Research Article
Pamukkale Medical Journal
doi:https://dx.doi.org/10.31362/patd.1315923

Knowledge levels and awareness of healthcare professionals on protection from chemical, biological, radiation, nuclear hazards, and emergency aid practices

Sağlık personellerinin kimyasal, biyolojik, radyasyon ve nükleer tehlikelerden korunma ve acil yardım uygulamaları ile ilgili bilgi düzeyleri ve farkındalıkları

Arzu Babacan

Received:17.06.2023 Accepted:28.08.2023

Abstract

Purpose: The accidental or intentional release of CBRN (Chemical, Biological, Radiological, Nuclear) substances into the environment causes significant loss of life and property and has adverse effects over a long time. This study was planned to raise awareness about protection from CBRN hazards and emergency aid practices, to create CBRN awareness, and to determine the knowledge level of healthcare professionals.

Materials and methods: After reviewing the literature and regulations, the questionnaire was prepared based on the training module on "Emergency Assistance in Chemical, Biological, Radiation, and Nuclear Hazards" for Emergency Health Services published by the Republic of Türkiye Ministry of National Education. The questionnaire was asked to participants before and after 10 hours of theoretical CBRN training, and the results were compared.

Results: The participants were 58.4% female, 41.6% male, and the average age was 38. Most participants were doctors or nurses, and approximately three-quarters of the participants were emergency service staff. 35.6% of them had been working in the emergency department for 1-5 years. 61.4% had not received CBRN training, and 84.2% thought they needed sufficient knowledge and experience. 77.2% had not experienced any CBRN incident nor performed any intervention for CBRN. When the 22 questions asked about the level of CBRN knowledge were evaluated, it was seen that the correct answer rate was above 50% in seven questions of 22 and was above 50% in all questions in the post-test applied after the training. Their level of knowledge was found to be low before CBRN training and good after training.

Conclusion: Theoretical training has a significant positive impact on creating CBRN awareness.

Keywords: CBRN, health knowledge, attitudes, practices, awareness.

Babacan A. Knowledge levels and awareness of healthcare professionals on protection from chemical, biological, radiation, nuclear hazards, and emergency aid practices. Pam Med J 2023;16:618-626.

Öz

Amaç: KBRN (Kimyasal, Biyolojik, Radyolojik, Nükleer) maddelerin kaza ile veya kasıtlı olarak çevreye yayılması önemli can ve mal kayıplarına yol açmakta ayrıca uzun bir zaman dilimi boyunca olumsuz etkiler doğurmaktadır. KBRN tehlikelerinden korunma ve acil yardım uygulamaları ile ilgili farkındalık yaratmak, KBRN bilinci oluşturmak, bilgi düzeylerini tespit etmek amacıyla planlanmıştır.

Gereç ve yöntem: Literatür ve yönetmelikler incelendikten sonra, Türkiye Cumhuriyeti Milli Eğitim Bakanlığı tarafından yayınlanan Acil Sağlık Hizmetleri için "Kimyasal, Biyolojik, Radyasyon ve Nükleer Tehlikelerde Acil Yardım" konulu eğitim modülü temel alınarak anket hazırlanmıştır. Anket, katılımcılara toplam 10 saatlik teorik KBRN eğitiminden önce ve sonra sorulmuş ve sonuçlar karşılaştırılmıştır.

Bulgular: Katılımcıların %58,4'ü kadın, %41,6'sı erkek ve yaş ortalaması 38'dir. Katılımcıların çoğu doktor veya hemşireydi ve katılımcıların yaklaşık dörtte üçü acil servis personeliydi. Katılımcıların %35,6'sı 1-5 yıldır acil serviste çalışmaktadır. 61,4'ü KBRN eğitimi almamıştı ve %84,2'si KBRN konusunda yeterli bilgi ve deneyime sahip olmaları gerektiğini düşünüyordu. 77,2'si herhangi bir KBRN olayı yaşamamış ve KBRN'ye yönelik herhangi bir müdahalede bulunmamıştır. KBRN bilgi düzeyi ile ilgili sorulan 22 soru değerlendirildiğinde, eğitim öncesi 7 soruda doğru cevap oranının %50'nin üzerinde olduğu, eğitim sonrası uygulanan son testte ise tüm sorularda %50'nin üzerinde olduğu görülmüş, KBRN eğitimi öncesi bilgi düzeylerinin düşük, eğitim sonrası ise iyi olduğu tespit edilmiştir.

