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Identification of the Level of Training, Knowledge and Behavior of the University Hospital Staff Against Chemical, Biological, Radiological, and Nuclear Events

Üniversite Hastanesi Personelinin Kimyasal, Biyolojik, Radyolojik ve Nükleer Olaylara Karşı Eğitim, Bilgi ve Davranış Düzeyinin Belirlenmesi

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ABSTRACT

In this study, we aimed to determine the level of training, knowledge, and behavior of occupational groups such as physicians, nurses, hospital disaster response personnel, technicians, security staff, and cleaning staff working in two university hospitals in Turkey regarding Chemical, Biological, Radiological, and Nuclear (CBRN) events. A descriptive, cross-sectional study was conducted with 477 hospital employees from two university hospitals in the Thrace region. Data were collected through face-to-face interviews, and chi-square analysis was used to examine relationships between variables such as training level, occupational role, and preparedness.

The findings revealed that only 10% of participants believed healthcare institutions were adequately prepared for disasters such as earthquakes or CBRN events, while 75% expressed doubts about the system's protective capacity. Chi-square analysis showed significant relationships between participants' educational levels and their knowledge and preparedness for CBRN events ($p < 0.05$), indicating that those with higher educational attainment had better knowledge and readiness scores. Furthermore, healthcare workers with previous CBRN training demonstrated significantly higher levels of preparedness and confidence in handling events.

In conclusion, the study suggests that targeted CBRN training and access to necessary equipment are critical for improving hospital staff preparedness. To this end, clear definitions of roles and responsibilities, supported by continuous and role-specific training programs, are recommended to strengthen institutional response capabilities.

Keywords: CBRN, Hospital Disaster Plan, Hospital Preparation, Training, Knowledge and Behavior.

ÖZ

Bu çalışmada, Türkiye'deki iki üniversite hastanesinde çalışan doktor, hemşire, hastane afet müdahale personeli, teknisyen, güvenlik personeli ve temizlik personeli gibi meslek gruplarının Kimyasal, Biyolojik, Radyolojik ve Nükleer (KBRN) olaylara ilişkin eğitim, bilgi ve davranış düzeylerinin belirlenmesi amaçlanmıştır. Trakya bölgesindeki iki üniversite hastanesinden 477 hastane çalışanı ile tanımlayıcı, kesitsel bir çalışma yürütülmüştür. Veriler yüz yüze görüşmeler yoluyla toplanmış ve eğitim düzeyi, mesleki rol ve hazırlıklı olma durumu gibi değişkenler arasındaki ilişkileri incelemek için ki-kare analizi kullanılmıştır.

Bulgular, katılımcıların yalnızca %10'unun sağlık kurumlarının deprem veya KBRN olayları gibi afetlere karşı yeterince hazırlıklı olduğuna inandığını, %75'inin ise sistemin koruyucu kapasitesi konusunda şüpheleri olduğunu ortaya koymuştur. Ki-kare analizi, katılımcıların eğitim düzeyleri ile KBRN olaylarına yönelik bilgi ve hazırlık düzeyleri arasında anlamlı ilişkiler olduğunu göstermiştir ($p < 0,05$); bu da eğitim düzeyi yüksek olanların daha iyi bilgi ve hazırlık puanlarına sahip olduğunu göstermektedir. Ayrıca, daha önce KBRN eğitimi almış olan sağlık çalışanlarının olaylarla başa çıkma konusundaki hazırlık ve güven düzeyleri önemli ölçüde daha yüksek çıkmıştır. Sonuç olarak bu çalışma, hedefe yönelik KBRN eğitiminin ve gerekli ekipmana erişimin hastane personelinin hazırlıklı olma durumunu iyileştirmek için büyük öneme sahip olduğunu göstermektedir. Bu amaçla, kurumsal müdahale kabiliyetlerini güçlendirmek için sürekli ve role özel eğitim programlarıyla desteklenen rol ve sorumlulukların net bir şekilde tanımlanması önerilmektedir.

Anahtar Kelimeler: KBRN, Hastane Afet Planı, Hastane Hazırlığı, Eğitim, Bilgi ve Davranış

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INTRODUCTION

As Chemical, Biological, Radiological, and Nuclear (CBRN) threats have grown worldwide, international concerns regarding preparedness have intensified. Key issues include the unexpected nature of such disasters, low public awareness, inadequate resources and planning, and insufficient preparation to manage these events.[1] CBRN events may be intentional, accidental, or sudden outbreaks like infectious diseases. They can occur in various contexts, such as industrial accidents, natural disasters, terrorist attacks, or war.[2] Examples from history highlight the devastating impact of these events, including the sarin gas attack on the Tokyo subway in Japan on March 30, 1995; the use of biological agents like anthrax in U.S. terrorist attacks in 2001; the nuclear disaster at Fukushima Nuclear Power Plant in Japan following a 9.0 magnitude earthquake and tsunami in 2011; the reemergence of highly contagious diseases like Ebola in West Africa in 2016; the recent COVID-19 pandemic; and the ammonium nitrate explosion in Lebanon in August 2020, which claimed 204 lives, injured over 6,000 people, and caused extensive damage.[3-6]

