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Emergency Preparedness for Heat Illness in Ethiopia: A Cross-Sectional Observational Study

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ABSTRACT

Background: *The incidences and fatalities from heat illness have increased in the recent decades along with more frequent heatwaves. Thus, providing effective urgent care for heat illness is crucial for improving patient outcomes. Yet, research on the necessary emergency preparedness for managing such cases has been minimally explored.*

Methods: *A content-validated survey, the Perceived Emergency Preparedness Scale for heat illness (heatPEPS), was distributed to emergency nurses across Ethiopia via Email from December 23, 2019, to January 23, 2020. A subset of these nurses underwent a retest after two weeks. Data analysis was conducted using SPSS 26, IRTPRO 4.2, and NVivo 12 Plus.*

Results: *A valid response rate of 46.4% (200/431) was achieved. Dichotomous scoring revealed a high mean heatPEPS score (7.29; SD 1.667). The refined 9-item heatPEPS demonstrated an excellent fit with the 2PL model ($M2 = 27.24$, $p > 0.05$; $RMSEA = 0.01$) and satisfactory internal ($\alpha = 0.68$) and test-retest reliability (intraclass correlation = 0.56). A significant portion of participants (74%) expressed dissatisfaction with their knowledge and skills related to heat illness, identifying a critical area for improvement in emergency preparedness.*

Conclusion: *While emergency departments seem to be well-prepared, this perception may be influenced by social desirability bias. The 9-item heatPEPS proves to be a valid and reliable instrument for assessing emergency preparedness for heat illness.*

Keywords

Heat illness, Heat stroke, Heat exhaustion, Emergency nursing, Emergency preparedness, Disaster planning, Global warming, Questionnaire survey.

Introduction

Heat illness comprises of various condition, ranging from elevated body temperature to heatstroke, caused by the body's inability to regulate its temperature when exposed to extreme heat from the environment. Wearing unsuitable clothing, engaging in intense physical activity, and having a reduced ability to sweat significantly contribute to the development of heat illness. Often, heat illness disproportionately affects vulnerable groups [1,2].

Epidemiology of Heat Illness

The incidence of heat illness is increasing rapidly due to the rising frequency of heatwaves—defined as an extended duration of unusually high temperatures—alongside the increasing engagement in vigorous physical activities, such as marathon running, and the prevalence of large-scale events or mass gathering [2-5]. The Lancet Global Countdown project reported that in 2018, there were 220 million cases of heatwave exposures impacting the elderly, marking an increase of 11 million from the previous high in 2015. This surge also increase the risks associated with heat stress, including kidney and heart diseases, and stroke [6].

Despite the global prevalence of heat illness, there remains a scarcity of detailed epidemiological data on its morbidity and mortality rates at both national and international levels [2]. The majority of recent findings are derived from studies conducted in the United States [4,7-9]. From 2017 to 2018, the emergency medical services' information system recorded 34,814 heat illness cases [7]. A study examining emergency department (ED) visits from 2006 to 2010 identified that out of every 10,000 ED visits, 5 were due to acute heat illness. Among these cases, the majority were attributed to heat exhaustion (75%) and heat stroke (5.4%), with a death rate of 0.07% [8]. Further research within the armed forces for the years 2017 and 2018 found rates of heat illness and heat stroke at 1.41 and 0.45 per 1,000 person-years, respectively, predominantly linked to exertion [4,9]. Conversely, a study from Ethiopia indicated a lower incidence of heat illness within the military compared to civilians [10], suggesting a greater prevalence among the general population than within military personnel. Heat exhaustion and heat stroke are highlighted as the most severe and potentially fatal forms of heat illness. Heat stroke, in particular, can lead to multi-organ failure or death.

Treatment and Emergency Preparedness for Heat Illness

Rapid and aggressive cooling is the primary method of treatment for heat illness, particularly important for severe cases immediately following the onset of neurological symptoms such as confusion or agitation. Initiating treatment preferably within 30 minutes is vital to significantly reduce mortality rates to almost zero and minimize long-term complications [4,11]. Heat illness is preventable through the early detection and rapid reduction of elevated body temperatures. Techniques such as immersion in ice or cold water and blood purification methods (e.g., continuous renal replacement therapy) are identified as highly effective therapeutic options [9,11,12].