Sonuç: KBRN bilinci oluşturmak için teorik gerçekleştirilen eğitimin anlamlı düzeyde olumlu etkisi olduğu belirlenmiştir.

Anahtar kelimeler: KBRN, sağlık bilgisi, tutumlar, uygulama, farkındalık.

Babacan A. Sağlık personellerinin kimyasal, biyolojik, radyasyon ve nükleer tehlikelerden korunma ve acil yardım uygulamaları ile ilgili bilgi düzeyleri ve farkındalıkları. Pam Tıp Derg 2023;16:618-626.

Arzu Babacan, M.D. Health Sciences University Ankara Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital Emergency Service, Ankara, Türkiye, e-mail: babacan.ar@hotmail.com (https://orcid.org/0000-0002-0540-8975) (Corresponding Author)

Introduction

As well as being used in many areas of daily life, especially in industry, medicine and scientific research, chemical, biological, radioactive and nuclear (CBRN) substances are also used as an instrument of war [1]. CBRN incidents are defined as events caused by the intentional or accidental release of chemical, biological, radioactive and nuclear substances, causing harmful and dangerous situations for humans and the environment [2]. Uncontrolled dispersal of CBRN agents through natural disasters, accidents and terrorist activities by humans, nature or technological sources poses great risks for the environment and humans. CBRN incidents can injure or even cause the death of many people if they do not receive urgent medical attention [1]. CBRN events have significantly affected the environment, climate, human life and social order in history. People are exposed to CBRN events and substances through industrial accidents such as the 2011 Fukushima Daiichi nuclear disaster, the 1986 Chernobyl disaster, the 1989 Exxon Valdez Oil spill; through wars such as the 1991 Gulf War, the 1945 atomic bombing of Hiroshima and Nagasaki, the use of mustard gas and tear gas during World War I; or terrorism events such as the 2001 US Anthrax attacks, the 1995 Tokyo sarin attacks. The Chernobyl accident was the most significant nuclear accident, and the Thrace and Eastern Black Sea regions were the most affected regions in our country.

The 1979 collision between a tanker and a dry cargo ship in the Bosphorus Strait in Istanbul, which resulted in the explosion of a tanker carrying 100 thousand tons of crude oil and causing damage to thousands of homes and businesses in the Bosphorus, the leakage of 6400 tons of Acrylonitrile during the 1999 Marmara earthquake, the 1986 explosion at the Kırıkkale MCI (Mechanical and Chemical Industry) corporation factory, and the explosion and fire caused by LPG cylinders in the Industrial Region of Ankara in 2011 are the CBRN incidents that have occurred in our country.

As a result of technological developments, rapid industrialization, an increase in weaponization, and developments in the industry, the production and availability of CBRN agents have increased and become more accessible. Inadequate knowledge, use and control of CBRN agents have brought the danger to the highest level today [3]. The geographical location of our country, being on the international transportation route and being surrounded by seas on three sides, nuclear facilities in surrounding countries, irregular urbanization, and industrialization increase the risk for our country [3]. The “Regulation No. 3033 on Chemical, Biological, Radiological, Nuclear (CBRN) Threats and Hazards” was published in 2020 to prevent or minimize the damage that may occur to human health and the environment in the event of any chemical, biological, radiological, nuclear threats and hazards that may occur in Türkiye or other countries. The responsibilities of the institutions and organizations that will take part in CBRN threats and hazards before, during, and after the incident are clearly defined by this regulation [4].

CBRN incidents are challenging and time-consuming events that require the cooperation of relevant institutions and organizations [3, 5]. The main task of healthcare personnel in CBRN incidents is to protect the injured people from the harmful effects of CBRN agents, to perform triage, first aid and decontamination, reporting, quarantine applications, advanced diagnosis, and treatment procedures [6, 7]. Healthcare organizations must determine the principles of healthcare services to be provided in these extraordinary events within the scope of the “Hospital Disaster Plan (HDP),” specially developed according to their organization. After an emergency, the affected community needs emergency intervention and long-term health services. It will lose functionality if the hospital staff is not prepared and trained and cannot perform medical intervention by providing the necessary occupational health and safety conditions. In order to develop the necessary knowledge, behaviors, and attitudes in the face of these events, training of hospital staff and testing of training through practices are of great importance [7].