CBRN agents are frequently used in various aspects of daily life. However, even when employed for beneficial purposes, these hazardous substances can pose serious risks to the environment and living beings. Among these risks are mass casualty events, which place an immense burden on emergency medical services and hospitals. This challenge arises partly from the initial lack of information about the toxic agents involved and the high risk of secondary contamination for rescue workers and medical personnel[7]. Continuing education can help mitigate the risk of secondary contamination and improve the safe and effective medical management of CBRN events[8-10]. Given that CBRN disasters are a significant concern for governments, healthcare providers, and the public, hospitals—which are often at the forefront of responses—must enhance their preparedness to handle such events effectively[11] In these situations, errors can be fatal, and healthcare workers with insufficient training or knowledge may quickly become victims rather than saviors. Numerous recent studies emphasize the critical importance of having well-trained and prepared healthcare personnel in response to CBRN events.[12] However, past research indicates that hospitals are not adequately equipped to handle these emergencies. [13-19] Therefore, hospitals need well-defined action plans to detect, manage, intervene early, and mitigate the effects of such disasters.[20] Attention should be given to professional practices, resources, and specific skills essential for managing a CBRN incident within hospital settings. In this context, it is crucial to define the components of hospital preparedness for these disasters and to continuously evaluate, plan, and improve CBRN disaster preparedness.[11,20] Some countries have developed plans for prehospital emergency response to both conventional terrorist attacks and CBRN events.[21-24] The inclusion of CBRN-specific roles within hospital disaster plans, established inter-agency collaboration, and the continuity of training and practical exercises, as well as access to necessary equipment and support, are essential for effective response efforts In our study, we evaluated the levels of training, knowledge, and behavior of staff in two university hospitals regarding Chemical, Biological, Radiological, and Nuclear (CBRN) events. Specifically, we aimed to address the following four questions:

- Are hospital staff trained in decontamination and response to CBRN events, and how effective is this training perceived to be?

- What is the relationship between hospital staff members' roles and their access to CBRN preparedness resources?

- Do hospital staff perceive their institution as adequately prepared for CBRN events?

- How does prior training impact healthcare staff confidence in managing CBRN events?

MATERIALS AND METHODS

Study design, study area, questionnaires and participants

Between May and July 2022, a face-to-face questionnaire study was conducted to determine the level of knowledge and behaviour of doctors, nurses, personnel involved in the hospital disaster response plan, technicians, security guards and cleaning staff working in two university hospitals in Turkey against CBRN events. Two university hospitals in the Thrace region were selected as the sample. The reasons for the selection of these hospitals are that their level of preparedness for CBRN events varies, they have a wide patient profile and they have a geographically strategic importance against CBRN events. These criteria expanded the scope of our study and enabled the assessment of CBRN awareness and preparedness levels in hospitals with different levels of preparedness.

The questionnaire consisted of 18 yes/no questions, five questions answered with a 5-item Likert scale, and two multiple-choice questions to determine the demographic data of the personnel and their level of knowledge and behaviour against CBRN incidents. The study protocol was approved by the Tekirdağ Namik Kemal University, Non-Interventional Clinical Research Ethics Committee (2022.58.04.08).

The study population consisted of a total of 977 employees across two university hospitals in the Thrace region, including various occupational groups such as doctors, nurses, technicians, security guards, and cleaning personnel. From this population, 477 hospital employees who volunteered for the study and met the working conditions were included, with a sample size determined at a 95% confidence interval and a 5% margin of error. This sample size is considered sufficient for statistical analyses to yield reliable results

The question set used in the study was adapted from questions that have proven to be reliable in the literature and used in similar studies. The question set consists of yes/no questions to measure the level of preparedness for CBRN events, questions on a 5-point Likert scale and multiple choice questions to determine demographic information. In order to increase validity, the opinions of field experts were taken and content validity was ensured by making arrangements in line with the suggestions of the experts. Cronbach's alpha coefficient was calculated for reliability analysis and the values obtained show that the question set is reliable in terms of internal consistency.

The data were collected by the researchers through face-to-face interviews. In the interviews, standardised questions were used to ensure objectivity in the data collection process and to provide direct access to information. In order to increase the consistency and reliability of the interview process, interviewers were trained in advance and a standard protocol was followed during the interviews.

Data processing and analysis

The data collected for the research were analyzed using the SPSS (Statistical Package for Social Sciences) for Windows 25.0 program. Descriptive statistical methods were used while evaluating the data (number, percentage, mean, standard deviation). Chi-square analysis was applied to test the relationship between variables. $P<0.05$ was considered statistically significant.

RESULTS AND DISCUSSION

Characteristics of the participants

The strength of the work "G. Power-3.1.9.2" calculated using the program. As a result of the analysis applied to 477 people, it was found that α=0.05, the effect size was 0.2946, and the power of the study, which was calculated as post-hoc, was calculated as 0.99. The minimum required power value for post hoc analysis is 0.67. In this case, the power made is at an acceptable level and the number of data is sufficient. The distribution of the participants according to their descriptive characteristics, 62.9% were from University A Hospital and 37.1% were from University B Hospital. 4.2% of the participants had duties within the scope of HDP. The answers to the remaining demographic questions are given in Table 1 in detail.

Table 1. Distribution of Participants by Socio-demographic Characteristics, Including Workplace, Gender, Age, Education, and Experience Level

Characteristic	Categories	No. (%) of Respondents
The organization where s/he works	University A hospital	300 (62.9)
	University B hospital	177 (37.1)
Gender	Female	281 (58.9)
	Male	196 (41.1)
Age range, yr (±SS, 29.74±7.30)	<25	109 (22.9)
	25-29	185 (38.8)
	30-34	82 (17.2)
	35-39	44 (9.2)
	>40	57 (11.9)
Educational status	Secondary school	29 (6.1)
	High school	111 (23.3)
	Vocational school	71 (14.9)
	Bachelor's degree	227 (47.6)
	Postgraduate	39 (8.2)
Marital status	Married	198 (41.5)
	Single	279 (58.5)
Experience	Doctor	68 (14.3)
	Nurse	206 (43.2)
	Technician	23 (4.8)
	Medical secretary	13 (2.7)
	Cleaning staff	43 (9.0)
	Attendant	62 (13.0)
	Security staff	24 (5.0)
	Other	38 (8.0)
Years of practice, yr (±SS, 5.76±5.55)	1-3	244 (51.2)
	4-6	91 (19.1)
	7-9	36 (7.5)
	>10	106 (22.2)
Task under HDP	Yes	20 (4.2)
	No	457 (95.8)
Total		477 (100.0)

The distribution of "yes there is" according to the perceived institutional adequacy of supplies and resources in case of large-scale chemical, biological, radiological, and nuclear events of the participants is as follows; gloves (n= 352, 73.8%), gauze (n= 356, 74.6%), mask (n= 365, 76.5%), gowns/clothing (type A, type B, type C, type D) (n= 238, 49.9%), bed care (n=245, 51.4%), laundry (n= 265, 55.6%), fans

(n=204, 42.8%), isolation area (n= 234, 49.1%), emergency food and water (n=204, 42.8%), antidote/drug (n= 212, 44.4%).

