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Core Competencies for Pediatric Disaster Medicine: An International Modified Delphi Study

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Abstract

Objectives: Children are disproportionately affected by disasters and represent a vulnerable population in such settings. However, no internationally recognized core competencies exist to guide health care providers in caring for children impacted by disasters (particularly non-pediatricians). This study aimed to establish consensus-based core competencies for pediatric disaster response through international expert agreement across disciplines.

Methods: A three-round modified Delphi study was conducted following CREDES criteria, using competency statements generated via a comprehensive scoping review of pediatric disaster literature. International disaster medicine experts rated competency statements on a 7-point linear scale (1 = disagree, 7 = agree). Consensus was defined a priori as standard deviation (SD) ≤ 1.0. Data were collected and analyzed using the STAT59 online platform.

Results: 57 competencies met consensus criteria across three Delphi rounds, with mean scores ranging from 5.4 to 6.6. The highest-ranked competencies (mean = 6.6) were pediatric vulnerabilities recognition, pediatric transport management, child identification and tracking, and child-parent reunification. Decontamination initiation was also highly ranked (mean = 6.5).

Conclusions: The 57 consensus-based core competencies for pediatric disaster medicine response, spanning 16 practice domains, provide a foundation to further develop standardized curricula, guide preparedness and response efforts, and define minimum training expectations for health care providers caring for children impacted by disasters.

Introduction

Children pose unique challenges in disaster response, difficulties that, if not properly understood and addressed, often lead to tragic short- and long-term outcomes. Differences in anatomy, physiology, psychological and emotional development between adults and children result in differences in vulnerability, clinical presentations of injury and illness, and psychosocial impacts of disaster, and thus necessitate pediatric-specific triage, pre-hospital care, transport to appropriate facilities, evaluation and management.[1] Worldwide, children are 25% of the population but are often impacted by disaster in even greater proportion, yet they are underrepresented in disaster preparedness and response. Additional millions face threats from natural disasters, epidemics, pandemics, and technological emergencies; all of this illustrates the magnitude of the pediatric population's vulnerability to major disasters.[2] Furthermore, approximately 473 million children live in conflict-affected areas. By the end of 2023 alone, nearly 47.2 million children were displaced due to conflict or violence.[2,3] Despite these realities, no US or internationally recognized consensus core competencies exist for training health care professionals who care for children impacted by disaster, mass casualty, pandemic, and/or humanitarian crisis.

Core competencies that address all pediatric-specific considerations are needed to optimize pediatric outcomes. Differences in children's anatomy and physiology result in greater susceptibility to multiorgan trauma and CBRN exposures. Children exhibit less developed coping mechanisms than adults and experience higher rates of acute and post-traumatic stress responses following disasters.[4] The separation of children from caregivers during response has been associated with increased psychological trauma and behavioral complications.[5,6] Depending on age, children require specific nutritional support ranging from specialized infant formulas to age-appropriate foods, and

some have dietary restrictions due to metabolic conditions.[7] Unlike adults who can typically communicate symptoms and identify themselves, children may be unable to provide medical histories, name their caregivers, identify allergies, or disclose developmental disabilities or special health care needs.[8] While children possess a moral standing and legal rights across most cultures, they often lack legal agency and rely upon adults for access to medical care, necessary resources, even in the utilization of their legal rights.

Given that disaster preparation and response systems historically have not adequately addressed pediatric-specific needs,[9,10] it is not surprising that health care workers report lower confidence in providing emergency care to children compared to adults, even in non-disaster settings.[9–11] When disaster strikes and health care systems become overwhelmed, these pre-existing gaps in pediatric emergency competency are magnified, leaving children vulnerable to suboptimal care and preventable short- and long-term suboptimal and often adverse outcomes.[12]

This study, led by the Beth Israel Deaconess Disaster Medicine Fellowship, aimed to establish global consensus core competencies for pediatric disaster medicine response in the acute setting, particularly for non-pediatric specialty/subspecialty trained professionals through international expert agreement across disciplines and roles.

The Preparedness and Competency Gap

Despite increased recognition of pediatric vulnerabilities, impacts, and needs in disaster, including natural and manmade, mass casualty, pandemic, and humanitarian crisis a substantial preparedness and competency gap persists.[6,9] Disaster preparation and response have traditionally followed an "all-hazard, all-populations" approach that may not adequately address the specific needs of vulnerable populations, particularly children who are under-represented and for whom needs are underprovided relative to the percent of the population they represent, and an often even greater percent of the population impacted by disaster.[13–15] In the United States, greater than 80% of children are seen in general emergency departments for routine emergency care, most by professionals without pediatric training as a specialty. One of the core goals of the Health Resources and Services Administration (HRSA) funded Emergency Medical Services (EMS) for Children Innovation and Improvement Center (EIIC) National Pediatric Readiness Project, developed to provide high-quality care that reduces mortality and improves outcomes for children in all US emergency departments and pre-hospital settings, is to improve readiness for children in disasters and mass casualties. Improving provider competencies is therefore one of the 7 key domains of the Pediatric Readiness Project.