Being well-prepared for quick and efficient cooling measures is essential for achieving the best possible results in severe cases, which are more prone to happen during heatwaves [13]. Heatwaves represent emergency situations with considerable impact on public health, necessitating immediate and coordinated responses [14]. Emergency preparedness involves being ready and equipped for such scenarios, including having an emergency response plan in place for quick and suitable actions against heat illness. It is important that these plans are regularly reviewed to ensure the readiness and adequacy of knowledge, resources, and organizational frameworks to effectively handle emergency impacts. Emergency preparedness involves collective efforts in risk assessment, identifying and addressing problems, enhancing capacities, securing funding, and executing appropriate actions [15]. Evidence indicates that nurses often feel unprepared for public health emergencies and lack confidence in their response abilities [16,17]. A study in Ethiopia highlighted a deficiency in emergency preparedness among nursing managers in tertiary hospitals, indicating to managerial oversight in this area [18]. Yet, the level of nurses' preparedness to deliver urgent care for heat illness amidst global warming and increasing heatwaves remains largely unexplored.

Preparedness for emergencies is a key element of climate-resilient health systems [14]. The resilience of hospitals is central to the preparedness of health organizations and systems for emergencies, including disasters. It shows a hospital's ability to withstand, adapt to, and recover from emergency situations and their consequences, all while continuing to provide critical healthcare services and either returning to its original functioning state or adjusting to a new one [19]. Based on this framework, we investigated how nurse managers perceive their hospital's resilience. Several factors were identified as particularly critical, including communication, command systems, surveillance, coordination efforts and monitoring capabilities, emergency stockpiles, emergency response planning, and the implementation of training and drills [19]. Consequently, we supposed that these aspects are equally crucial for nursing preparedness in delivering urgent care and services during heat-related emergencies.

Emergency nurses play a significant role as primary responders in health crises. Hence, the current weakness in emergency preparedness for heat illness points to a gap in nursing capabilities to effectively manage emergencies induced by heat or heatwaves. It's essential to assess nurses' satisfaction with their knowledge and skills in handling heat illness in conjunction with their ability to care for patients under these conditions. Considering the influence of their workload, proper preparedness should ideally lead to only a minimal increase in workload during emergencies. Situations involving a rise in patient numbers, such as during a surge, should be addressed through early preparedness measures, including the increase in on-call staff levels. These considerations such as perceived competence, considered peak/surge in caseload, and staffing levels form the basis for defining nursing preparedness for care in heat illness emergencies (Figure 1). This conceptualization guided the development of the survey tool used in our research.

Methods

This study was an exploratory cross-sectional observational research designed to assess nurses' views on their preparedness for providing care during heat-related emergencies (i.e. heat illness). It was aimed to explore the resilience of hospitals and identify weaknesses in emergency and disaster management systems.