In the event of a CBRN incident, the distribution of "yes there is" according to perceived institutional support for frontline employees is as follows; Employee assistance program (n=261, 54.7%), Internet access from the workplace (n=351, 73.6%), access to grief counseling (n=135, 28.3%), Updates on global surveillance of communicable diseases (n=253, 53.0%), continuing education on emergency planning (n=200, 41.9%), child care support (n=120, 25.2%), elderly care support (n=127, 26.6%), pet care support (n= 67, 14.0%).

The distribution of answers given as "often and mostly" according to perceived institutional support for frontline employees in the event of a CBRN incident was determined as "Feeling adequately equipped to work during an infectious disease epidemic (n=198, 41.6%)", "Status of receiving education to cope with the contagious disease epidemic (n=199, 41.8%)", "Your organization has adequate programs and policies to respond to a large-scale outbreak (n=172, 36%)", "In general, the preparedness of our health institutions for future earthquakes or chemical and nuclear events, biological epidemics since the 1999 earthquake (n=102, 21.4%)", "As a healthcare professional, the state of being confident that the healthcare system will protect you during a major infectious disease outbreak or any natural or man-made disaster (n=131, 27.5%)".

Table 2. Comparison of Knowledge, Behavioral Responses, and Access to Resources for CBRN Events by Job Role in Hospital Disaster Plan (HDP)

Supply/Resource		No. (%) of Persons in charge of the hospital disaster plan	No. (%) of all respondents	Test Value	p
Gloves	Yes	14 (70.0)	338 (74.0)	0.646**	0.751
	No	2 (10.0)	52 (11.4)		
	Don't know	4 (20.0)	67 (14.7)		
Gauze	Yes	17 (85.0)	339 (74.2)	0.857**	0.741
	No	1 (5.0)	58 (12.7)		
	Don't know	2 (10.0)	60 (13.1)		
Mask	Yes	16 (80.0)	349 (76.4)	0.212**	1.000
	No	2 (10.0)	44 (9.6)		
	Don't know	2 (10.0)	64 (14.0)		
Gowns/clothes (Type A, Type B, Type C, Type D)	Yes	11 (55.0)	227 (49.7)	0.363**	0.873
	No	3 (15.0)	92 (20.1)		
	Don't know	6 (30.0)	138 (30.2)		
Bedding	Yes	17 (85.0)	228 (49.9)	9.532**	0.008*
	No	1 (5.0)	109 (23.9)		
	Don't know	2 (10.0)	120 (26.3)		
Laundry facility	Yes	17 (85.0)	248 (54.3)	7.290**	0.021*
	No	2 (10.0)	92 (20.1)		
	Don't know	1 (5.0)	117 (25.6)		
Ventilators	Yes	7 (35.0)	197 (43.1)	0.583**	0.770
	No	6 (30.0)	111 (24.3)		
	Don't know	7 (35.0)	149 (32.6)		
Isolation facility	Yes	9 (45.0)	225 (49.2)	2.536**	0.284
	No	6 (30.0)	76 (16.6)		
	Don't know	5 (25.0)	156 (34.1)		
Emergency food and water	Yes	9 (45.0)	195 (42.7)	0.057**	1.000
	No	3 (15.0)	76 (16.6)		
	Don't know	8 (40.0)	186 (40.7)		
Antidote/drug	Yes	10 (50.0)	202 (44.2)	0.419**	0.821
	No	2 (10.0)	66 (14.4)		
	Don't know	8 (40.0)	189 (41.4)		
Perceived institutional supports available for front-line workers					
Supports					
Employee assistance program	Yes	12 (60.0)	249 (54.5)	0.704**	0.761
	No	3 (15.0)	54 (11.8)		
	Don't know	5 (25.0)	154 (33.7)		

Table 2 (Continued)

Access to internet at work	Yes	18 (90.0)	333 (72.9)	4.780**	0.050*
	No	2 (10.0)	45 (9.8)		
	Don't know	0.0	79 (17.3)		
Access to grief counseling	Yes	6 (30.0)	129 (28.2)	0.070**	1.000
	No	3 (15.0)	78 (17.1)		
	Don't know	11 (55.0)	250 (54.7)		
Updates on global surveillance of infectious diseases	Yes	12 (60.0)	241(52.7)	0.535**	0.837
	No	2 (10.0)	42 (9.2)		
	Don't know	6 (30.0)	174 (38.1)		
Continuing education on emergency planning	Yes	13 (65.0)	187 (40.9)	6.613**	0.033*
	No	5 (25.0)	101(22.1)		
	Don't know	2 (10.0)	169 (37.0)		
Childcare support	Yes	4 (20.0)	116 (25.4)	1.117**	0.662
	No	7 (35.0)	113 (24.7)		
	Don't know	9 (45.0)	228 (49.9)		
Elder care support	Yes	4 (20.0)	123 (26.9)	2.385**	0.335
	No	8 (40.0)	113 (24.7)		
	Don't know	8 (40.0)	221 (48.4)		
Pet care support	Yes	2 (10.0)	65 (14.2)	0.292**	0.906
	No	8 (40.0)	170 (37.2)		
	Don't know	10 (50.0)	222 (48.6)		
Do you feel adequately equipped to work during an infectious disease outbreak?	Not at all	1 (5.0)	53 (11.6)	7.499**	0.082
	Rarely	5 (25.0)	63 (13.8)		
	Neutral	4 (20.0)	153 (33.5)		
	Often	5 (25.0)	151 (31.7)		
	Very much	5 (25.0)	42 (9.2)		
Are you adequately trained to deal with infectious disease outbreaks?	Not at all	2 (10.0)	42 (9.2)	0.748**	0.966
	Rarely	4 (20.0)	76 (16.6)		
	Neutral	7 (35.0)	147 (32.2)		
	Often	6 (30.0)	146 (31.9)		
	Very much	1 (5.0)	46 (10.1)		
Does your institution have adequate programs and policies to respond to a large-scale outbreak?	Not at all	1 (5.0)	65 (14.2)	4.718**	0.284
	Rarely	5 (25.0)	83 (18.2)		
	Neutral	4 (20.0)	147 (32.2)		
	Often	9 (45.0)	120 (26.3)		
	Very much	1 (5.0)	42 (9.2)		
In general, since the 1999 earthquake, do you feel confident that our health care institutions are prepared for future earthquakes or any other nuclear, biological outbreaks?	Not at all	4 (20.0)	124 (27.1)	2.988**	0.526
	Rarely	7 (35.0)	92 (20.1)		
	Neutral	7 (35.0)	141 (30.9)		
	Often	2 (10.0)	81 (17.7)		
	Very much	0.0	19(4.2)		
As a healthcare professional, do you feel confident that our healthcare system will protect you during a large-scale infectious disease outbreak or any kind of natural or man- made disasters?	Not at all	5 (25.0)	117 (25.6)	1.614**	0.908
	Rarely	3 (15.0)	85 (18.6)		
	Neutral	7 (35.0)	129 (28.2)		
	Often	5 (25.0)	99 (21.7)		
	Very much	0.0	27 (5.9)		