A wealth of evidence-based resources to enhance pediatric disaster medicine preparedness and response are available, including a Pediatric Disaster Preparedness & Response Competency Checklist from the Pediatric Readiness Project, Pediatric Pandemic Network (PPN) and ASPR-funded Pediatric Disaster Centers of Excellence offer extensive, evidence-based resources to enhance pediatric emergency preparedness. Key tools include the Pediatric Readiness Project Pediatric Disaster Preparedness Competency Checklist, PPN Resource Central, pediatric disaster medicine curricula, surge capacity guidelines, and simulation exercises. Several pediatric disaster courses and modules have also been developed, including AAP and TEEX. However, previous efforts have been limited to single institutions, specific disciplines (e.g., pediatric surgeons or emergency medicine physicians).

While the disaster medicine field has made progress in establishing general competency frameworks for health care providers, particularly within subspecialties and roles, medical directors and response coordinators,[16] no nationally or internationally recognized consensus exists regarding core competencies for health care providers at the point of care. Knowledge of core competencies can aid frontline medical doctors, nurses, physician assistants, paramedics, and other independent providers who directly assess and treat pediatric patients during disasters.[17,18]

This gap has multiple consequences. First, many health care organizations lack guidance on what knowledge and skills their pediatric disaster responders should possess.[6,10] Second, educational programs lack consensus-based curricula for training health care providers in pediatric disaster medicine.[6,14] Third, individual providers cannot reliably assess their own preparedness or identify learning needs. Fourth, the global health community lacks a framework for establishing minimum standards or assessing provider competency in the disaster medicine domain.[19,20]

The absence of established pediatric disaster medicine competencies occurs despite clear calls for such standardization. Multiple authors and professional organizations have highlighted the need for defined competencies specific to pediatric disaster care.[14–21] Given that disasters, while requiring local preparedness and response, occur globally and require core knowledge and competency for preparedness and response, broad international expert consensus adaptable for specific type and site of disaster could markedly improve short- and long-term outcomes for children.[22,23]

Study Purpose and Objectives

This study sought to identify and achieve international expert consensus on core competencies for pediatric disaster medicine applicable to all independent health care non pediatrician/pediatric subspecialty providers who might be expected to care for children during or after disasters. The research question guiding this work was: what are the essential knowledge, skills, and competencies that non-pediatric-focused health care providers need to effectively care for children in disaster settings?

The primary objective was to develop a Delphi consensus-based, prioritized list of core competencies that could serve as a foundation for standardized pediatric disaster medicine training for both the student and practicing professional levels.

The secondary objective was to identify areas for which expert consensus could not be achieved, thereby highlighting topics requiring additional research, clarification, or context-specific adaptation.

Methods

Study Design

This study employed a modified three-round Delphi methodology to achieve expert consensus on core competencies for pediatric disaster medicine. The Delphi technique is particularly well-suited for achieving consensus among experts when the evidence base is incomplete or when expert judgment is required to synthesize diverse perspectives.[24]

The modified Delphi approach differs from the traditional 4-round format in that it omits the initial open-ended round and instead begins with a pre-developed list of competency statements derived from a scoping literature review of pediatric disaster training. This modification accelerates the consensus-building process while maintaining methodological rigor.[25,26]

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Participant Identification and Recruitment

Study participants were identified as recognized experts in pediatric disaster medicine, pediatric emergency medicine, emergency medicine, general pediatrics, med-peds, pediatric global health, pre-hospital medicine, and/or disaster response with substantial experience caring for children in emergency and disaster contexts as relevant to their practice. Eligibility criteria for participation required: (1) minimum 5 years of experience in pediatric emergency, emergency medicine, general pediatrics or disaster medicine; (2) demonstrated disaster relevant contributions to their field through publications, presentations, or leadership roles; (3) direct experience planning or delivering emergency care for children in disaster or mass casualty settings; and (4) recognition by peers as subject matter experts.

Potential participants were identified through multiple mechanisms: review of professional organizations' membership rosters (American Academy of Pediatrics, American College of Emergency Physicians, International Society of Disaster Medicine, World Association of Disaster and Emergency Medicine), review of relevant literature for active authors in pediatric disaster medicine, recommendations from established disaster medicine networks, and purposeful sampling to ensure geographic and disciplinary diversity. All invited participants were known to at least one of the study team members.

Recruitment occurred between January 22, 2024 and April 20, 2025. Invitations were extended via email, which included: study background and purpose, explicit description of time commitment for each round, explanation of anonymity protections, description of the consensus methodology, and a clickable link to enroll in the STAT59 platform. Participants provided informed consent through the STAT59 system prior to accessing survey materials.

Participant Delphi Participation

On the day of the first round of the Delphi, all participants joined either over Zoom or in person, and all competencies were presented via a slide deck. When each competency was presented, all participants would state whether they agreed with the competency as written, disagreed with the competency as written, or offered edits to the competency as written. After each participant offered their opinion on a competency, the next competency was presented. This process lasted for several hours, with half of the competencies being assessed by the SMEs. Following this event, the remaining competencies (the ones that had not been presented or commented upon by the SMEs) were placed into an online survey and emailed to the SMEs who had participated. Once all SMEs had offered their input on all initial competencies, the results were compiled. Competencies which had been viewed as irrelevant or of very low priority were discarded, competencies which were edited were rewritten, and competencies approved of as originally presented were unaltered) and used for the second round of the Delphi.

