ORIGINAL RESEARCH

Household Emergency Preparedness Instrument Development: A Delphi Study

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ABSTRACT

Objective: The main objective of this research was to generate a consensus on the conceptual definition of household emergency preparedness from experts representing multiple disciplines and countries, in order to facilitate the development of an all-hazards, comprehensive, valid, and reliable instrument.

Methods: Questions were generated via 3 methods: literature search, using existing instruments, and expert panels using the Delphi technique.

Results: Panelists (n = 154) representing 36 countries came to a consensus that household emergency preparedness is defined as the completion of several preparedness actions and assembling a kit that can be transported in an evacuation. The new 51-question instrument demonstrates face, content, and criterion validity and internal consistency reliability ($\alpha = 0.96$). The instrument assesses whether specific preparedness actions have been taken, and the presence or absence of essential supplies that could enable households to safely endure conditions that disasters would likely present (loss of power, water limitations, and/or lack of access to additional supplies for a few days).

Conclusion: A valid and reliable instrument provides researchers with a replicable approach to assessment of preparedness levels, which is necessary to plan mitigation strategies, enhance health promotion, prevent injuries, and increase resilience for individuals and communities. The instrument can provide evidence to support interventions addressing health needs of community members following a disaster.

Key Words: delphi technique, disaster medicine, disaster planning, disasters, emergency preparedness

Household emergency preparedness (HEP) includes the actions, or empirical referents, that represent preparation for a disaster. Increased levels of HEP could save lives, prevent worsening of chronic medical conditions, and decrease the likelihood of responders having to brave dangerous situations to assist those in need.[1-10] Currently, there is no 'gold standard' HEP instrument.[1,8,11-17] Household emergency preparedness can be considered a mature concept in that it has commonly accepted recommendations, distinct characteristics, and defined boundaries. Therefore, the concept of HEP is ready to be operationalized into a valid and reliable instrument that is appropriate for measurement of HEP levels in developed and developing nations. Instrument development starts with defining the construct and developing the questions. The instrument should then be administered to a representative sample and psychometric testing should be performed on the results. The purpose of this study was to generate a consensus on the concept definition of HEP from experts representing multiple disciplines and countries, along with community stakeholders, to develop a valid, all-hazards and reliable HEP instrument.

METHODS

Instrument questions were generated via 3 methods: literature search, using existing instruments, and expert panels. A criterion-referenced measurement framework was used because the goal of the instrument is to determine whether a respondent has acquired a predetermined set of target behaviors.[18]

Literature Search

In 2016, Heagele documented a lack of a valid and reliable HEP instrument in the public health and emergency management research community.[1] For the current study, a review of the existing literature was conducted again to determine if a valid and reliable instrument emerged since that publication. The search was delimited to peer-reviewed academic journal articles published between January 2015 and January 2019, with abstracts available, and in the English language. Simultaneous searches of the MEDLINE Complete (EBSCO, Ipswich, MA), CINAHL Complete (EBSCO, Ipswich, MA), APA PsycINFO (APA, Washington, DC), Social Sciences Full Text (EBSCO, Ipswich, MA), and Health and Psychosocial Instruments (EBSCO, Ipswich, MA),

 DOI: 10.1017/dmp.2020.292

databases were conducted in December 2018. Eligibility criteria included original research studies measuring HEP of individuals or households (i.e., not communities, responders, or health care organizations) with a survey, tool, scale, instrument, or checklist. The following key word combinations were used: "household OR citizen OR emergency OR disaster AND preparedness," "individual AND preparedness," "individual AND disaster OR emergency AND preparedness OR planning," "disaster OR emergency AND supplies OR kit," and "hazard AND preparedness OR readiness." After removing duplicates, 38 articles met eligibility criteria from the 1587 initial results. Another 14 articles were identified either through citation trails or the social networking website for researchers, ResearchGate.

Of the 52 articles suggested, only 22 articles provided brief instrument question development information.[2-4,7,8,15-17,19-32] However, none of these articles specifically focused on instrument development. A few researchers analyzed data from nationally representative surveys that included questions on HEP, such as the Behavioral Risk Factor Surveillance System Questionnaire,[6] Health Retirement Survey,[5,12] General Social Survey,[11] and the Public Readiness Index's Readiness Quotient.[33,34] For the researchers who created their own instruments, the Federal Emergency Management Agency (FEMA) recommendations were the most popular definition of HEP used to inspire the instrument questions. The authors of 21 articles provided their instrument questions in their articles.[2,5,7,12,14-17,19,20,24,25,28,29,33,35-40] Some authors asked broad questions about HEP, such as "did you assemble a disaster supply kit?," whereas others asked about the presence of specific supply kit items such as flashlights, radios, food, and water. Only 8 articles contained information on pilot-testing of the instrument.[2,4,8,22,32,34,41,42] A total of 15 articles included instrument reliability data,[5,8,11,12,16,20,23,26,27,34,36-38,41,43] and 4 articles contained validity data.[8,12,36,44] The remainder of the articles provided no instrument development data or reliability and validity information.