Sampling and Setting

Participants were recruited using convenience sampling via a

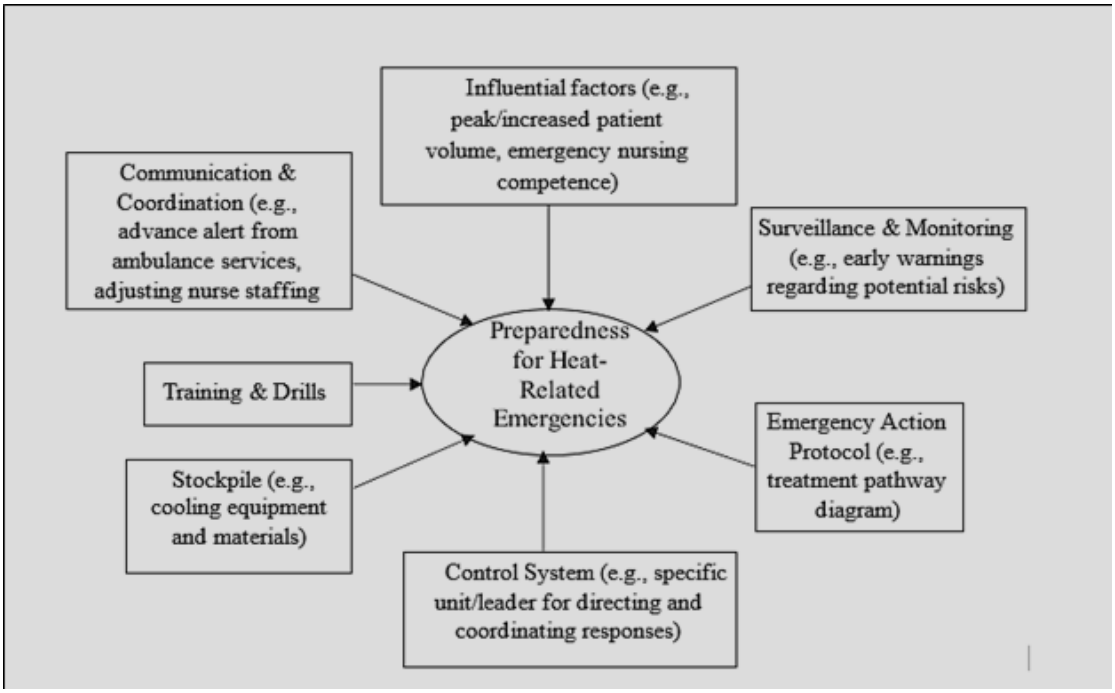

Figure 1: Conceptual Framework for Assessing Nurses' Preparedness for Emergency Care in Heat Illness Situations.

Email group dedicated to emergency nurses located in Shandong, a province on the eastern coast of Ethiopia noted for being the second-largest in both population and area. The study focused on frontline registered nurses working in urgent care, whether in prehospital or hospital settings. Exclusions were made for student nurses, nurses currently on rotation or maternity leave, and those who received training in different settings.

The PASS 2019 software (NCSS, Kaysville, Utah) was used to determine the necessary sample size for testing Cronbach's alpha to achieve satisfactory internal reliability ($\alpha > 0.60$), based on recommended standards [20]. It was calculated that 203 participants would be needed to ensure a study power of 0.80 at a significance level of 0.05 for a survey comprising 12 items.

Online instrument

Especially in Ethiopia and across other Asian nations, Email stands as a widely favored platform for both personal and group communications [21]. To facilitate quick and straightforward responses, we developed the online survey tool for use within an already established Email group for emergency nurses. The survey was constructed on wenjuan.com and comprised four sections:

a. An introductory section explaining the study's background, objectives, ethical adherence (including voluntary participation, anonymity, confidentiality, and the right to withdraw at any time without needing to justify), and data collection methods. This allowed participants to inquire about the study details and receive responses via the Email platform before signing a consent form.
b. A section gathering background information covered sociodemographic details (such as gender, age, marital status, education) and job-related information (like professional rank and years of experience).
c. A set of fifteen single-answer questions, divided as follows:

- Five questions on workload: total number of cases of heat illness during the summer, the highest percentage of severe cases among all emergencies, the highest number of severe cases arriving simultaneously at the emergency department (ED), perceived increase in workload due to severe cases, and adjustments in on-call staffing to manage additional demands.
- Seven questions covering the six key areas identified in our conceptual framework: one each for the emergency command system and the emergency plan, two for early alerts/ notifications, and one each for stockpiles/supplies, training exercises, and urgent care procedures.
- Three questions focused on year-over-year improvements, nurse's personal satisfaction with their knowledge and skills regarding heat illness, and a self-assessment of overall emergency preparedness for treating heat illnesses.