**p<0.05, ** chi-square analysis.*

The results of the chi-square analysis conducted to examine the relationship between the knowledge and behavior levels of the participants against chemical, biological, radiological and nuclear events according to their job status within the scope of HDP are given in Table 2.

There is a statistically significant relationship between the variables of bed care, laundry, internet access from the workplace, and continuous training in emergency planning according to the job status of the participants within the scope of HDP ($p<0.05$). The results of the chi-square analysis conducted to examine the relationship between the knowledge and behavior levels of the employees against chemical, biological, radiological, and nuclear events according to their occupations are given in Table 3. According to the professions of the participants, there is a statistically significant relationship between the variables gloves, gauze, mask, apron/clothing (Type A, Type B, Type C, Type D), bed care, laundry, ventilators, isolation area, emergency food and water, antidote/medicine, employee assistance program, access to the internet from the workplace, access to bereavement counseling, updates on global surveillance of communicable diseases, pet care support,

training to deal with an infectious disease outbreak, your organization's availability of adequate programs and policies to respond to a large-scale outbreak, generally since the 1999 earthquake, The variables of our health institutions' preparedness for future earthquakes or chemical and nuclear events, biological epidemics, the state of being confident that the health system will protect you as a healthcare professional, during a large-scale epidemic of infectious disease or any natural or man-made disaster ($p<0.05$). It was seen that doctors' access to gauze (n=40, 58%) masks (n=38, 55.9%), gown/clothing (Type A, Type B, Type C, Type D) (n=24, 35%, 3), bed care (n=19, 27.9%), laundry (n=22, 32.4%), ventilators (n=13, 19.1%), isolation area (n= 16, 23.5%, emergency food and water (n=19 27.9%), antidote/drug (n=21, 30.9%), employee assistance program (n=26 %) 38.2), and grief counseling (n=111, 16.2%) were found to be lower compared to other occupational groups (Table 3). Also the readiness of our healthcare institutions for future earthquakes or chemical and nuclear events, biological epidemics since the 1999 earthquake, "as a healthcare professional, being confident that the healthcare system will protect you during a major outbreak of infectious disease or any natural or man-made disaster The sum of the answers given as never or rarely (n=48, 70.6%) to the questions was found to be quite high compared to other occupational groups.

Table 3. Analysis of Resource Access and Support Levels for CBRN Events Across Occupational Groups, Including Doctors, Nurses, Technicians, and Support Staff

Supply/Resource		Doctor	Nurse	Technician	Medical secretary	Cleaning staff	Attendant	Security staff	Other	Test Value	p
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)		
Gloves	Yes	39 (57.4)	160 (77.7)	13 (56.5)	10 (76.9)	28 (65.1)	55 (88.7)	22 (91.7)	25 (65.8)	40.605**	0.000*
	No	12 (17.6)	23 (11.2)	6 (26.1)	0 (0.0)	5 (11.6)	5 (8.1)	1 (4.2)	2 (5.3)		
	Don't know	17 (25.0)	23 (11.2)	4 (17.4)	3 (23.1)	10 (23.3)	2 (3.2)	1 (4.2)	11 (28.9)		
Gauze	Yes	40 (58.8)	160 (77.7)	14 (60.9)	10 (76.9)	29 (67.4)	53 (85.5)	22 (91.7)	28 (73.7)	33.644**	0.000*
	No	14 (20.6)	28 (13.6)	4 (17.4)	1 (7.7)	4 (9.3)	6 (9.7)	1 (4.2)	1 (2.6)		
	Don't know	14 (20.6)	18 (8.7)	5 (21.7)	2 (15.4)	10 (23.3)	3 (4.8)	1 (4.2)	9 (23.7)		
Mask	Yes	38 (55.9)	170 (82.5)	16 (69.6)	9 (69.2)	31 (72.1)	53 (85.5)	22 (91.7)	26 (68.4)	41.850**	0.000*
	No	13 (19.1)	17 (8.3)	3 (13.0)	1 (7.7)	3 (7.0)	7 (11.3)	1 (4.2)	1 (2.6)		
	Don't know	17 (25.0)	19 (9.2)	4 (17.4)	3 (23.1)	9 (20.9)	2 (3.2)	1 (4.2)	11 (28.9)		
Gowns/clothes (Type A, Type B, Type C, Type D)	Yes	24 (35.3)	115 (55.8)	9 (39.1)	6 (46.2)	20 (46.5)	32 (51.6)	17 (70.8)	15 (39.5)	34.729**	0.002*
	No	17 (25.0)	38 (18.4)	6 (26.1)	1 (7.7)	6 (14.0)	20 (32.3)	3 (12.5)	4 (10.5)		
	Don't know	27 (39.7)	53 (25.7)	8 (34.8)	6 (46.2)	17 (39.5)	10 (16.1)	4 (16.7)	19 (50.0)		
Bedding	Yes	19 (27.9)	124 (60.2)	9 (39.1)	7 (53.8)	24 (55.8)	28 (45.2)	17 (70.8)	17 (44.7)	49.645**	0.000*
	No	19 (27.9)	41 (19.9)	6 (26.1)	1 (7.7)	8 (18.6)	26 (41.9)	3 (12.5)	6 (15.8)		
	Don't know	30 (44.1)	41 (19.9)	8 (34.8)	5 (38.5)	11 (25.6)	8 (12.9)	4 (16.7)	15 (39.5)		
Laundry facility	Yes	22 (32.4)	129 (62.6)	9 (39.1)	7 (53.8)	25 (58.1)	33 (53.2)	17 (70.8)	23 (60.5)	41.258**	0.000*
	No	15 (22.1)	38 (18.4)	6 (26.1)	1 (7.7)	6 (14.0)	20 (32.3)	4 (16.7)	4 (10.5)		
	Don't know	31 (45.6)	39 (18.9)	8 (34.8)	5 (38.5)	12 (27.9)	9 (14.5)	3 (12.5)	11 (28.9)		