Round 1: Quantitative Rating and Consensus Building

Participants evaluated and commented on 119 competencies generated based on scoping literature review. Agreed-upon competencies were advanced to Round 2.

Round 2: Confirmation and Refinement

In Round 2, participants accessed the online STAT59 platform and rated the statements advanced from Round 1 using a 7-point linear scale anchored with "1" = "strongly disagree" and "7" = "strongly agree." This scale was selected for its intuitive interpretation, widespread use in health care education research, and established validity in Delphi studies.[25–28]

In Round 2 (the first online round), participants also provided the following demographic and background information: professional title, years of experience in disaster medicine, geographic location of practice, disaster response experience (direct patient care, planning, training, research), health professional credentials, and roles in disaster preparedness.

Importantly, as part of the Round 2 Delphi, participants were invited to propose new competency statements they believed should be included in Round 3.

Round 3: Confirmation and Refinement (Cont.)

Following Round 2, statements achieving consensus (SD ≤1.0) were retained but not advanced to Round 3. Competency statements proposed during Round 2 were refined and condensed by the study team into new statements. These were combined with the statements from Round 2 that did not achieve consensus and progressed to Round 3 rating.

In Round 3, participants rated the statements on the same 7-point linear scale. Participants were provided with feedback showing the Round 2 mean score and SD for each statement that had been rated in Round 2. As is typical for Delphi studies, experts were also shown their own individual rating from Round 2, encouraging participants to reconsider their judgments considering group response patterns.

Consensus Criteria

Consensus was defined a priori as SD ≤1.0 on the 7-point rating scale. This criterion was selected based on published literature demonstrating its reliability in Delphi studies with greater than 5 participants. Research by Franc et al. demonstrated that with greater than 5 experts, the probability of false grading using this criterion is less than 10%.[24]

The choice of SD rather than other consensus measures (e.g., percentage agreement, quartile agreement, median score) reflects current best practices in Delphi methodology and allows for precise parametric analysis of group judgment.[25]

Data Analysis

Descriptive statistics (means, standard deviations, frequencies) were calculated for all ratings. Statements were assessed for consensus individually during each round using the a priori criterion (SD ≤ 1.0).

Following Round 2, all statements meeting consensus criteria were identified and excluded from further rounds. Proposed new statements were reviewed by the study team (SZG, AJH, FI, JFM, DLW, GRC) for: (1) relevance to pediatric disaster medicine competencies; (2) clarity and specificity; (3) overlap with existing statements; and (4) organizational appropriateness. Redundant or highly overlapping statements were consolidated.

Following Round 3, the consensus criteria were applied to all Round 3 statements. All consensus statements from both rounds were combined and rank-ordered by mean score to create a final prioritized competency list.

Statements not achieving consensus were cataloged separately with their respective mean scores and SDs, providing a resource for identifying areas requiring further research or discussion.

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Statistical Methods

Analysis employed parametric statistical methods using mean and standard deviation to characterize central tendency and variability in group judgment. While some researchers debate the appropriateness of parametric analysis for Likert-scale data, Franc et al. provide empirical support for parametric analysis of 7-point linear scale data in Delphi studies with adequate sample sizes.[24] The 7-point scale used in this study produces distributions sufficiently close to normal to justify parametric analysis, and the mean provides a more precise estimate of central tendency than ordinal measures.

Study Setting and Platform

Data collection was conducted entirely online through STAT59 (STAT59 Services Ltd., Edmonton, AB, Canada), a software platform specifically designed for Delphi studies. STAT59 provided complete anonymity of participants and responses, preventing bias from hierarchy or social desirability effects. The platform facilitated automated data management, statistical calculation, and secure data storage.

Ethical Considerations

This study received institutional review board approval from BIDMC IRB Protocol # 2023P000969. All participants provided informed consent through the STAT59 platform before accessing study materials. Participation was entirely voluntary, and participants could withdraw at any time without penalty. The anonymity protocols embedded in STAT59 ensured that individual participants' identities were never revealed to other participants or the study team during data analysis.

Results

Participant Characteristics and Response Rate

Round 1: 14 SMEs assessed 119 competencies. 10 were Medical Doctors, 3 were Nurses, and one was a Paramedic. 6 participants were male, while 8 were female.

Round 2 was completed by 26 participants (response rate: 100% of invited participants). Geographic distribution included the United States (n = 14, 53.8%), Australia (n = 2, 7.7%), Canada (n = 1, 3.8%), France (n = 1, 3.8%), Japan (n = 1, 3.8%), and Singapore (n = 1, 3.8%). Six participants (23.1%) did not specify geographic location. The panel included multiple professional disciplines: Medical Doctors (MDs) and Doctors of Osteopathy (DOs) specialized in emergency medicine or pediatrics, Nurses and Nurse Practitioners with advanced emergency or disaster medicine training, paramedics, and other health care professionals with advanced training. Professional diversity was intentional, reflecting the reality that pediatric disaster response requires interdisciplinary teams.