Researchers accrue evidence for validity by examining the scores resulting from an instrument that is used for a specific purpose, with a specified group of respondents, under a certain set of conditions.[18] Validity must be assessed each time an instrument is used in order to determine if validity generalization can be made for various populations under study.[18]

Rigorous research designs need to start with instruments that are psychometrically sound; information about the psychometric properties should be obtained and evaluated before an instrument is selected for use.[18,45] Without access to publications focusing on instrument development, it is impossible for researchers to evaluate the psychometric properties of current HEP instruments. Unfortunately, no official publications detailing original instrument development of any HEP instruments were available for review. As such, it was impossible to discern the conceptual basis that guided the instrument development, critique the methods used to generate questions, and compare the questions to an original concept definition.

After the literature search and review of the evidence, the investigators agreed that a valid and reliable HEP instrument had not emerged. The decision to proceed with the development of a HEP instrument via a Delphi study was made.

Existing Instruments: Criterion Validity

Criterion validity is established when a newly developed instrument has an empirical association with a commonly used, benchmark instrument.[46] Lacking a benchmark instrument resulted in lack of criterion validity for HEP measurement, but many of the instruments were inspired by the FEMA recommendations. This lends support for criterion validity of these HEP instruments. Data were collected for 2 studies with iterative versions of the Preparedness Assessment (PA), an instrument that was based on the "Ready"[47] and the Texas "Ready or Not?"[48] campaign materials.[7,19] The initial PA was a dichotomous survey where respondents were asked to answer 'yes' if they had an item, or 'no' if they did not. Examples of questions posed to participants include, "Have you ever had any emergency preparedness education?" and "Do you have a first aid kit?" Participants reporting they possessed the item scored 1 (yes); while those reporting they did not scored 0 (no). These question response scores were summed to create a preparedness index with a possible range of 0 to 28.[19]

The PA questions were compared to questions of 22 other instruments from the literature search; the similarities and differences between what was included on the instruments and how questions were worded were examined. The investigators, including the developers of the PA, agreed to adapt the PA for the Delphi study. This new instrument was named the Household Emergency Preparedness Instrument (HEPI). The goal was to create an all-hazards, comprehensive, easily understandable HEP instrument to present to the disaster research community.

Expert Panels: The Delphi Technique

The Delphi technique was used to establish face and content validity and evaluate cultural bias of the HEPI. The online Delphi technique is a widely accepted survey method used to generate group consensus and develop measurement instruments from geographically dispersed expert participants spanning a wide range of disciplines and roles.[18,49,50]

There is no consensus on what constitutes an expert, but Delphi participants should be primary stakeholders with various interests related to the target issue, have somewhat related backgrounds and experiences, and include representation from all relevant social and cultural groups.[18,49,50] While there is also no general agreement on the number of participants required for a consensus study, Delphi studies are commonly

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completed with under 100 participants.[49,50] The Delphi technique is recommended when: (a) the participants do not have a history of adequate communication; (b) input is needed from more individuals than can effectively interact in a face-to-face exchange; (c) time and cost make frequent group meetings infeasible, and; (d) participant anonymity is needed to reduce the effects of dominant individuals (i.e., the bandwagon effect).[18,49,50] In addition to being fast, inexpensive, and versatile, the strengths of the Delphi technique include: opinions of many experts can be condensed into a few precise statements; participants can respond at their own convenience; and participant anonymity limits the potential influence of other experts to conform to social norms, organizational culture, or standing within a profession.[18,49,50]

Recruitment

Delphi participants are purposefully selected for their expertise.[49] Interdisciplinary colleagues of the investigators with disaster response or disaster research experience, and the corresponding authors of the articles found in the literature search were e-mailed an IRB-approved recruitment and consent script, along with the link to the survey. The snowball sampling technique where participants suggest other potential participants was also utilized. In addition, the World Association of Disaster and Emergency Medicine (WADEM) sent the recruitment message via e-mail to members on the investigators' behalf. Inclusion criteria were English-reading adults aged 21 years or older, reflecting the highest age of consent worldwide.[51]

Participants came from 36 low, middle, and high income countries on 5 different continents (Figure 1) and represented disaster response experts from the disciplines of public health, emergency management, medicine, nursing, pharmacology, firefighting, emergency medical services, social work, psychology, sociology, epidemiology, bio-ethics, hospitality, national security, environmental management, geography, public administration, humanitarian relief, education, and business. Participants were asked to self-identify as either an expert or a community stakeholder. Table 1 describes the sample demographic characteristics.

Data Collection

While there are no universal guidelines for how to carry out a Delphi study,[50] common data collection procedures include asking participants to complete multiple iterations of a structured, formal, electronic questionnaire designed to elicit opinions and exchange feedback. All rounds of the Delphi were exchanged via Qualtrics online survey software, version August 2019 (Qualtrics, Provo, UT, USA).

Typically 3 rounds are needed to reach a consensus.[49] Through their endorsement of the degree to which specific HEP actions and items are essential, participants compared their concept definition of HEP to the HEPI questions. They also evaluated question clarity and conciseness and pointed out ways of measuring the phenomenon that may have been excluded.[46] Qualitative and statistical analyses were used by the investigators to modify subsequent iterations of the questionnaire until consensus was reached.[18,49] Once the responses were tabulated and summarized, they were returned to the participants. Additional feedback was sought on the questions that did not achieve consensus. Participants were given 2 weeks to participate in each round. Prospective rounds were limited to the group of participants who responded to the questionnaire in the first round.