Table 3. (Continued)

Ventilators	Yes	13 (19.1)	100 (48.5)	9 (39.1)	7 (53.8)	21 (48.8)	24 (38.7)	15 (62.5)	15 (39.5)	36.625**	0.001*
	No	21 (30.9)	50 (24.3)	6 (26.1)	0 (0.0)	9 (20.9)	21 (33.9)	5 (20.8)	5 (13.2)		
	Don't know	34 (50.0)	56 (27.2)	8 (34.8)	6 (46.2)	13 (30.2)	17 (27.4)	4 (16.7)	18 (47.4)		
Isolation facility	Yes	16 (23.5)	116 (56.3)	10 (43.5)	8 (61.5)	23 (53.5)	30 (48.4)	16 (66.7)	15 (39.5)	35.156**	0.001*
	No	18 (26.5)	34 (16.5)	5 (21.7)	0 (0.0)	5 (11.6)	13 (21.0)	3 (12.5)	4 (10.5)		
	Don't know	34 (50.0)	56 (27.2)	8 (34.8)	5 (38.5)	15 (34.9)	19 (30.6)	5 (20.8)	19 (50.0)		
Emergency food and water	Yes	19 (27.9)	85 (41.3)	9 (39.1)	8 (61.5)	23 (53.5)	28 (45.2)	15 (62.5)	17 (44.7)	37.143**	0.001*
	No	10 (14.7)	45 (21.8)	8 (34.8)	0 (0.0)	2 (4.7)	9 (14.5)	4 (16.7)	1 (2.6)		
	Don't know	39 (57.4)	76 (36.9)	6 (26.1)	5 (38.5)	18 (41.9)	25 (40.3)	5 (20.8)	20 (52.6)		
Antidote/drug	Yes	21 (30.9)	89 (43.2)	12 (52.2)	8 (61.5)	20 (46.5)	30 (48.4)	16 (66.7)	16 (42.1)	33.005**	0.003*
	No	10 (14.7)	34 (16.5)	8 (34.8)	0 (0.0)	3 (7.0)	7 (11.3)	4 (16.7)	2 (5.3)		
	Don't know	37 (54.4)	83 (40.3)	3 (13.0)	5 (38.5)	20 (46.5)	25 (40.3)	4 (16.7)	20 (52.6)		
	Perceived institutional supports available for front-line workers										
	Supports										
Employee assistance program	Yes	26 (38.2)	108 (52.4)	11 (47.8)	3 (23.1)	28 (65.1)	42 (67.7)	21 (87.5)	22 (57.9)	34.508**	0.002*
	No	12 (17.6)	23 (11.2)	5 (21.7)	3 (23.1)	6 (14.0)	4 (6.5)	1 (4.2)	3 (7.9)		
	Don't know	30 (44.1)	75 36.4	7 30.4	7 53.8	9 20.9	16 25.8	2 8.3	13 34.2		
Access to internet at work	Yes	43 (63.2)	151 (73.3)	15 (65.2)	6 (46.2)	32 (74.4)	53 (85.5)	23 (95.8)	28 (73.7)	25.448**	0.030*
	No	11 (16.2)	22 (10.7)	2 (8.7)	3 (23.1)	4 (9.3)	3 (4.8)	0 (0.0)	1 (2.6)		
	Don't know	14 (20.6)	33 (16.0)	6 (26.1)	4 (30.8)	7 (16.3)	6 (9.7)	1 (4.2)	9 (23.7)		
Access to grief counseling	Yes	11 (16.2)	43 (20.9)	5 (21.7)	3 (23.1)	22 (51.2)	23 (37.1)	14 (58.3)	14 (36.8)	42.116**	0.000*
	No	16 (23.5)	40 (19.4)	6 (26.1)	3 (23.1)	5 (11.6)	7 (11.3)	2 (8.3)	2 (5.3)		
	Don't know	41 (60.3)	123 (59.7)	12 (52.2)	7 (53.8)	16 (37.2)	32 (51.6)	8 (33.3)	22 (57.9)		
Updates on global surveillance of infectious diseases	Yes	27 (39.7)	116 (56.3)	8 (34.8)	3 (23.1)	29 (67.4)	35 (56.5)	16 (66.7)	19 (50.0)	25.279**	0.032*
	No	11 (16.2)	15 (7.3)	4 (17.4)	3 (23.1)	4 (9.3)	3 (4.8)	1 (4.2)	3 (7.9)		
	Don't know	30 (44.1)	75 (36.4)	11 (47.8)	7 (53.8)	10 (23.3)	24 (38.7)	7 (29.2)	16 (42.1)		
Continuing education on emergency planning	Yes	16 (23.5)	97 (47.1)	9 (39.1)	4 (30.8)	18 (41.9)	26 (41.9)	13 (54.2)	17 (44.7)	21.489**	0.090
	No	23 (33.8)	40 (19.4)	4 (17.4)	3 (23.1)	14 (32.6)	14 (22.6)	2 (8.3)	6 (15.8)		
	Don't know	29 (42.6)	69 (33.5)	10 (43.5)	6 (46.2)	11 (25.6)	22 (35.5)	9 (37.5)	15 (39.5)		
Childcare support	Yes	14 (20.6)	43 (20.9)	4 (17.4)	3 (23.1)	10 (23.3)	23 (37.1)	11 (45.8)	12 (31.6)	20.782**	0.107
	No	17 (25.0)	54 (26.2)	7 (30.4)	4 (30.8)	16 (37.2)	12 (19.4)	5 (20.8)	5 (13.2)		
	Don't know	37 (54.4)	109 (52.9)	12 (52.2)	6 (46.2)	17 (39.5)	27 (43.5)	8 (33.3)	21 (55.3)		
Elder care support	Yes	13 (19.1)	50 (24.3)	4 (17.4)	3 (23.1)	14 (32.6)	21 (33.9)	10 (41.7)	12 (31.6)	17.334**	0.239
	No	17 (25.0)	51 (24.8)	8 (34.8)	3 (23.1)	16 (37.2)	14 (22.6)	6 (25.0)	6 (15.8)		
	Don't know	38 (55.9)	105 (51.0)	11 (47.8)	7 (53.8)	13 (30.2)	27 (43.5)	8 (33.3)	20 (52.6)		