Gender distribution among participants who reported this demographic: 11 male (42.3%), 8 female (30.8%), with 7 participants (26.9%) not specifying. Age distribution: 6 participants (23.1%) were over 60 years old, 13 (50.0%) were 41-60 years old, and 7 (26.9%) were 30-40 years old. Experience in pediatric emergency or disaster medicine ranged from 5 to 35+ years, with a median of 18 years (IQR: 10-25 years).

All 20 participants who completed experience questions (76.9% of the cohort) reported direct experience with pediatric disaster response, including participation in actual disaster response (n = 12), mass casualty exercises or simulations (n = 15), disaster preparedness planning (n = 18), and emergency medicine education for pediatric populations (n = 14).

Round 3 retention was 15 participants (57.7% of Round 2 participants). While this represents participant attrition, the sample size remains well within published recommendations for Delphi studies (typically 8-20 experts) and above the minimum of 8-10 participants required for statistical precision in parametric analysis.[24–27] The 11 participants who did not complete Round 3 cited time constraints (n = 7) or competing professional demands (n = 4). This decline from Round 2 to Round 3, a reduction of 42.3%, is consistent with the response fatigue commonly observed across successive rounds in multi-round Delphi studies. Notably, the reasons cited for non-completion were logistical time constraints and competing professional demands rather than disagreement with the competencies under evaluation, which lessens, though does not eliminate, the likelihood that attrition was driven by divergent viewpoints. The potential for selection bias nonetheless warrants consideration: had the experts who completed Round 3 differed systematically from those who withdrew with respect to professional discipline, geographic region, or strength of opinion on contested statements, the resulting consensus could disproportionately reflect the perspectives of the retained subgroup. The progressive convergence of mean ratings and the reduction in standard deviations across rounds suggest that the retained panel preserved sufficient disciplinary and geographic diversity to support credible consensus; nevertheless, Round 3 findings should be interpreted with this possibility in mind.

Round 1 Results

The Round 1 process generated initial competency statements organized across 16 domains of practice: Disaster Concepts and Principles, Provider Self-Preparedness, Pediatric Vulnerabilities, Disaster Activation and Response Logistics, Infection Control and Exposure, Transport, Triage, Evaluation, Treatment, Chemical/Biological/Radiological/Nuclear/Explosive (CBRNE) Response, Decontamination, Behavioral and Mental Health, Patient Information and Tracking, Reunification, Austere Environment Response, and Legal and Ethical Issues. The final competency list developed in Round 1 was 105 statements selected for inclusion in Round 2 by the expert panel of participants.

Round 2 Results

In Round 2, 26 participants rated 105 competency statements, yielding 2,727 individual ratings. Mean scores ranged from 4.6 to 6.6 on the 7-point scale, with standard deviations ranging from 0.6 to 2.0. Twenty statements reached consensus with SD ≤ 1.0 and were thus not advanced to Round 3. In addition, participants gave 32 new proposed statements. Three of the proposed statements contained only null text. Following analysis of the 29 proposed statements that contained text by the analysis team, these were reduced into 15 new statements.

Round 3 Results

Round 3 consisted of 100 statements (85 of the original statements that did not reach consensus plus 15 added based on the proposed statements). Fifteen participants rated 100 statements (85 non-

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Table 1. Consensus competencies for pediatric disaster medicine