Data Analysis

Descriptive statistics were used to summarize the collective judgements of the participants (using the Statistical Package for the Social Sciences for Windows, version 25.0 software; International Business Machines Corporation, Armonk, NY, USA).[18,49] In the first round, consensus on a HEPI question was achieved when 80% of the participants' votes fell within 2 categories based off a 5 point scale.[49] A HEPI question was kept when 80% or more of the participants marked the question as important or essential. Likewise, questions were discarded if 80% of the responses fell in 2 categories on the lower end of the rating scale.

The open-ended responses were analyzed with qualitative content analysis via NVivo software for Mac version 11.4.1 (QSR International Pty Ltd, Doncaster, Victoria, Australia). Content analysis aims to attain a condensed description of a phenomenon by categorizing written data so that it can be counted.[52] Participants' responses were coded and placed into categories. These data were primarily used to edit existing HEPI questions.

RESULTS

A total of 3 rounds of the Delphi study were required to ascertain consensus from the large panel of participants. Highlights of each round are described below and detailed in Table 2.

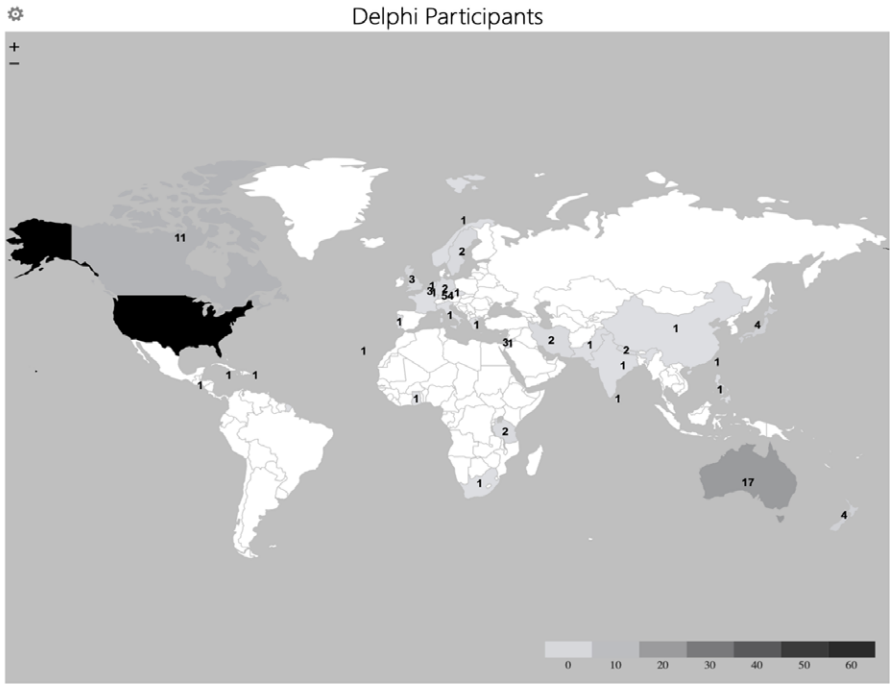
First Round

The Delphi study started with a 106-question HEPI; 50 questions from the PA plus 56 new questions that were developed by the investigators from an extensive review of the literature. Participants (n = 154) were asked to rate each question on the HEPI from 1 to 5 (1 = unessential, 2 = a little important, 3 = neutral, 4 = important, and 5 = essential). In addition, 8 questions were included to determine how to score the HEPI, quantity of food, water, and medication needed, and if there should be child, pet, and access and functional skills subscales. Open-ended questions (2) were added to provide the Delphi participants the opportunity to describe their HEPI experience in greater detail and served as a virtual focus group.[53,54] Participants were asked if any additional questions should be included on the HEPI, if supply kit items were named something different in their community, and if any questions were difficult to understand. Demographic questions (8) were also included to describe characteristics of the Delphi participants.

https://doi.org/10.1017/dmp.2020.292 Published online by Cambridge University Press

FIGURE 1

Country	Sample
United States	54
Australia	17
Canada	11
Japan	4
New Zealand	4
Belgium	3
United Kingdom	3
Israel	3
Tanzania	2
Sweden	2
Iran	2
Nepal	2
Germany	2
Philippines	1
Jordan	1
Jamaica	1
Puerto Rico	1
Italy	1
Pakistan	1
India	1
Singapore	1
Greece	1
Ghana	1
El Salvador	1
Taiwan	1
France, Metropolitan	1
United States Minor Outlying Islands	1
France	1
Netherlands	1
China	1
Norway	1
Sri Lanka	1
Portugal	1
Czech Republic	1
Luxembourg	1
South Africa	1



The number of questions which achieved consensus for inclusion on the HEPI was 35. Valid percent responses were utilized for each question, meaning that the percentage that did not include missing data was used to calculate consensus. Participants agreed that an access and functional needs subscale should be offered (n = 125, 94%) for respondents with a health issue or disability, a pet preparedness sub-scale should be offered (n = 112, 84.2%) for respondents with pets, and a child preparedness sub-scale should be offered (n = 129, 97%) for respondents with a child.