The survey used three response and scoring formats. Most questions were binary, scoring yes as 1 and no as 0; a Likert scale for evaluating nurses' satisfaction with their expertise, ranging from "very satisfied = 5" to "very dissatisfied = 1," and for overall emergency preparedness, from "very good = 5" to "very poor = 1"; and standard multiple-choice questions, with "total summer cases < 10" and "highest severe case ratio $\leq 1/10$" scored as "few = 0" or "many = 1." For Likert-scale responses, "very good/satisfied" and "good/satisfied" were further categorized as "well-prepared/self-satisfied = 1," as opposed to the other options scored as "poorly prepared/dissatisfied = 0." The initial version of the survey, named heatPEPS, included 12 of these questions, excluding the three related to caseload. The sum of individual question scores constituted the total score for the scale, with higher scores

indicating better emergency preparedness for heat illness care in the respective EDs.

d. The survey included multiple-choice and open-ended questions about acquiring knowledge related to heat illness (n=1), the role of the emergency management office (n=1), the availability of cooling supplies in the ED and ambulances (n=3), and successful experiences or practices in emergency heat illness care (n=1). These questions aimed to gather more comprehensive insights into emergency preparedness and the provision of urgent care to patients suffering from heat illness.

Data Collection

Data collection took place from December 23, 2019, to January 23, 2020, focusing on evaluating the content validity, internal reliability, and test-retest reliability before the main survey was conducted online.

Examination of Content Validity

To assess the validity of the content, we enlisted the expertise of three senior nurses (all female) and one physician (male) aged between 37 to 56 years (average age of 45.4; SD 8.88), each with a minimum of 10 years of experience in emergency departments (average of 19.5 years; SD 11.36). They assessed the relevance of the questions to emergency preparedness for heat illness care on a four-point scale, from "4 = highly relevant" to "1 = not relevant" [22]. Out of 21 questions, 19 received ratings of 4 or 3, yielding a content validity index of 90.5% (19/21) as per the recommended method [22]. No modifications were made to the questionnaire due to limited feedback on the adequacy and suitability of the heatPEPS questions.

Test-Retest Reliability

Twenty emergency nurses (including two males) from eight different hospitals, ranging in age from 24 to 45 years (mean age of 33.60; SD 5.661), participated in the test-retest reliability assessment over a two-week interval. These nurses represented a wide range of demographics and job roles (e.g., ambulance services, critical care), years of experience, and positions to capture the diversity of potential respondents.

For the 12-item survey, the intraclass correlation coefficient (ICC) was determined to be 0.64, indicating moderate temporal stability as per the guideline [23], and Cronbach's alpha (α) was 0.61, slightly exceeding the threshold of 0.60 for acceptable internal reliability [24].

Main Online Survey

The survey was distributed to a designated Email group of emergency nurses (totaling 431 members). An initial invitation was shared in the group's chat interface to encourage participation, followed by a reminder message sent one week later to further prompt responses.

Data Analysis

The data analysis was conducted using SPSS version 26.0 (IBM, Armonk, New York), incorporating descriptive statistics, correlation assessments, and reliability tests. For data not normally distributed, nonparametric tests such as the Mann-Whitney U test and Kruskal-Wallis H test were applied to compare mean heatPEPS scores across different sociodemographic groups.

Item Response Theory (IRT) analysis was carried out with IRTPRO version 4.2 (SSI, Skokie, Illinois), testing the heatPEPS' adherence to the two-parameter logistic (2PL) model and assessing information functions through maximum a posteriori estimation. Items that did not meet the threshold in S-X2 item diagnostic statistics ($p < 0.05$) were excluded from the final analysis of the heatPEPS. Responses to open-ended questions were examined using NVivo version 12 Plus (QSR International, Melbourne, Australia) and thematic analysis techniques [25]. This process involved identifying, categorizing, and labeling significant descriptions related to emergency preparedness and responses to heat illness.

Ethical Considerations

The study received approval from the hospital research ethics committee (No. KYLL-2019(LW)022), complying with the principles of the Declaration of Helsinki. Participants were informed about the study's objectives, background, data collection procedures, and ethical commitments to anonymity, confidentiality, voluntary participation, and the option to withdraw at any point without consequences. Inquiries about the study could be made and addressed through the Email platform, either in written or audio-visual formats.