Table 3.(Continued)

Pet care support	Yes	7 (10.3)	13 (6.3)	3 (13.0)	2 (15.4)	9 (20.9)	15 (24.2)	10 (41.7)	8 (21.1)	40.679**	0.000*
	No	29 (42.6)	82 (39.8)	8 (34.8)	3 (23.1)	19 (44.2)	21 (33.9)	7 (29.2)	9 (23.7)		
	Don't know	32 (47.1)	111 (53.9)	12 (52.2)	8 (61.5)	15 (34.9)	26 (41.9)	7 (29.2)	21 (55.3)		
Do you feel adequately equipped to work during an infectious disease outbreak?	Not at all	10 (14.7)	19 (9.2)	5 (21.7)	4 (30.8)	4 (9.3)	4 (6.5)	1 (4.2)	7 (18.4)	39.694**	0.070
	Rarely	15 (22.1)	26 (12.6)	5 (21.7)	1 (7.7)	3 (7.0)	12 (19.4)	0 (0.0)	6 (15.8)		
	Neutral	18 (26.5)	70 (34.0)	4 (17.4)	4 (30.8)	16 (37.2)	26 (41.9)	11 (45.8)	8 (21.1)		
	Often	21 (30.9)	68 (33.0)	6 (26.1)	3 (23.1)	13 (30.2)	19 (30.6)	9 (37.5)	12 (31.6)		
	Very much	4 (5.9)	23 (11.2)	3 (13.0)	1 (7.7)	7 (16.3)	1 (1.6)	3 (12.5)	5 (13.2)		
Are you adequately trained to deal with infectious disease outbreaks?	Not at all	11 (16.2)	16 (7.8)	3 (13.0)	3 (23.1)	4 (9.3)	1 (1.6)	2 (8.3)	4 (10.5)	45.479**	0.020*
	Rarely	11 (16.2)	34 (16.5)	4 (17.4)	3 (23.1)	5 (11.6)	17 (27.4)	1 (4.2)	5 (13.2)		
	Neutral	27 (39.7)	70 (34.0)	6 (26.1)	1 (7.7)	11 (25.6)	20 (32.3)	11 (45.8)	8 (21.1)		
	Often	16 (23.5)	66 (32.0)	9 (39.1)	5 (38.5)	13 (30.2)	18 (29.0)	6 (25.0)	19 (50.0)		
	Very much	3 (4.4)	20 (9.7)	1 (4.3)	1 (7.7)	10 (23.3)	6 (9.7)	4 (16.7)	2 (5.3)		
Does your institution have adequate programs and policies to respond to a large-scale outbreak?	Not at all	13 (19.1)	30 (14.6)	4 (17.4)	3 (23.1)	4 (9.3)	4 (6.5)	2 (8.3)	6 (15.8)	51.174**	0.005*
	Rarely	18 (26.5)	43 (20.9)	3 (13.0)	2 (15.4)	2 (4.7)	15 (24.2)	1 (4.2)	4 (10.5)		
	Neutral	25 (36.8)	59 (28.6)	9 (39.1)	3 (23.1)	13 (30.2)	25 (40.3)	8 (33.3)	9 (23.7)		
	Often	11 (16.2)	61 (29.6)	6 (26.1)	3 (23.1)	17 (39.5)	12 (19.4)	7 (29.2)	12 (31.6)		
	Very much	1 (1.5)	13 (6.3)	1 (4.3)	2 (15.4)	7 (16.3)	6 (9.7)	6 (25.0)	7 (18.4)		
In general, since the 1999 earthquake, do you feel confident that our health care institutions are prepared for future earthquakes or any other nuclear, biological outbreaks?	Not at all	27 (39.7)	56 (27.2)	5 (21.7)	4 (30.8)	12 (27.9)	11 (17.7)	1 (4.2)	12 (31.6)	76.080**	0.000*
	Rarely	21 (30.9)	46 (22.3)	4 (17.4)	2 (15.4)	5 (11.6)	17 (27.4)	1 (4.2)	3 (7.9)		
	Neutral	16 (23.5)	68 (33.0)	10 (43.5)	3 (23.1)	11 (25.6)	18 (29.0)	11 (45.8)	11 (28.9)		
	Often	4 (5.9)	35 (17.0)	1 (4.3)	3 (23.1)	12 (27.9)	13 (21.0)	6 (25.0)	9 (23.7)		
	Very much	0 (0.0)	1 (0.5)	3 (13.0)	1 (7.7)	3 (87.0)	3 (4.8)	5 (20.8)	3 (7.9)		
As a healthcare professional, do you feel confident that our healthcare system will protect you during a large-scale infectious disease outbreak or any kind of natural or man- made disasters?	Not at all	27 (39.7)	58 (28.2)	6 (26.1)	5 (38.5)	6 (14.0)	9 (14.5)	1 (4.2)	10 (26.3)	65.756**	0.000*
	Rarely	21 (30.9)	39 (18.9)	3 (13.0)	2 (15.4)	6 (14.0)	11 (17.7)	2 (8.3)	4 (10.5)		
	Neutral	14 (20.6)	63 (30.6)	6 (26.1)	1 (7.7)	14 (32.6)	20 (32.3)	8 (33.3)	10 (26.3)		
	Often	5 (7.4)	42 (20.4)	6 (26.1)	4 (30.8)	14 (32.6)	14 (22.6)	8 (33.3)	11 (28.9)		
	Very much	1 (1.5)	4 (1.9)	2 (8.7)	1 (7.7)	3 (7.0)	8 (12.9)	5 (20.8)	3 (7.9)		