At the completion of Round 1, it was undecided how respondents should answer questions about preparedness kit items or how the final instrument should be scored. The amount of extra food, water, prescription medications, and medical supplies a household should have in order to be considered prepared for a disaster did not achieve consensus and went to Round 2 of the Delphi study. None of the survey questions achieved consensus (80% or higher on the lower end of the rating scale) to be discarded.

A specific theme that emerged from the qualitative data via 23 comments was skepticism of a global, all-hazards instrument. Delphi participants felt that the HEPI may have to be tailored to specific communities, according to the disaster scenarios expected and capability of responders. For example, a snow shovel was a supply kit item in Round 1. Participants commented that this item was not relevant for respondents living in tropical climates. Participants struggled to narrow in on a specific time frame for quantity of water, food, and medical supplies needed to be considered prepared because it was felt that how quickly these supplies would be brought in post-disaster would vary greatly from country to country, and even from community to community within the same country. Participants also acknowledged that acquisition of an adequate supply of medications prior to predicted disasters is a systemic versus a personal responsibility problem due to the policies of insurance companies.

A second theme that emerged was potential response burden of the instrument. A total of 14 new questions could have been added to the HEPI from the qualitative data. However, due to comments on the length of the HEPI and concern for response burden, only 6 of the 14 questions were added to the HEPI because these actions and items were mentioned more than once. The questions proposed by the participants that were not added to the HEPI can be found in Table 3.

https://doi.org/10.1017/dmp.2020.292 Published online by Cambridge University Press

TABLE 1

Sample Demographics

Category	N (%)
Gender	154
Female	65 (49%)
Male	67 (50%)
Other	1 (1%)
Missing data	21
Age	154
23–49 years	56 (43%)
50–65 years	53 (41%)
66–77 years	20 (16%)
Missing data	25
Minimum – 23 years	
Mean – 52 years	
Maximum – 77 years	
Panelist Category	154
Community stakeholder	17 (13%)
Expert	115 (87%)
Missing data	22
Discipline	154
Business	1 (0.8%)
Education	7 (5.3%)
Emergency management	19 (14.3%)
Emergency medical services	10 (7.5%)
Environmental health	1 (0.8%)
Environmental management	1 (0.8%)
Epidemiology	4 (3%)
Hospitality	1 (0.8%)
Humanitarian relief	3 (2.3%)
Medicine	25 (18.8%)
National security	1 (0.8%)
Nursing	26 (19.5%)
Psychology	4 (3%)
Public administration	1 (0.8%)
Public health	13 (9.8%)
Social work	1 (0.8%)
Sociology	1 (0.8%)
Other	14 (10.5%)
Missing data	21
Military Experience	154
Yes	24 (18%)
No	109 (82%)
Missing	21

Category	N (%)
Personally Affected by a Disaster	154
Yes	85 (64%)
No	48 (36%)
Missing	21
Education	154
Some college, no degree	5 (3.8%)
Two year college degree	1 (0.8%)
Fouryear college degree	9 (6.8%)
Graduate degree	118 (88.7%)
Missing	21

Second Round

After adjusting for consensus in the first round to retain 35 questions, 71 of the previous questions were re-evaluated in Round 2. New questions about preparedness actions (5) and 1 question about a disaster supply kit item were created from the qualitative data in the first round. In the second round, the participants were only given 2 response options for the HEPI questions (1 = unessential, 2 = essential) and no open-ended questions were included.

At the conclusion of Round 2 (n = 85), 14 more questions achieved consensus to stay on the HEPI. In addition, 2 out of the 6 questions added from the first round's qualitative recommendations were considered "essential" by 80% or more of the participants and were retained. Discarded HEPI questions (those items deemed un-essential) can be found in Table 2. Panel recommendations for quantification of select supply items failed to reach consensus. The decision was made to take the top choice for each of the requested recommendations:

1) food and water – 1 week (n = 34, 43%)
2) prescription medication – 2 weeks (n = 38, 48.1%)
3) medical supplies – 2 weeks (n = 33, 42.31%)

The way in which respondents should answer questions about disaster supply kit items did not achieve consensus, but a scaled response (I do not have this item, I have this item in my home, or I have this item in my disaster supply kit) received more

https://doi.org/10.1017/dmp.2020.292 Published online by Cambridge University Press