Statement	n	Mean	SD
Pediatric Vulnerabilities 1: Understands that children are more vulnerable to disasters and disproportionately affected by disasters, and recognizes the anatomic, physiologic, and developmental differences that underlie those vulnerabilities.	25	6.6	0.9
Transport 1: Describes the fundamentals and challenges of safe transport of pediatric patients in a disaster and challenges of reunification.	24	6.6	0.7
Patient Information and Tracking: Understands responder role and responsibility of tracking children in disasters and follows child identification and reunification best practices.	21	6.6	0.9
Reunification 2: Prioritizes keeping child/parent dyads together whenever possible (including during decontamination).	21	6.6	0.8
Triage 1: Understands the purpose and limitations of triage in the pediatric population and its role in appropriate destination and decision-making.	24	6.5	0.8
Legal and Ethical Issues 4: Understands and practices the principles of ethical care of children in disasters.	21	6.5	1
Treatment 1: Demonstrates the ability to assess and manage children with traumatic injury.	15	6.5	0.9
Decontamination 1: Identifies the need for patient decontamination and initiates decontamination processes.	15	6.5	0.6
Transport 2: Understands criteria for transfer of pediatric patients that cannot be managed in their current setting and determines safe disposition.	24	6.4	0.8
Disaster Concepts, Principles 1: Explains definitions of disasters, the disaster cycle and the international humanitarian response system.	15	6.4	0.7
Infection Control, Exposure, and Protection 2: Understands the role of immunization, infection control, and post-exposure prophylaxis for pediatric populations in disasters.	15	6.4	0.9
Understand the principles of psychological first aid.	15	6.4	0.8
Behavioral and Mental Health 1: Recognizes and initiates prompt mental health care for children affected by disasters.	22	6.3	1
Austere Environment Disaster/Humanitarian Crisis Response 6: Ensures adequate age-specific nutrition, including infant formulas and encouraging breastfeeding.	21	6.3	1
Disaster Concepts, Principles 4: Understands overall disaster response structure (for example, ICS).	15	6.3	0.9
Disaster Activation, Response Logistics 15: Understands the roles that schools and daycare centers may play in disaster response.	15	6.3	1
Treatment 13: Manages the acutely ill child and provides age-specific and age-appropriate care.	15	6.3	0.9
Triage 2: Demonstrates child-appropriate triage methods using different techniques.	24	6.2	0.8
Triage 3: Recognizes the challenges of triage in children with special health care needs.	24	6.2	0.8
Decontamination 2: Demonstrates the importance and use of PPE and methods of decontamination of pediatric patients after radiation exposure.	22	6.2	0.9
Behavioral and Mental Health 3: Takes into account patient age and developmental stage, dependency on caregivers, gender, and physical/mental health when evaluating emotional vulnerability.	15	6.2	0.7
Understands pediatric hemodynamic responses to hemorrhagic shock, including tachycardia as an early sign of shock.	15	6.2	1
Disaster Activation, Response Logistics 1: Identifies chemical, biological, and radiological exposures and toxidromes in children.	25	6.1	1
Infection Control, Exposure, and Protection 6: Understands and works to mitigate the impacts of isolation and quarantine on children and families.	24	6.1	0.9
Disaster Concepts, Principles 6: Develops plans for different types of disasters which include mitigation of pediatric vulnerabilities, and maximizes patient flow, staff identification, response team development, supply acquisition, and language services.	15	6.1	0.9
Disaster Activation, Response Logistics 9: Understands how remote communication can be used to access pediatric expertise in disasters (i.e., telehealth/telemedicine).	15	6.1	0.9
Evaluation 2: Recognizes chemical agents and patients who have sustained injuries from chemical agents.	15	6.1	1
Behavioral and Mental Health 4: Engages with pediatric patients using appropriate means to express themselves and their feelings about what has happened.	15	6.1	0.8
Disaster Activation, Response Logistics: Identifies equipment and medications suitable for pediatric use from adult equipment/ medication lists.	15	6.1	0.9
Understand how to provide bereavement support for a grieving child.	15	6.1	1
Disaster Activation, Response Logistics 12: Appropriately utilizes a disaster response notification system that is inclusive of pediatric specialists for disasters involving children.	24	6	1
Infection Control, Exposure, and Protection 4: Recognizes and adjusts to the challenges of using PPE when caring for young children, including those with disabilities or communication difficulties, and uses adaptive PPE where appropriate.	24	6	1

(*Continued*)

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Table 1. (*Continued*)

Statement	n	Mean	SD
CBRNE 1: Appropriately triages pediatric patients with radiation exposure, performs primary decontamination, and refers patients to appropriate centers for further care as needed.	23	6	1
Disaster Concepts, Principles 3: Understands team structure, leadership, and own role-specific responsibilities within their system as well as Emergency Support Functions (ESFs).	15	6	1
Evaluation 4: Recognizes biological agents and patients who have sustained injuries from biological agents.	15	6	0.9
CBRNE 2: Recognizes toxidromes and treats chemical agents.	15	6	0.9
Disaster Activation, Response Logistics 2: Ensures procurement of appropriate and safe dosing and administration of pediatric medications in disaster contexts.	25	5.9	1
Disaster Activation, Response Logistics 11: Understands and follows a security plan which assures the safety of staff, visitors and addresses unique challenges of child safety in disaster response.	24	5.9	1
Provider, Staff, Self-Preparedness 2: Develops and maintains individual mental and emotional capacity and skills to care for children and families in disasters.	15	5.9	0.9
Provider, Staff, Self-Preparedness 4: Understands the responsibility of responders to care for their own mental and physical needs and security in disasters and discusses methods to do so.	15	5.9	0.9
Infection Control, Exposure, and Protection 7: Recognizes the need and initiates protocols for communicable diseases in pediatric populations.	15	5.9	1
Treatment 2: Demonstrates ability to manage emergencies involving obstetrics/gynecology, newborn/neonatal resuscitation, and transport of newborns/neonates.	15	5.9	0.9
Treatment 5: Understands and performs the initial management, resuscitation, and stabilization of bone fractures.	15	5.9	0.9
Decontamination 7: After radiation exposure, appropriately performs primary decontamination and refers patients to appropriate centers for further care as needed.	15	5.9	1
Reunification 1: Able to account for and responsibly track children separated from their caregivers, children who carry no identification, children who are unable to provide important medical information such as drug allergies or medical histories (especially among infants and young children), and children who are unable to give their names or identify their legal caregivers.	15	5.9	1
Pediatric Vulnerabilities 5: Understands the impact of sex and gender-based exploitation and violence against children and families in disaster settings.	15	5.8	0.9
Treatment 3: Manages burn injuries (including extremity burns and escharotomy).	15	5.8	0.9
Disaster Activation, Response Logistics 7: Understands best methods to coordinate with response agencies in the private, public, and non-governmental sectors at local, state, and international levels of a disaster.	15	5.7	0.8
CBRNE 3: Recognizes symptoms and treats biological agents.	15	5.7	1
CBRNE 4: Recognizes and treats Acute Radiation Syndrome.	15	5.7	0.9
Be able to conduct an assessment of acute mental health risk of children (e.g., suicidal ideation) in the context of a disaster.	15	5.7	0.9
Be able to conduct appropriate death notification for children in a disaster setting.	15	5.7	1
Disaster Concepts, Principles 9: Provides an overview of how best to reduce risk for pediatric populations during and after disasters (for instance, the Sendai Framework for Disaster Risk Reduction for Children).	15	5.6	1
Austere Environment Disaster/Humanitarian Crisis Response 4: Provides focused care for technology-dependent children in a disaster.	21	5.5	1
Disaster Activation, Response Logistics 10: Understands and participates in disaster surveillance systems.	15	5.4	1
Treatment 9: Recognizes and manages patients with emergency complications of genetic, congenital, and developmental disabilities and CSHCN (Children with Special Health Care Needs).	15	5.4	1
Behavioral and Mental Health 2: Manages a variety of mental health responses of children in disasters (including PsySTART).	15	5.4	0.9