The distribution of the education status of the participants participating in the research is given in Table 4. According to the answers of 65% of the participants, we see that decontamination training was not given to the personnel who could be a part of the response to CBRN events in the hospital, according to the response of 4%, this training was planned within 6 months, and according to the answer of 7.5%, the training curriculum is currently being developed. In addition, when the people included in the HDP plan of the hospital were asked about the regional emergency planning group's training on CBRN intervention, it is seen that 99.8% of them did not receive training and such a plan was not made within 6 months.

Table 4. Distribution of Participants Based on Training and Educational Status in Decontamination and Emergency Preparedness for CBRN Events

Education Status			**n (%)**
The hospital provides decontamination training to personnel who may be part of the response to CBRN events.	No, and it is not planned for the next 6 months.	No	312 (65.4)
		Yes	165 (34.6)
	No, but the hospital plans to provide training for the next 6 months.	No	458 (96.0)
		Yes	19 (4.0)
	The training curriculum is currently being developed.	No	441 (92.5)
		Yes	36 (7.5)
	Yes, decontamination training is provided	No	311 (65.2)
		Yes	166 (34.8)
	Other	No	388 (81.3)
		Yes	89 (18.7)
The status of the regional emergency planning group's training on CBRN response of the persons specified in the Hospital Disaster Plan	No, and it is not planned for the next 6 months.	No	476 (99.8)
		Yes	1 (0.2)
	No, but the hospital plans to provide training to people identified in the hospital's Hospital Disaster Plan within the next 6 months.	No	474 (99.4)
		Yes	3 (0.6)
	Training is currently ongoing.	No	472 (99.0)
		Yes	5 (1.0)
	Yes, training has been received on CBRN intervention	No	469(98.3)
		Yes	8 (1.7)
Total			**477 (100)**

Due to its geopolitical position, Turkey has to be prepared for CBRN events. With Covid-19, we have experienced how important it is for the health system to be prepared. If an integrated disaster management system is not planned, it will not be possible for hospitals to be prepared and to cope with a possible CBRN event. Just like the global response to the COVID-19 pandemic, healthcare emergency professionals need to be prepared for CBRN events. In this study, we aimed to evaluate the knowledge, training, and behavior levels of healthcare workers from various occupational groups working in two university hospitals in the Thrace region of Turkey regarding Chemical, Biological, Radiological, and Nuclear (CBRN) incidents. Specifically, the study focused on assessing the perceived preparedness of these employees by examining their access to CBRN-related training, their awareness of protocols, and their ability to respond effectively in CBRN scenarios. Based on a review of previous studies, it appears that while most hospitals have a disaster plan, they are often inadequately prepared for effective response to major emergencies and disasters[25-27]. As the main finding of the study was found the inadequate decontamination and intervention training of the personnel working in the 2 centers, the low perceived institutional competence, and the low access rates of nurses and doctors to the necessary equipment and support in CBRN events. As a result, the hospitals are unprepared for CBRN events. These findings were consistent with previous similar studies conducted in hospitals.[28-30] Inadequate training is proof that hospital disaster plans are not working. Although it is learned through bilateral interviews that both hospitals have hospital disaster plans and regularly conduct exercises at least once a year, it is seen that the training are insufficient according to the survey results (Table 4). Although there are exercises in hospitals, the rate of feeling unprepared can reach 50%.[31] In this context, carrying out exercises together with theoretical training in which all hospital employees are included can improve the knowledge and skills of health service providers and increase the level of perception of institutional competence in case of a possible disaster.

There is ample evidence that education is an important component in CBRN preparation.[32-36] There are studies that health professionals in Australia, the United States, and Mecca improve their knowledge and skills by receiving advanced training in disaster management.[37-39] Research shows

that 75% of what is heard is forgotten after 2 days. Moreover, only 10% of what is read, 20% of what is heard, 30% of what is seen, 50% of what is heard and seen, and only 80% of what is heard, observed, and practiced are retained in the human mind. Exercising and participating in exercises will likely contribute to long-term learning, as sensory exercises alone may not always be effective. In this context, special training sessions and exercises should be developed to increase the effectiveness of training subjects.[17] There is a need for a specialized team responsible for the preparation and implementation of hospital disaster planning in CBRN events.[33] In our study, it is seen that the number of employees working within the scope of the hospital disaster plan (n=20) is quite low compared to other employees. The reason for this is the thought that it is undesirable to see the lack of information that may arise while taking part in such a plan.[40]

Continuing education on bed care (n=17, 85%), laundry (n=17, 85%), internet access from the workplace (n=18, 90%), emergency planning (n=13, %) of the participants working within the scope of HDP were found to be relatively more knowledgeable (Table 2).