TABLE 2

HEPI Questions Retained and Discarded by Round

Questions Retained (reliability $\alpha = 0.96$)	Round 1 N = 154 Consensus to Retain ≥ 80%	Round 2 n = 85 Consensus to Retain ≥ 80%	Round 3 n = 79 Mean (SD) of Weight
Preparedness Actions (reliability $\alpha = 0.79$)			
Have you prepared or discussed a family emergency plan?	**94.1%**		4.4 (0.84)
Have you practiced or drilled on what to do in an emergency at home?	**81.2%**		3.5 (1.04)
Have you taken first aid training?	**82.5%**		3.5 (1.13)
Have you signed up for a community emergency alert system?	71.4%	**81.8%**	3.7 (1.14)
Do you have supplies set aside in your home in a kit to use in case of a disaster?	**90.3%**		4.3 (0.97)
Do you have working smoke detectors?	**86.4%**		4.5 (0.92)
If you have the shut off valves in your home, do you know how to turn off the utilities (water, gas, propane, etc.)?[a]	**90.9%**		4.2 (0.96)
Do you have a fire escape plan for your home?	**90.5%**		4.1 (0.98)
Do you have important family documents such as copies of insurance policies, identification, and bank account records in a waterproof, portable container *or stored on a flash drive or cloud storage server*?[a]	**84.5%**		4.1 (0.95)
Do you check your disaster supplies regularly for expired items?[a]		**88.3%**	3.6 (1.06)
Do you know the types of disasters that are most likely to occur in your community[a]		**94.8%**	3.9 (1.08)
Communication Plans (reliability $\alpha = 0.74$)			
Have you planned for how you and your family would contact each other in an emergency if you were separated?	**92.1%**		4.4 (0.92)
Do you have written contact information of family and friends?	**81.9%**		3.8 (1.06)
If there were no power or telephones, would you have a way to receive information about disasters in your area, such as with a solar, hand-crank, or battery-operated radio?	**87.3%**		4.1 (0.90)
Evacuation Plans (reliability $\alpha = 0.90$)			
Do you know if your home is in an evacuation zone?	**80.9%**		3.8 (1.23)
In the event of an evacuation, have you considered safe and *unsafe* places in your community?[a]	73.3%	**83.1%**	3.9 (0.98)
Have you planned where to go if you had to evacuate from your home?	**93.1%**		4.2 (0.92)
Do you have working carbon monoxide detectors?	63.9%	64.9%	
Is everyone in your home aware of your evacuation plan?	**90.4%**		4.1 (0.97)
Have you planned what route to take if you evacuate from home?	**80.2%**		3.8 (1.12)
Do you have a family meeting place in case of separation?	**89.7%**		4.1 (1.02)
Do you know where your local emergency shelter is?	69.9%	**87.0%**	3.5 (1.08)
Do you have a plan for what you will take if you had to leave your home quickly?	**88.3%**		4.2 (0.83)
Have you prepared a small kit with emergency supplies to take with you if you had to leave quickly?	**89.0%**		4.1 (1.05)
Do you have a source of transportation to leave your neighborhood quickly in the event of a necessary evacuation of your home?	**83.6%**		4.0 (0.96)
Do you have family or friends that you could stay with during an emergency?	**80.1%**		3.5 (1.05)
*If you have a pet, d*o you have an evacuation plan for your pet?[a]	68.9%	**80.5%**	3.9 (1.18)
Disaster Supplies (reliability $\alpha = .92$)			
Do you have a *one-week* supply of *ready-to-eat* food that will not spoil for all those living with you?[a]	**88.7%**		4.3 (0.83)
Do you have a supply of water that would provide at least 3.8 liters (one gallon) of water per day for each person in your home for *one week*?[a]	**92.3%**		4.4 (0.90)
Do you have a sleeping bag or warm blanket for each person?	77.4%	**89.6%**	3.8 (0.88)
Do you have a first aid kit?	**93.7%**		4.3 (0.78)
Do you have *moist wipes, hand sanitizer,* and other personal hygiene supplies *(soap, tampons, pads, etc.)*?[a]	69.1%	**90.9%**	3.9 (0.93)

(Continued)

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TABLE 2

Continued

Questions Retained (reliability $\alpha = 0.96$)	Round 1 N = 154 Consensus to Retain ≥ 80%	Round 2 n = 85 Consensus to Retain ≥ 80%	Round 3 n = 79 Mean (SD) of Weight
Do you have a flashlight*/torch*, *a headlamp,* lanterns, *glow sticks, candles,* or *other* non-electric portable lighting?[a]	**97.8%**		4.35 (0.77)
Do you have extra batteries?	**94.4%**		4.1 (0.99)
Do you have matches?	**82.4%**		3.7 (1.03)
Do you have cash?[a]	69.0%	**85.7%**	4.0 (1.09)
Do you have a wrench, pliers or multi-tool to turn off utilities (water, gas, propane, etc.)?	76.5%	**88.3%**	3.7 (1.09)
Do you have a fire extinguisher?	**85.0%**		3.7 (1.24)
If you wear prescription glasses or contact lenses, do you have extra glasses or contact lenses?	**84.7%**		3.6 (1.08)
If you have a pet, do you have a *one week* supply of pet food and water *for each pet*?[a]	**80.8%**		3.9 (1.22)
If your pet takes medications, do you have *a two-week supply of* extra medications[a]	66.0%	**87.0%**	4.0 (1.18)
If you have a baby, do you have a *one-week* supply of formula, bottles, and baby food?[a]	**87.4%**		4.5 (0.81)
If you have a baby, do you have a *one-week* supply of diapers/ nappies?[a]	**81.5%**		4.2 (1.03)
Access & Functional Needs (reliability $\alpha = .91$)			
If you take medications prescribed to you by your doctor, do you have *a two-week supply of* extra medications?[a]	**95.6%**		4.3 (1.02)
If you take prescription medications, do you have a written list of your medications including how much you must take?	**93.4%**		4.2 (0.96)
Do you have a plan for an alternate power source for medical equipment or refrigerated medicine in the event of a power outage?	**84.7%**		4.1 (1.05)
Do you have a small cooler, *portable ice chest, ice box, cool box, chilly bin, or an esky* and cold packs*/freezer bricks* for refrigerated medications?[a]	77.4%	**85.5%**	3.9 (1.00)
Do you have *a two-week* supply of special diet food, syringes, blood sugar monitoring strips, oxygen cylinders, or other needed medical supplies?[a]	**88.3%**		4.3 (0.91)
Do you have your medical history *written on paper or stored on a flash drive or cloud storage server*?[a]	73.8%	**86.8%**	3.8 (1.02)
Do you have a list of your doctors *on paper or stored on a flash drive or cloud storage server*?[a]	67.1%	**85.5%**	3.5 (1.12)
Do you have a paper copy of your advanced directives or provider's order for life-sustaining treatment form *or is it stored on a flash drive or cloud storage server*?[a]	65.7%	**81.6%**	3.5 (1.27)
Have you asked family or friends if they will be able to help you in a disaster?	75.2%	**82.9%**	3.4 (1.09)
Questions Discarded			
Have you ever had any disaster preparedness education?	77.9%	59.7%	
Do you have working fire alarms?	73.4%		
Have you found a place in your home that can withstand extreme wind?	71.5%	58.4%	
Do you know your home insurance coverage?	70.8%	64.9%	
Have you saved your insurance company phone numbers in your phone?	51.3%	41.6%	
Have you secured or made your home stronger in some way, such as installing storm resilient windows, *raising the home, or securing furniture to the wall*?[a]	47.7%	54.5%	
Do you keep dead or weak branches trimmed from trees and bushes?	54.3%	51.9%	
Have you documented your valuables?	67.5%	55.8%	
Do you have a fireplace or a wood-burning stove?	43.5%	32.5%	
Do you have a sump pump with a battery backup?	40.2%	42.9%	

