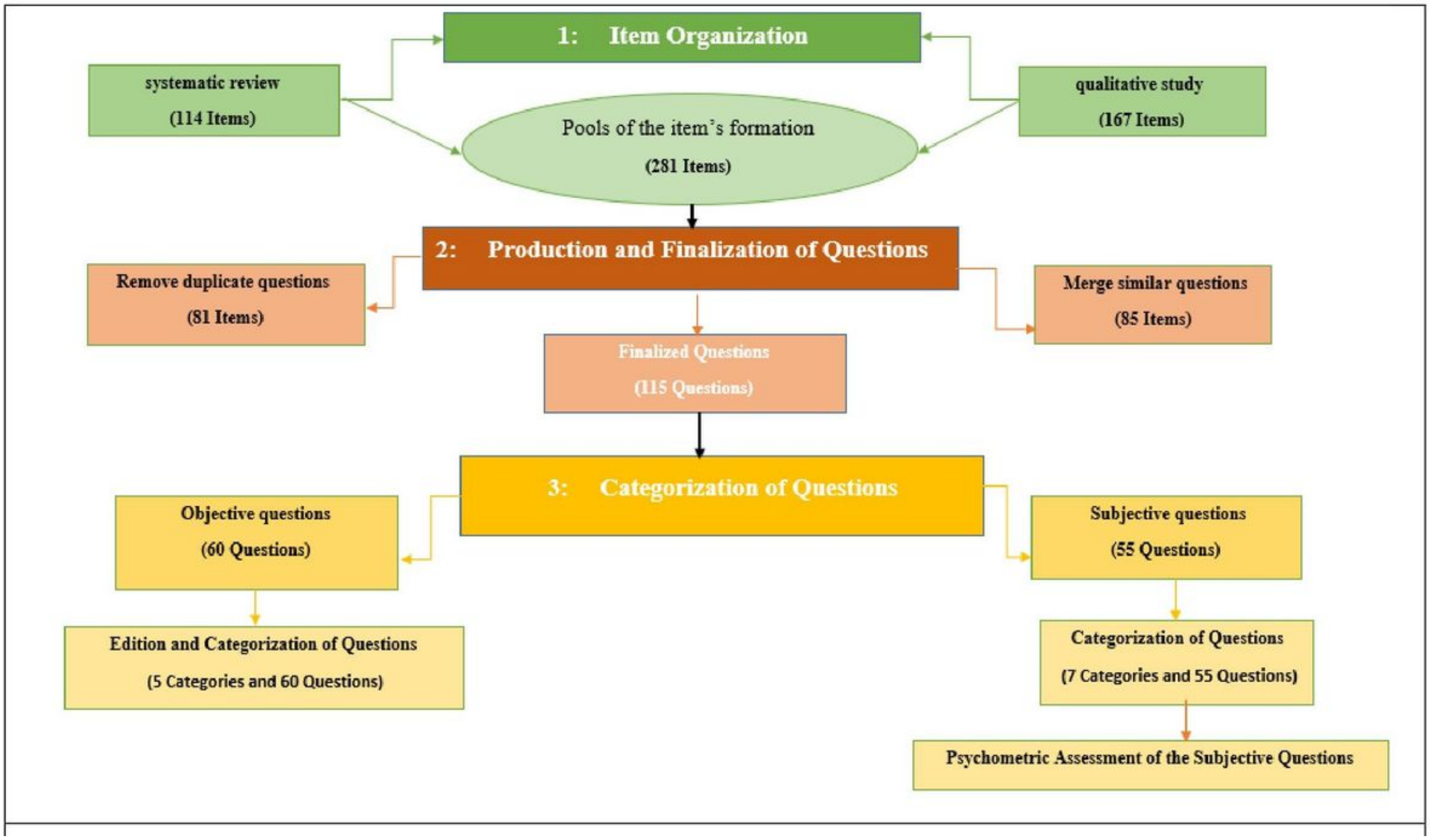

Figure 1

Designing a Questionnaire to