Note. Competencies are listed in descending order of mean score. SD = Standard deviation. Consensus defined as SD ≤ 1.0 on a 7-point scale.

consensus statements from Round 2 + 15 refined new statements). This yielded 1,500 individual ratings. Thirty-seven statements reached consensus.

Combined across both rounds, 57 competency statements achieved consensus (SD ≤ 1.0) (20 in Round 2 and 37 in Round 3). Final results of consensus competencies are presented in Table 1.

Discussion

The 57 competencies (spanning 16 domains of practice) produced by this modified Delphi study represent the first internationally derived expert consensus on essential knowledge and skills required for health care providers caring for children in disaster settings. The high level of consensus on certain competencies (5 competencies with mean score = 6.6 on a 7-point scale) reflects broad agreement

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among geographically and disciplinarily diverse experts regarding foundational pediatric disaster medicine competencies.

Key Themes in Consensus Competencies

Analysis of consensus competencies reveals several recurring themes:

Theme 1: Pediatric-Specific Vulnerabilities and Differences

The highest-ranked competency emphasizes understanding that children are fundamentally different from adults anatomically, physiologically, and developmentally and that these differences affect disaster response.[5,12,14] This foundational competency reflects growing recognition that pediatric disaster medicine cannot simply apply adult protocols to children. The inclusion of competencies addressing special populations, triage in children with special health care needs, and age-appropriate interventions reinforces that pediatric disaster care requires adapted approaches rather than scaled-down adult protocols.

Theme 2: Family-Centered and Psychologically Informed Care

Strong consensus emerged around competencies emphasizing family-centered principles, including keeping child-parent dyads together during decontamination, evacuation, and treatment; prioritizing reunification; and minimizing separation trauma.[4,6] Four of the 5 highest-ranked competencies directly or indirectly address family preservation. This emphasis aligns with trauma-informed care principles and emerging evidence demonstrating that separation from caregivers during response operations significantly increases psychological injury risk in children.[4] These competencies challenge traditional disaster medicine mass casualty protocols that prioritize triage by clinical severity without considering the psychological impact of separation.

Theme 3: Operational and Practical Competencies

Strong consensus emerged for practical operational competencies: safe transport of pediatric patients, decontamination procedures, child identification and tracking, triage methodology adapted for children, and infection control principles specific to pediatric populations. These competencies reflect experts' judgment that effective pediatric disaster care requires both specialized knowledge and adapted procedures. The emphasis on operational competencies suggests that training programs should not limit focus to clinical knowledge but should include practical procedures and systems-level responses.

Theme 4: Provider Preparedness and Self-Care

Consensus emerged around competencies addressing provider mental and physical capacity, responder self-care responsibilities, and provider psychological resilience.[28] This represents an evolution in disaster medicine training, moving beyond exclusive focus on patient care to recognize that provider wellbeing directly impacts response effectiveness. These competencies acknowledge secondary traumatic stress, burnout, and vicarious trauma as occupational hazards in pediatric disaster response, requiring proactive attention.

Theme 5: Special Populations and Equity

Several competencies achieved consensus, which address the care of children with special health care needs, recognition of vulnerable subpopulations, and protection from exploitation and harm. This emphasis reflects growing awareness that disasters disproportionately impact already-vulnerable children, and that equitable disaster response requires intentional focus on special populations.

Comparison With Prior Competency Frameworks

This study builds upon previous work establishing general disaster medicine competencies. Walsh et al. established core competencies for disaster medicine and public health but did not specifically address pediatric populations.[18] While that framework remains foundational, it lacks the granularity and specificity needed for pediatric disaster medicine training.

This study fills an important gap by providing the first internationally derived expert consensus on pediatric-specific competencies. Unlike institutional training programs developed in isolation, this Delphi process engaged a range of international experts, increasing the likelihood that competencies are generalizable across different health care systems, disaster types, and cultural contexts.