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TABLE 2

Continued

Questions Retained (reliability $\alpha = 0.96$)	Round 1 N = 154 Consensus to Retain ≥ 80%	Round 2 n = 85 Consensus to Retain ≥ 80%	Round 3 n = 79 Mean (SD) of Weight
Do you have enough money to use the bus or train to leave your area before an emergency?	74.0%	71.4%	
Do you have enough money to *pay for overnight lodgings such as a hotel, motel, or rental home* during an emergency?[a]	59.6%	71.4%	
Do you keep your car gas tank at least half full at all times?	66.5%	74.0%	
Do you have a non-electric can opener?	73.9%	75.3%	
Do you have *a small shovel/trowel, a bucket, or garbage bags that can be used to make a toilet*?[a]	74.6%	67.5%	
Do you have a way to purify water without power or running water?	69.0%	77.9%	
Do you have dental care items like a toothbrush and toothpaste?	53.5%	59.7%	
Do you have emergency reference materials such as a first aid or survival book?	49.3%	57.1%	
Do you have a dust mask?	53.5%	59.7%	
Do you have a whistle?	63.4%	64.9%	
Do you have a paper local road map?	61.9%	51.9%	
Do you have disposable dishware?	30.7%	27.3%	
Do you have at least one change of clothing per person in a kit?	58.5%	66.2%	
Do you have a generator?	40.0%	45.5%	
Do you have paper and a pencil?	62.1%	57.1%	
Do you have sunscreen?	40.0%	39.0%	
Do you have insect repellent *or a mosquito net*?[a]	58.5%	58.4%	
Do you have plastic sheeting and duct/*gaffer* tape *to cover windows*?[a]	55.7%	54.9%	
Do you have a plastic tarp?	51.4%	56.6%	
Do you have rope or cording?	58.6%	66.2%	
Do you have extra keys for the home?	65.7%	55.8%	
Do you have extra keys for the car?	67.2%	57.1%	
Do you have a cooler, *portable ice chest, ice box, cool box, chilly bin or esky*?[a]	48.6%	58.4%	
Do you have cold packs *or freezer bricks*?[a]	43.6%	41.6%	
Do you have fuel containers?	51.8%	48.1%	
Do you have a solar charger *that can be used to charge your phone*?[a]	47.2%	57.1%	
Do you have a snow shovel?	45.0%	41.6%	
Do you have extra blankets to cover refrigerators and freezers for more insulation when there is a power outage?	37.1%	33.8%	
Are you registered with any programs in your community or medical organization that would offer to help you if there was a disaster?	68.6%	77.6%	
Have you spoken with your power company about a need for quick return of electricity because of your medical needs if there is a power outage?	62.1%	73.7%	
Do you have a medical alert bracelet with your important medical information?	73.0%	77.6%	
Do you have a list of the style and serial numbers of your medical equipment?	53.7%	61.8%	
Has your healthcare provider discussed emergency preparedness planning with you?	56.9%	56.6%	
Has your healthcare provider discussed emergency preparedness planning with you for your specific health conditions (i.e., prescription refills, dialysis needs)?	70.1%	76.3%	
Do you have air conditioning in your home?	40.8%	36.8%	
Do you have adequate heating in your home?	56.2%	56.6%	
Do you have a pet carrier or crate available for each pet?	65.2%	75.3%	
Have you labeled your pet carriers with the name and address of owner and the pet's medical history?	53.4%	59.7%	
Is your pet micro-chipped?	57.8%	62.3%	
Do you have a current pet photo in case you are separated?	59.3%	62.3%	
Do you have a leash?	71.9%	76.6%	
Do you have portable food and water bowls?	60.0%	76.6%	