However, although they are in charge of the hospital disaster plan, “the state of feeling adequately equipped to work during an epidemic of infectious disease” (n=10, 50%), “the state of being trained to cope with an epidemic of infectious disease” (n=7, 35%), “the state of your institution have adequate programs and policies to respond to a large-scale epidemic” (n=10, 50%), “in general, the preparedness of our health institutions for future earthquakes or chemical and nuclear events, biological epidemics since the 1999 earthquake (n=2, 10%)), "the state of being confident that the health system will protect you during a large-scale epidemic of infectious disease or any natural or man-made disaster" (n=5, 25%), where the sum of their answers is quite low. In a similar study, Azeem et al. found that although more than 50% of respondents believed they could manage an emergency during a CBRN incident, 60% felt that their institution lacked adequate preparedness and would be unable to protect them in the event of a mass CBRN incident[29]. The authors emphasized that the insufficient level of preparedness for CBRN events highlighted the need for large-scale emergency drills and training seminars. They also suggested that computer simulation and planning tools could be instrumental in bridging this gap in preparation and training.

CONCLUSION AND RECOMMENDATIONS

Preparation for CBRN threats at individual and institutional level will be possible by firstly revealing the current situation and identifying the deficiencies. The results of this study show that there are significant deficiencies in training for CBRN events at both theoretical and practical levels. The lack of training and the limited access of nurses and doctors to the necessary equipment and support may cause the level of institutional competence to remain low.

Research in the United States reveals serious weaknesses in CBRN preparedness following the COVID-19 pandemic. For example, Alahmari and Khan (2023) reported that the level of preparedness for CBRN events was inadequate in some public hospitals in the US, and this became even more evident during global health crises such as COVID-19[41]. Similarly, in our study, it was observed that healthcare workers in Turkey lack access to CBRN training and have low levels of preparedness. This similarity suggests that there is a need for training and equipment support on CBRN preparedness in both Turkey and the US.

In Asia, especially in countries such as Japan and South Korea, CBRN awareness has increased after COVID-19 and some improvements in preparedness levels have been achieved[42]. Jama and Kuisma's (2022) study of emergency departments in Finland highlights similar shortcomings in Asia and Europe: Although hospitals have

preparedness programmes, there are problems in implementation[43]. In our study, it was observed that the CBRN preparedness levels of hospitals in Turkey are limited in terms of both theoretical knowledge and practice. This situation reveals that Turkey needs a more comprehensive CBRN preparedness policy compared to Asian and European countries.

Although some steps have been taken in Europe to increase the emergency preparedness and CBRN capacity of hospitals, especially after COVID-19, deficiencies continue. The findings of the study by Mohammadi et al. (2022), which examined the preparedness of emergency departments in Iran against biological threats, are in line with hospital preparations in many European countries. In this study, it was reported that systematic preparedness planning for CBRN events was lacking in hospitals. In our study, a similar deficiency was observed in hospitals in Turkey; especially the preparedness structure for CBRN events needs to be strengthened. These similarities point to a similar need for improvement in CBRN preparedness in Europe and Turkey[44-47].

Hospitals need to have plans, supplies, equipment and support in place. In case of insufficiency of these elements, it may become impossible to manage disasters. Adequately trained hospital staff plays a critical role in the preparedness process. Pre-disaster training and information are very important for an effective response and these trainings should be designed according to the level of education and duty areas of the personnel. In order to increase the level of CBRN preparedness, it is recommended to take concrete steps such as increasing regular training programmes and practical simulations and developing simulation tools that can be used in emergencies. In addition, reviewing and updating policies and protocols on emergency management will enable healthcare professionals to gain competence in CBRN preparedness. In this way, the level of preparedness of hospital personnel can be increased and CBRN events can be responded more effectively.

In addition, the employment of well-equipped people with undergraduate and postgraduate education in the field of CBRN and disasters in the disaster units of hospitals stands out as an important factor in the preparation and implementation of Hospital Disaster Plans. It is also recommended that CBRN courses should be added to the curricula of all undergraduate programmes in the field of health. In such events, determining the roles and responsibilities related to CBRN management before the incident and supporting them with trainings will prevent healthcare professionals from quickly becoming victims instead of rescuers.

In conclusion, the CBRN preparedness levels of hospitals in Turkey have similar deficiencies with the USA and some European and Asian countries. However, it is understood that Turkey needs a more comprehensive preparation and training process. In this context, to increase the CBRN preparedness capacity of hospitals in Turkey, it is recommended to develop policies on equipment supply and training of healthcare professionals by taking international practices as an example.

Limitations

The findings of this study conducted in two university hospitals cannot be directly generalised to all hospital employees. However, despite the limitations of the study, it is thought that it provides valuable information to CBRN preparedness studies in similar hospital environments and can be guiding in this context. Our study may contribute to the identification and improvement of existing deficiencies in CBRN incident preparedness in such hospital environments. In addition, although the fact that most of the personnel working in the Hospital Disaster Plan did not participate in the survey is seen as an important limitation of the study, this situation also clearly reveals the need for information and training on CBRN incidents for hospital employees. Although no direct data was obtained about

the reasons of the personnel who did not participate in the study, it is thought that the lack of awareness and knowledge of the employees about CBRN preparedness may have created a lack of interest in such a study. This situation indicates that there is an urgent need to increase the level of knowledge of healthcare workers on CBRN and to provide comprehensive training programmes.

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Author Contribution Study design and conceptualization was conducted by all authors. AHD conducted the study design, study supervision, and critical fnal revision of the manuscript. AHD, OA and EK contributed to the conduct of the psychological assessment part of the methodology. OA and EK was involved in data collection, analysis, and interpretation of data. AHD, OA and EK were involved in the analysis and interpretation of data, reviewing the literature, drafting, and revising the manuscript.

Ethics Approval: Non-Interventional Clinical Research Ethics Committee Presidency, Dean of Faculty of Medicine of TNKU approved the study (2022.58.04.08)

Data Availability: The datasets analyzed during the current study are available from the corresponding author. On request the data extraction file will be provided.

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