Methodological Strengths

This study demonstrates several methodological strengths that enhance the validity and generalizability of findings. The international composition of the expert panel, drawing participants from 6 countries with diverse disaster experience spanning natural and manmade disasters, pandemics, and humanitarian conflicts, likely increases the generalizability of findings across different disaster contexts and health care systems. The interdisciplinary nature of the panel, which included physicians, nurses, paramedics, and other professionals, reflected the reality of interdisciplinary disaster response teams and ensured that competencies captured diverse professional perspectives.

The analytical approach employed parametric statistical methods utilizing a 7-point linear scale with mean and standard deviation, which provides precise measurement of agreement and is statistically appropriate for this scale.[24] The iterative design of Rounds 2 and 3 allowed participants to reconsider their ratings in light of group responses and expert-reviewed new competencies, facilitating convergence toward consensus through informed deliberation. The methodological transparency inherent in the a priori definition of consensus criteria and detailed reporting of ratings, means, and standard deviations ensures reproducibility and allows readers to assess the strength of consensus for each competency independently.

Limitations

Several limitations warrant consideration when interpreting these findings. While the sample sizes of 26 Round 2 participants and 15 Round 3 participants fall within typical Delphi ranges of 8 to 20 experts, larger samples might have produced different consensus patterns. The 42% attrition rate from Round 2 to Round 3, though the remaining sample size remains adequate for statistical analysis, introduces potential attrition bias whereby participants who withdrew may have differed systematically from those completing Round 3, potentially influencing the final consensus results.

The modified Delphi approach, which utilized a pre-developed competency list rather than beginning with open-ended Round 1 responses as in traditional Delphi studies, may have biased

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emphasis toward certain domains which have seen more robust publication in the academic literature. However, this risk is at least partially decreased by allowing participants to propose new competencies in Round 2. Geographic and professional representation limitations persist, as despite international recruitment efforts, a substantial proportion of participants were from the United States (53.8%), and participants predominantly represented academic or leadership roles in disaster medicine rather than frontline responders. These sampling characteristics may limit the applicability of findings to resource-limited settings or frontline practice contexts. Notably, no panelists were drawn from low- or middle-income countries, sub-Saharan Africa, South America, or South Asia, regions that bear a disproportionate share of disaster-related pediatric morbidity and mortality, which constrains the global generalizability of the competency set and may bias prioritization toward the resource assumptions of high-income health systems. Moreover, while the competencies articulate what providers should know and be able to do, they do not establish the feasibility of implementing or sustaining them across settings with markedly different staffing, equipment, pharmaceutical, and infrastructure constraints. Competencies that presuppose capabilities such as decontamination, advanced resuscitation, or telehealth-enabled access to pediatric specialists may be difficult to operationalize in austere or resource-limited environments without substantial adaptation and investment.

Perhaps most importantly, expert consensus does not constitute empirical validation that these competencies actually predict effective pediatric disaster response. Future research must examine whether health care providers and systems achieving these competencies demonstrate superior performance in simulation-based assessments or actual disaster responses. The context-dependent nature of disaster response suggests that competencies prioritized in resource-rich health care systems may differ from those most critical in resource-limited settings. While the international panel composition partially addresses this concern, competency adaptation for specific contexts remains necessary for optimal local implementation.

Clinical and Practical Implications

These consensus competencies provide health care systems, educational institutions, and individual providers with evidence-based guidance for pediatric disaster preparedness and training. At the health care system and emergency management level, the results of this study have immediate applicability to workforce planning, as health care facilities can now ensure their disaster response teams include personnel trained in these 57 consensus pediatric competencies. The explicit emphasis on decontamination, pediatric-specific medications, equipment and supplies, and staffing provides actionable direction for resource procurement decisions. Organizations can use these competencies to develop more effective pediatric disaster drills and tabletop exercises that explicitly address identified knowledge and skill domains, while also utilizing the competencies in assessing institutional pediatric disaster preparedness capabilities.

For educational programs across medicine, nursing, paramedicine, and public health, these competencies offer a foundation for curriculum development at undergraduate and graduate levels, providing specific learning objectives that can be integrated into existing educational frameworks. Educational institutions should develop valid assessment instruments to measure competency achievement through knowledge tests, simulation-based performance assessments, and workplace-based evaluation methods. The framework further enables development of competency-based progression models, allowing learners to advance through curricula as they demonstrate mastery. This is consistent with contemporary competency-based medical education principles, rather than completion of fixed time-period learning.

At the individual health care provider level, practitioners can assess their own competency levels against this framework to identify specific learning needs and seek targeted continuing education addressing identified gaps. The breadth of competencies across 16 domains highlights a critical reality: pediatric disaster response requires diverse expertise, and no single professional discipline possesses all necessary competencies. This recognition underscores the importance of intentional interdisciplinary collaboration in pediatric disaster preparedness and response, challenging siloed approaches to disaster medicine training and practice.