(Continued)

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TABLE 2

Continued

Questions Retained (reliability $\alpha = 0.96$)	Round 1 N = 154 Consensus to Retain ≥ 80%	Round 2 n = 85 Consensus to Retain ≥ 80%	Round 3 n = 79 Mean (SD) of Weight
Do you have pet toys?	25.6%	22.1%	
Do you have pet blankets or jackets?	35.5%	45.5%	
Do you have a pet first aid kit?	37.7%	50.6%	
Do you have comfort items such as books, games, and toys for children?	63.7%	67.5%	
Do you have a current photo of your family in case you are separated? [a]		77.9%	
Is your pet up to date on all recommended vaccinations/immunizations? [a]		70.1%	
Does each member of the household carry photo identification in case there is a need to evacuate? [a]		76.4%	
Do you have work gloves? [a]		67.5%	

[a] new or revised question based on panel recommendations from round one

TABLE 3

Proposed Questions Created from the Qualitative Data – Not Included in the Delphi Study

- Are you up to date on all recommended vaccinations/immunizations?
- Are you prepared to shelter in place for at least three days if an evacuation is not required?
- Do you have written contact information of your local government and municipal authorities?
- Do young children know how to state their name, address, phone number, and parent/guardian name?

Proposed Disaster Supply Kit Items from the Qualitative Data - Not Included in the Delphi Study

- Iodine tablets or syrup for radiation emergencies
- Satellite phone
- Signal mirror
- Weapon

votes (n = 44, 56.41%). The approach to scoring the final instrument met consensus (n = 62, 79.5%), with the result that respondents' choices would be weighted in terms of the importance of an item or action.

Third Round

The investigators assembled a 51-question HEPI incorporating the recommendations from Round 2 for quantification and scaling. The domains represented in the final HEPI include: preparedness actions (11 questions), communication planning (3 questions), evacuation planning (12 questions), disaster supplies (16 questions), and specific to those with access or functional needs (9 questions). To decide which questions will be weighted higher when scoring the HEPI, Delphi participants (n = 79) were asked to weight questions from 1 = least essential, to 5 = most essential. See Table 2 for questions included and the corresponding mean weight recommended by the panelists.

At the conclusion of Round 3, the questions were assessed for reliability. The retained questions had a total Cronbach's alpha of 0.96. Cronbach's alpha for the domain scales ranged from $\alpha = 0.74$ (communication plans) to $\alpha = 0.92$ (disaster supplies). This version of the HEPI will be pilot tested.

DISCUSSION

Delphi participants came to a consensus that adequate HEP is defined as the completion of several preparedness actions and assembling a disaster supply kit that can be taken in a precipitous evacuation (Table 4). Content validity of the HEPI is now supported because the participants agreed that the instrument questions adequately captured the domains of content of the phenomenon of interest.[45]

The HEPI is an all-hazards, comprehensive survey used to ascertain if a respondent is prepared for the common conditions that disasters create (i.e., living without power, limitations on drinking

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TABLE 4

Concept Definition of Household Emergency Preparedness

Preparedness Actions
- Prepared and discussed a family emergency plan
- Practiced or drilled on what to do in an emergency at home
- Taken first aid training
- Has working smoke detectors
- Has a fire escape plan for the home
- Knows the types of disasters that are most likely to occur in their community
- Has important family documents in a waterproof, portable container or stored on a flash drive or cloud storage server
- Has signed up for a community emergency alert system
- Has supplies set aside in the home in a kit to use in case of a disaster
- Checks the supplies regularly for expired items
- Knows how to turn off the utilities

Communication Plans
- Planned for how the family would contact each other in an emergency if they were separated
- Has written contact information of family and friends
- Has a way to receive information about disasters if there were no power or telephones (such as with a solar, hand-crank or battery-operated radio)

Evacuation Plans
- Has considered safe and unsafe places in the community
- Knows if the home is in an evacuation zone
- Has a plan on where to go
- Has planned which routes to take
- Has a source of transportation to leave the neighborhood quickly
- Has a family meeting place in case of separation
- Everyone in the home is aware of the evacuation plans
- Has family or friends that they could stay with
- Knows where the local emergency shelter is located
- Has a plan for what to take if they had to leave the home quickly
- Has prepared a small kit with emergency supplies to take with them
- If applicable, has an evacuation plan for the pets