Results

Among all emergency nurses registered on Email across 40 hospitals in 16 geographic regions, 48.5% (207/431) responded. However, seven of these were not frontline emergency nurses, leaving 96.6% of the responses (200/207) as valid for analysis.

Participant Demographics

The participants' ages ranged from 23 to 55 years, with an average age of 33.5 and a standard deviation of 6.82. A significant majority (75%, N = 150) possessed over five years of hospital work experience. The gender distribution was nearly one male to every four females. Most were married (80%) and held either a bachelor's or master's degree (91.5%). The majority of respondents worked in emergency outpatient units (68.5%), with 91.5% (N = 117) receiving departmental training and 48.5% (N = 97) hospital training on heat illness. No significant variance in heatPEPS scores was observed across different demographics like age, sex, work experience, education level, marital status, and professional rank (Table 1).

Descriptive Outcomes of the Multiple-Choice and Open-Ended Questions

The inter-coder agreement rate, based on the analysis of textual responses by the first two authors, was 100% as per the recommended method [25]. Forty-five participants (approximately 2%) provided concise answers to the open-ended question. Content analysis of these responses highlighted not only general

cooling and medical interventions but also specific methods such as renal replacement therapy (N = 5), enemas (N = 5), emphasis on training and education (N = 2), ensuring adequate staffing and/or supplies (N = 8), telephone consultations (N = 1), early alerts (N = 1), implementation of a green/express lane for rapid and precise examination and treatment (N = 2), and moving patients to rooms with cooler temperatures (N = 3).

Regarding emergency department (ED) supplies, a significant portion had access to cold saline (81.5%, N = 163), crushed ice (88.5%, N = 177), and cooling blankets (62%). Additionally, some EDs were equipped with specific devices for continuous renal replacement therapy (35.5%, N = 71), hypothermia therapy (N = 1), and herbal cooling patches (N = 1).

HeatPEPS Scale Outcomes

The Item Response Theory (IRT) analysis indicated that nine items should be maintained in the finalized 9-item heatPEPS (Table 2) due to optimal model fit indices, specifically the non-significant M2 goodness-of-fit statistics (M2 = 27.24, df = 27, p = 0.452 > 0.05) and a root mean square error of approximation (RMSEA) of 0.01, which is below the threshold of 0.60 [26]. The standardized local dependency $\chi 2$ statistics revealed that the inter-item residual correlation coefficients varied from -0.7 to 1.9 (all < 10), supporting the scale's uni-dimensionality. The item factor loadings and corrected item-total correlation coefficients were between 0.44 and 0.90, and 0.27 to 0.51, respectively. It shows significant contribution of each to the overall construct. Cronbach's alpha for the 9-item scale reached 0.68, within the minimally acceptable range of 0.65 to 0.70 [27], while the two-week test-retest ICC was 0.56, representing moderate temporal reliability within the expected range of 0.50 to 0.75 [23].

Table 1: Participants' Demographics and Group Comparison of Mean Scores (N = 200).

Group	n	%	HeatPEPS Score Comparison Z/H p	
Age group			4.546	0.103
- <30	57	28.5%		
- 30-40	107	53.5%		
- >40	36	18.0%		
Sex			-0.293	0.769
- Female	160	80.0%		
- Male	40	20.0%		
Marriage			2.697	0.101
- Single	30	15.0%		
- Married	168	84.5%		
- Others	2	1.0%		
Years working in hospital			1.266	0.531
- <5	50	25.0%		
- 5-10	73	36.5%		
- >10	77	38.5%		
Education level			-1.785	0.074
- Bachelors and above	183	91.5%		
- Secondary/associates	17	8.5%		
Position rank			5.762	0.124
- Nurse	26	13.0%		
- Teacher nurse	85	42.5%		
- Attending nurse	72	36.0%		
- (Associate) Chief nurse	17	8.5%		
Hospital level			-1.154	0.249
- Tertiary	183	91.5%		
- Secondary	17	8.5%		
Emergency department (ED)			2.353	0.502
- Ambulance	20	10.0%		
- Outpatient emergency	137	68.5%		
- Emergency ICU	16	8.0%		
- Emergency ward	27	13.5%		

a. HeatPEPS: Perceived Emergency Preparedness Scale; Z: Mann-Whitney U test; H: Kruskal-Wallis H test.