Measure the Causes of Flood Death

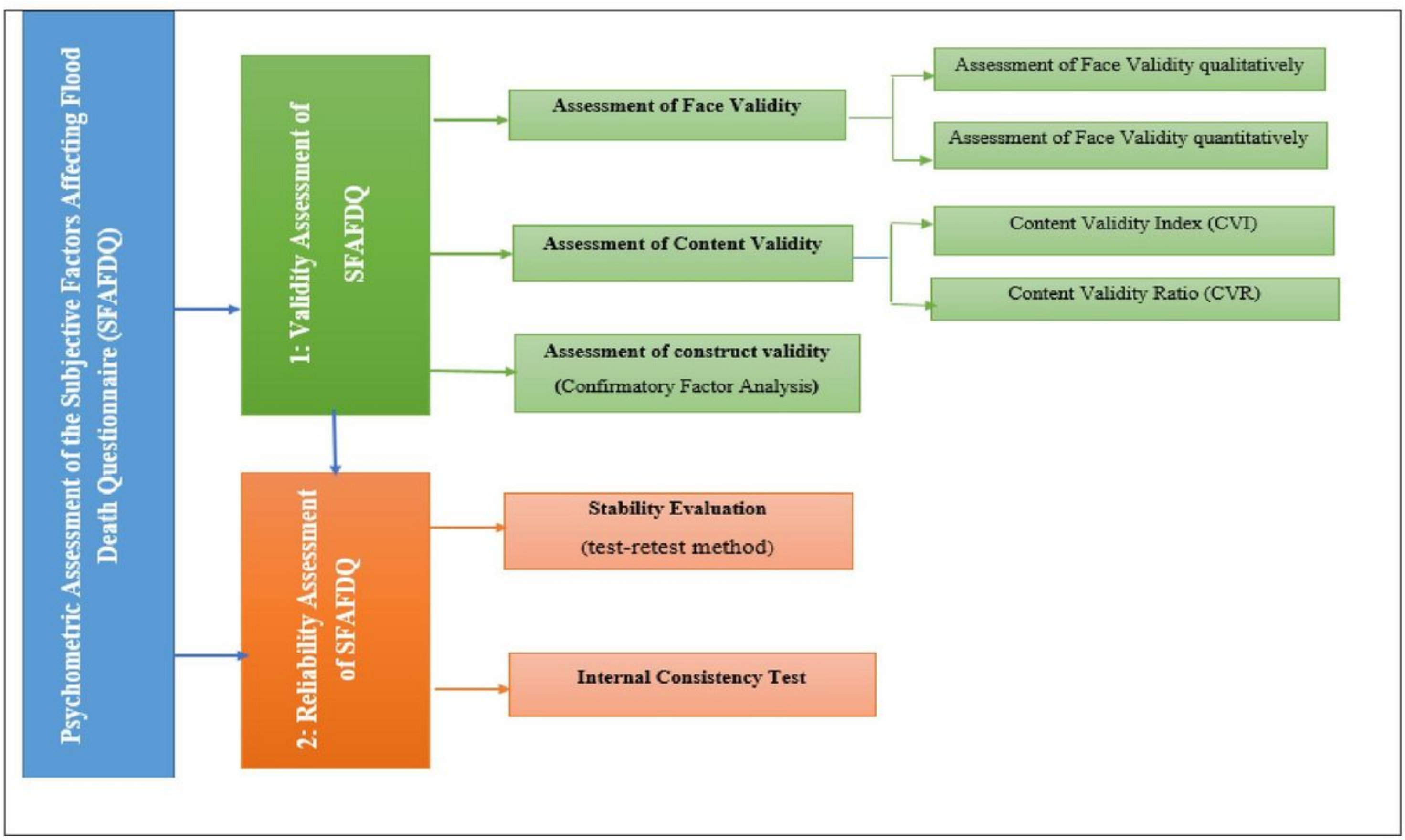

Figure 2