Disaster Supplies
- 3.8 liters (one gallon) of water per person per day for each person in the home for 1 week
- 1-week supply of ready-to-eat food that will not spoil for all those living in the home
- Moist wipes, hand sanitizer, soap, and other personal hygiene supplies
- Non-electric portable lighting such as a flashlight/torch, a headlamp, lanterns, glow sticks, candles
- First aid kit
- Sleeping bag or warm blanket for each person
- Cash
- Batteries
- Matches
- Fire extinguisher
- Wrench, pliers, or multi-tool
- If applicable:
  - o Extra prescription glasses or contact lenses
  - o 1-week supply of formula, bottles, and baby food
  - o 1-week supply of diapers/nappies
  - o 1-week supply of pet food and water for each pet
  - o 2-week supply of pet medications

water, and being unable to leave the home to acquire additional supplies for a few days). As discussed previously, there is support for criterion validity of this instrument. The HEPI questions are objective and ask about what the respondent presently owns or does in a multiple-choice format, allowing the participants little latitude in constructing their responses.[18] For the questions that ask about child, pet, and access/functional needs preparedness, a "this does not apply to me" response option is provided. Due to the dynamic conceptualization of HEP, the present-time context and format of the instrument questions are appropriate for this phenomenon. The investigators intend to make the HEPI free for non-commercial use, so long as proper credit is afforded to the developers of the HEPI in publications. Respondent participation in the HEPI should take about 15 minutes. The HEPI questions do not ask about sensitive information. Both respondent and researcher burden should be low for using the HEPI.

After the instrument was developed, field testing (n = 23) was used to determine if any questions were difficult to respond to, unclear, or in need of revision. There were no recommended

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HEPI revisions after the field testing. This version of the HEPI has a Flesch Kincaid reading level of 6.3. The instrument will be pre-tested on a sample of respondents under conditions that approximate as nearly as possible, the conditions expected to exist when it is employed.[18] The first internet-based pilot test of the HEPI will be conducted on a convenience sample of faculty, staff, and students from one of the most diverse universities in the United States, the City University of New York (CUNY). The globally representative sample obtained from CUNY will be ideal to evaluate cultural bias of the HEPI. After the initial pool of HEPI questions are developed, scrutinized, and administered to an appropriately large and representative sample, the authors of the HEPI will evaluate the performance of each question to determine which questions to keep on the final instrument.[46] Some of the discarded questions may be added back to the HEPI after the pilot test if the majority of the variance is not explained by the current version.

Delphi participants will be provided with the HEPI and encouraged to utilize the instrument with diverse populations in their own communities, especially as a measurement of change in pre- and post-intervention studies and longitudinal studies evaluating the outcomes of adequate HEP. Researchers may translate the HEPI into languages other than English and make modifications to tailor the instrument to specific populations of interest so long as they disclose these changes and provide psychometric data for the instrument in publications. This data may inform future modifications of the HEPI.

Preparedness recommendations are not centered on income,[47] and individuals affected by disasters commonly experience basic post-disaster needs related to food, water, shelter, safety and health.[55] Household emergency preparedness may be tailored to the individuals' specific needs and based on contextual considerations such as culture, environment, setting, and the types of disasters for which the household is most at risk.[55] However, the investigators were able to develop an instrument that assesses preparedness for the conditions that all disasters create, such as power outages, limitations on drinking water, and the inability to acquire additional supplies.

Limitations

"Critics of the Delphi method assert that results represent the opinions of experts and may or may not be consistent with reality,"[18] which is why community stakeholders were included as participants. The requirement for English reading skills may have limited participation. It may also have impacted attempts for global representation. As expected, there was over representation from the US, Australia, and Canada. There was no representation from South America or Russia. Inclusion of WADEM and snowball sampling in the survey dissemination was an attempt to expand survey outreach and increase representation of this non-random sample.

Pet preparedness was considered an essential element by the majority of the participants; however, there was no representation from the field of veterinary medicine which might have limited the number and type of questions included on the final HEPI. Data regarding sub-specialties within fields was not collected. Therefore, it is unknown if the input of Delphi participants with expertise in pediatrics, geriatrics, and access and functional needs issues was included. However, participants with this expertise were targeted during recruitment. Finally, the impact of attrition due to the decrease in sample size from 154 for the first round to 79 for the third round is unknown. The size of the original and final panels may have provided sufficient protection related to inclusivity.

CONCLUSION

It is anticipated that this instrument will benefit society. Once the instrument is adequately pilot tested, it can be used to determine whether there is an association between being prepared for a disaster and surviving the disaster without the need for rescue or outside assistance. For medically frail community members, it can be determined whether there is an association between being prepared for a disaster and surviving the disaster without an acute exacerbation of a chronic illness and with no change in baseline functional status. This instrument can also be used in experimental studies to build evidence for promising individual and community HEP interventions. Researchers are encouraged to use the HEPI to provide additional validity and reliability data, which may inform future modifications of the instrument.

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Acknowledgements

We would like to acknowledge the work of our research assistants Asha Ewrse, BSN, RN, Wenpin Hu, BSN, RN, Kamil Krekora, BSN, RN, and Soon-Hee Shimizu, BSN, RN. You contributed meaningfully to this important research while maintaining academic success in a rigorous Bachelor of Science in Nursing program. That is an amazing accomplishment.

Ethical considerations

This international Delphi study received institutional review board (IRB) approval from Hunter College, The City University of New York (protocol #2019-0121), Texas Christian University (protocol #M-1904-141-1905), and The University of Texas at Tyler (protocol #Spring2019-101). Participants' consent was implied by completing the questionnaire.

https://doi.org/10.1017/dmp.2020.292 Published online by Cambridge University Press

Conflicts of Interest Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The authors have no financial or personal relationships with other people or organizations that could inappropriately influence or bias their work. We have no commercial associations that could pose a conflict of interest or financial bias.

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