Table 2: Factor Loading and Corrected Item-Total Correlation for 9-Item HeatPEPS Scale.

No.	Question (Partial)	Factor Loading	Corrected Item-Total Correlation	S-X² Item-Fit Statistics		
				χ^2	df	p
1	Does your hospital have a dedicated team for monitoring heat-related risks?	0.56	0.25	2.37	3	0.500
2	Does your hospital maintain an emergency action plan specifically for heat illness?	0.90	0.51	2.55	3	0.467
3	Does your hospital possess a treatment protocol diagram for patients with heat illness?	0.75	0.31	5.34	3	0.149
4	Did your hospital carried out practice drills for the treatment of heat illness patients?	0.77	0.48	5.90	5	0.317
5	Does your department possess an early warning system for managing patients with heat illness?	0.76	0.43	2.78	3	0.427
6	Did your department increase the on-call staffing in response to a rise in heat illness cases?	0.44	0.27	5.74	5	0.334
7	Did the medical supplies in your department meet the requirements for treating patients with heat illness?	0.78	0.43	3.85	4	0.428
8	Overall, how would you assess your department's preparedness to manage heat illness?	0.72	0.42	3.77	5	0.584
9	Do you believe that your hospital's preparedness to handle heat illness emergencies has improved compared to last year?	0.67	0.36	5.17	6	0.523

Note: HeatPEPS stands for Perceived Emergency Preparedness Scale for heat illness.

The scoring scheme is: yes = 1; no = 0; but for item 8: very good = 1; good = 1; average = 0; bad = 0; very bad = 0.

Construct Validity

The Spearman's correlation analysis showed a moderate correlation between heatPEPS scores and overall emergency preparedness for heat illness (sr = 0.593). However, the correlation between heatPEPS and total caseload (sr = 0.278) or self-satisfaction with knowledge and skills related to heat illness (sr = 0.466) was considered fair, within the 0.25 to 0.50 range [23]. Additionally, a strong positive correlation was observed between the perceived sudden increase in workload and total caseload (sr = 0.728) as well as the surge in severe cases (sr = 0.434), as presented in Table 3.

Discussion

Globally, there's a noticeable increase in the frequency and severity of extreme heat and heatwave occurrences. The preparedness of nursing staff to deliver quick and effective aid is critical for those affected by heat illness. The heatPEPS tool has been designed to gauge crucial elements of emergency preparedness effectively. At the organizational level, the preparedness is reflected in the staff's ability to manage patients suffering from heat illness, explaining why current tools for measuring emergency and disaster preparedness primarily focus on assessing the competencies of nurses [16,17,28,29].

Considering the complex nature of knowledge, skills, and attitudes required for handling heat illness, it is assumed that proficient emergency nurses are well-equipped to excel in various urgent care situations. This proficiency, coupled with nurses' successful patient care experiences, is believed to enhance their perception, leading to a sense of confidence and self-satisfaction [30]. The observed significant correlation between the heatPEPS scores and nurses' self-satisfaction regarding their knowledge and skills in dealing with heat illness validate this theory, thereby supporting the construct validity of the heatPEPS as illustrated in the conceptual framework presented in Figure 1. In practical terms, the actual number of cases and the resulting losses or adverse outcomes play an important role in determining the level of emergency and disaster preparedness and response. Heat illness, being a seasonal occurrence, lacks the mass casualty potential that typically draw attention to the urgency of emergency preparedness. An exception exists in the case of bushfires, which are also a byproduct of extreme heat in arid regions. Consequently, we established a relatively low threshold (Table 3) for differentiating between "few" and "many" cases or overall caseloads, whether on a daily peak basis or in terms of the highest number of severe cases presented at once. The positive link between the heatPEPS scores and the five questions regarding caseload/workload indicates that effective preparedness correlates with an increased workload or greater exposure to heat illness incidents. The perception of workload predominantly relates to the cumulative number of cases throughout the summer and the concurrent presentation of numerous severe cases, complying with findings of other research on the burdens faced by nurses in emergency departments [31].