Research Implications and Future Directions

The establishment of consensus competencies opens several critical avenues for future investigation that span methodological, educational, and outcomes-focused domains. The immediate research priority involves operationalizing these competency statements into measurable learning objectives and developing validated assessment instruments. This work requires systematic development and psychometric validation of knowledge assessments, performance-based evaluations utilizing high-fidelity simulation, and workplace-based assessment methods that can reliably measure competency achievement across diverse practice settings. Such assessment development represents essential foundational work without which the practical utility of the competency framework remains limited.

Concurrent with assessment development, researchers must design and rigorously evaluate educational interventions targeting these competencies. Potential intervention modalities include immersive simulation scenarios, adaptive online learning modules, and interprofessional team training programs, each requiring systematic evaluation of educational effectiveness through robust study designs. Implementation science methodologies offer valuable frameworks for addressing the critical question of how competency-based training can be effectively disseminated and implemented across heterogeneous health care settings, guiding approaches to scaling while enabling necessary adaptation for different organizational contexts, resource environments, and cultural settings.[29]

The 70 competency statements that failed to achieve consensus warrant dedicated qualitative investigation to understand the sources and nature of expert disagreement. Such inquiry could reveal important contextual factors influencing competency prioritization, identify opportunities for developing more precisely worded competency statements, and potentially uncover systematic differences in perspectives between different professional groups, geographic regions, or practice contexts. Understanding these patterns of non-consensus may prove as valuable as the consensus findings themselves for advancing conceptual development in this field.

Perhaps most crucially, future research must establish empirical linkages between competency achievement and actual performance outcomes. Do health care providers and systems demonstrating mastery of these competencies actually deliver superior pediatric disaster care? This fundamental question demands investigation through multiple methodological approaches, potentially including correlation of competency assessment scores with performance in high-fidelity disaster simulations, comparative effectiveness studies

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examining patient outcomes in health care systems with varying levels of competency-based training implementation, and analysis of after-action reports from actual disaster responses. Such outcome linkage research would provide the empirical validation that expert consensus alone cannot supply.

The dynamic nature of disaster medicine practice necessitates periodic competency framework review and updating. The field should establish mechanisms for systematic reassessment every 3 to 5 years, incorporating evolving evidence, emerging threats, and changing best practices. Finally, given the emphasis on special populations within the consensus competencies, targeted research should clarify which specific competencies prove most critical for serving particularly vulnerable pediatric subpopulations, including unaccompanied children, children with disabilities, and children from marginalized communities. Such focused investigation would enable more nuanced, equity-oriented approaches to competency-based training development and implementation.

Limitations of Consensus Approach

While the Delphi methodology provides valuable expert consensus, it should be recognized that consensus does not equate to evidence of effectiveness. These competencies represent expert judgment regarding what knowledge and skills are important for pediatric disaster medicine, but empirical evidence regarding their relationship to actual disaster response outcomes remains limited. Implementation and evaluation of competency-based training will provide the ultimate validation of this framework.

Conclusions

This international modified Delphi study successfully established 57 evidence-based core competencies for pediatric disaster medicine reflecting expert consensus. The highest-ranking competencies emphasize understanding pediatric vulnerabilities, maintaining family-centered care principles, and ensuring operational readiness in critical areas including decontamination, triage, and transport. These competencies span 16 domains of practice and provide an essential foundation for standardizing pediatric disaster medicine training globally.

The establishment of consensus competencies represents significant progress in addressing a critical competency gap. For too long, health care providers caring for children in disasters have lacked consensus guidance on what knowledge and skills they should possess. These competencies provide that guidance while acknowledging that training programs and health care systems will need to adapt competencies to their specific contexts, resources, and populations.

Implementation of competency-based training has substantial potential to improve pediatric disaster medicine through several interconnected mechanisms. Such training can ensure baseline knowledge and skills among responders, thereby reducing variability in pediatric disaster care quality across different providers and settings. The results of the study enable systematic identification of learning needs and gaps, facilitating more targeted professional development interventions. Furthermore, the explicit articulation of competencies across multiple domains and professional disciplines can facilitate more effective interdisciplinary collaboration in disaster response. Ultimately, these improvements in provider preparedness, care standardization, and team coordination have the potential to enhance outcomes for children affected by disasters.

Realizing this potential will require deliberate validation and implementation efforts, with particular attention to low- and middle-income countries, where disasters exact a disproportionate toll on children yet pediatric disaster resources and specialized training are most scarce. Because this competency set was derived predominantly from experts practicing in high-income settings, prospective studies should test its applicability, feasibility, and prioritization in resource-limited contexts, engaging local clinicians, ministries of health, and humanitarian and nongovernmental organizations to adapt competencies to available infrastructure, workforce composition, and cultural norms. Pilot implementation through context-appropriate, low-cost training modalities including low-fidelity simulation, mobile or offline-capable learning platforms, and train-the-trainer models would help determine whether these competencies can be operationalized where the need is greatest.

As the world faces increasing disaster risks from climate change, conflict, pandemics, and other hazards, the need for competent pediatric disaster medicine providers has never been greater. While not a final destination, this compilation of consensus competencies provides a roadmap toward the ultimate goal: preparing the global health care workforce to meet a critical demand and protect one of the world's most vulnerable populations—children experiencing disasters.

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