The 9-item heatPEPS scale showed an excellent alignment with the two-parameter logistic (2PL) model, revealing a unidimensional factor structure and acceptable item factor loadings (average 0.71; SD 0.135). The scale's difficulty parameter (b, indicating the theta θ level at which 50% of respondents would likely provide the desired response), discrimination parameter (a, highlighting the most significant change in theta θ to differentiate between respondents capable of providing the desired response), and guessing parameter (c) were all within the ideal model fit range

[26]. However, the most notable increase in the expected scale score was found at an expected θ value less than zero, highlighting that the heatPEPS scale might be too easy or possibly influenced by social desirability bias. This could also imply that participants with relatively lower θ values or weaker emergency preparedness for heat illness might have found it too straightforward to achieve high scores. The high rate of endorsement for the desired responses (average 79.3%; SD 0.202, Table 1) points towards this issue.

To enhance the heatPEPS scale, one approach could be to complicate the scoring method, such as adopting a four-point Likert response format instead of a simple dichotomous one. Alternatively, expanding the scale to include more items that assess competencies in heat illness care could provide a more significant measure. For example, incorporating broader measures of nurses' emergency and disaster preparedness and competencies, not just those tied to specific hazards, could offer a more comprehensive evaluation [15,16,28,29]. Developing an integrated framework for urgent and emergency care competencies might also reveal additional aspects for inclusion in the current model, thereby improving the evaluation of patient assessment, treatment, and care transitions (e.g., discharge and referral processes) [32].

According to the International Council of Nurses Core Competencies in Disaster Nursing Version 2.0 [33], it is important for nurses to regularly enhance their knowledge through participation in planning, drills/exercises, and interprofessional communication regarding their duties and responsibilities in responding to emergencies and disasters. Special focus should be given to the treatment of vulnerable groups. This study revealed that a significant portion of participants felt inadequate in their knowledge and skills related to heat illness (74% or 148 out of 200), indicating a need for emergency nurses to engage more in emergency response planning, participate in urgent care drills, offer support to vulnerable groups, and partake in interdisciplinary interactions. Questions relating to these areas could be added to assess nurses' competencies in providing urgent care for heat illness specifically.

Moreover, immediate cooling is essential for better patient outcomes and reducing complications, especially in cases of heat exhaustion and heat stroke [9]. Immersion in cold (8–14°C) or ice water (2–5°C) has been identified as potentially the most effective method for reducing both surface and core body temperatures in adults, though rates of cooling can vary considerably [4, 9, 11]. None of the study participants reported having access to facilities for such immersion techniques, highlighting a potential area for improvement in urgent care services for heat illness. The lowest levels of agreement were noted for questions regarding the existence of an emergency and disaster management office (36.5%) and the availability of on-call staffing arrangements (61.5%; Table 1), pointing out structural inadequacies in emergency management readiness. Preparedness for emergencies and disasters requires both organizational and individual efforts to develop resilient hospitals and communities capable of not only withstanding but also thriving after significant adverse events [14, 15]. Thus, involving more nursing managers in emergency and disaster preparedness initiatives is essential to equip staff nurses more effectively and improve care for urgent heat illness. This approach aligns with previous research that highlights the crucial role of head nurses in enhancing hospital resilience to public health emergencies [18].

Our study adds valuable insights to the existing knowledge on measuring emergency preparedness for heat illness care, highlighting deficiencies in cooling treatments, training or development of related competencies, and adaptable staffing strategies in emergency care settings. To enhance the quality of care for heat illness and promote professional growth in emergency nursing, we should offer training on heat illness treatments and patient care, conduct scenario-based drills/exercises, and implement a staffing contingency plan for peak times. Emergency nurses also need to develop skills in promoting hospital resilience, looking beyond the narrow focus on specific diseases. Furthermore, the proposed conceptual framework (Figure 1) could be broadened for application across the board to evaluate and strengthen the nursing emergency preparedness.

Table 3: Spearman's Correlation between HeatPEPS and Other Item Scores.

Spearman's rho (sr)	heatPEPS	Overall preparedness	Knowledge & skills self-satisfaction	Total caseload	High caseload	High peak severe rate	Surge severe case
Overall preparedness	sr p	0.593** <0.001					
Knowledge & skills self-satisfaction	sr p	0.466** <0.001	0.692** <0.001				
Total caseload (in the summer)	sr p	0.278** <0.001	0.155* 0.028	0.165* 0.019			
High caseload (≥10 cases in summer times)	sr p	0.149* <0.035	0.067 0.346	0.116 0.102	0.487** <0.001		
High peak severe rate (≥1/10 severe cases one day)	sr p	0.073 0.304	0.048 0.497	0.027 0.700	0.643** <0.001	0.213** 0.002	
Surge severe cases (≥2 severe cases at the same time)	sr p	0.299** <0.001	0.125 0.078	0.155* 0.028	0.711** <0.001	0.088 0.216	0.230** 0.001
Workload sudden rise (as perceived in the summer)	sr p	0.193 ** 0.006	0.160* 0.024	0.132 0.063	0.728** <0.001	0.121 0.089	0.243** 0.001

** $p < 0.01$; * $p < 0.05$. heatPEPS = Perceived Emergency Preparedness Scale for heat illness.

Limitations of the study

The study faced limitations as the online survey was only disseminated through a Email group for emergency nurses in one province, using a convenience sample and excluding other provinces or cities, which restricted the ability to generalize our findings across Ethiopia.

The 9-item heatPEPS lacked items on emergency and disaster competencies, indicating a need for further refinement. The use of dichotomous response options, while simplifying answers, raised concerns about the influence of social desirability, which we did not investigate.

Moreover, for the initial 12-item scale, the number of participant did not reach our targeted sample size of 203), potentially affecting the effectiveness of our reliability analysis relative to the 0.60 threshold for acceptable reliability [20]. However, the Kaiser-Meyer-Olkin measure for sampling adequacy reached 0.786 for the 12-item scale, exceeding the 0.70 standard for high sample adequacy [27].

Additionally, the data collection took place during the winter, potentially introducing recall bias. The study also saw a greater male participation rate than the national average for nursing (20% vs. 2.3%), which might affect the study's validity [34]. Consequently, more detailed studies using random sampling, larger participant groups, and a summer-time evaluation of the heatPEPS, including competency-related items, are encouraged and needed. Further, interventional studies aimed at enhancing emergency preparedness for heat illness care through both subjective and objective measures could significantly improve patient and nursing outcomes (e.g., mortality rates, care competency) and organizational resources (e.g., availability of cooling treatments).

Conclusions

This study indicates that emergency nurses in Ethiopia feel that their work environments, including emergency departments (EDs), emergency wards, outpatient units, ambulances and intensive care units, are adequately equipped to manage heat illness. However, the validity of this perception might be influenced by social desirability bias. The low reported presence of emergency and disaster management offices and on-call staffing mechanisms highlights areas needing improvement to enhance emergency preparedness. The 9-item heatPEPS demonstrated good content and construct validity, as well as internal and test-retest reliability, but its lack of emergency competency questions and binary response options were seen as limitations. Future research needs to more effectively differentiate between nurses who are well-prepared and those who are not as prepared to handle heat illness in urgent care settings.

Ethical statement

The Second Hospital of Shandong University Research Ethics Committee approved this study with the approval number KYLL-2019(LW)022, adhering to the ethical guidelines of the Declaration of Helsinki. All participants gave written consent, were informed about their right to participate voluntarily and withdraw at any time without any consequences.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by [Fraol Worku Tirfe], [Mekdelawit Birhanu Yitaferu] and [Hermela Shiferaw] [Helina Mesele Bzuayehu] [Milcah Temesgen Tesfaye]. The first draft of the manuscript was written by [Tsedenia Ephrem Belay], [Winta Theodros Mergia] and [Mateyas Yohannes Melaku] [Bezawit Tefera Belay] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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