The aim of this study was to determine the level of knowledge and awareness of healthcare workers working in the emergency service in our institution about protection from CBRN threats and hazards and emergency aid practices and to compare the level of knowledge before and after the training, and to evaluate the effectiveness of the training about CBRN awareness training.

Materials and methods

This descriptive study was planned to investigate the knowledge levels and awareness of healthcare personnel working in the emergency service of our hospital about protection from chemical, biological, radiation, and nuclear hazards and emergency aid practices. The ethics committee approval was obtained from Health Sciences University, Ankara, Dr. Abdurrahman Yurtarslan Oncology Training and Research Hospital. The questionnaire method was used for data collection. After reviewing the literature and regulations, the questionnaire was prepared based on the training module on "Emergency Assistance in Chemical, Biological, Radiation, and Nuclear Hazards" for Emergency Health Services published by the Republic of Türkiye Ministry of National Education [3]. A total of 10 hours of theoretical CBRN awareness training was given on CBRN introduction, personal protection from CBRN hazards (warning and alarm signs, PPE features and use, protection levels), chemical hazards, scene, front of hospital organization and triage in CBRN exposure, decontamination, biological agents, radiation and nuclear hazards, hospital organization in line with the HDP plan of our hospital. The questionnaire form, which consists of multiple-choice questions, was applied face-to-face before and after training to measure and evaluate the training module. The first section consisted of five questions about the sociodemographic characteristics of the participants, the second section consisted of three questions about CBRN training status, self-assessment of knowledge and skills, and history of experiencing an incident, and the third section consisted of twenty-two multiple-choice questions to assess the level of knowledge about CBRN. Correct answers were given a "1" point. In the third question, four questions were asked about CBRN risk perception, and they were asked to answer correctly or incorrectly. A total CBRN knowledge score was calculated by giving 1 point for each correct answer. Out of a total of 25 points; for the level of knowledge; 0-8 points were classified as low, 9-16 points as moderate, and 17-22 points as good. Participants who did not participate in CBRN awareness training and answered the survey questions incompletely were excluded from the study. One hundred and one health personnel participating in CBRN awareness training working in the emergency service completed the study.

Statistical analysis

The data were analyzed with SPSS 25.0 (IBM Co®. USA). The Kolmogorov-Smirnov test was used to determine normal distribution. Categorical data are presented as numbers and percentages (%). Numerical variables not normally distributed are shown as the median and interquartile range (IQR: 25th-75th percentile). Wilcoxon signed-rank test was used to compare the pre-and post-training knowledge level questionnaire results. Mann Whitney U and Kruskal Wallis tests were used to compare the pre-and post-training questionnaire results according to gender, duty, place, and task duration.

Results

Of the participants, 58.4% were female, 41.6% were male, and the median age was 38. Most of the participants were doctors or nurses. Approximately three-quarters of the participants were staff of the emergency service. 35.6% of them had been working in the emergency department for 1-5 years. The demographic characteristics of the participants are given in Table 1.

61.4% of the participants had not received CBRN training, and 84.2% thought they needed more knowledge and experience. 77.2% had not experienced any CBRN incident nor performed any intervention for CBRN (Table 2).

When the 22 questions asked about the level of CBRN knowledge were evaluated, it was seen that the correct answer rates were above 50% in a total of seven questions in the pretest about knowledge of the CBRN codes, risk perception, institutions and organizations concerned with CBRN, danger warning signs, precautions that should be taken in the hospital in case of CBRN exposure, the route of entry of biological agents into the body and the most potent toxin, and radiation beams. However, their level of knowledge could have been higher in general evaluation. The correct answer rates were above 50% in all questions in the post-test applied after the training, and their knowledge levels were found to be good in the general evaluation (Table 3).

Table 1. The demographic characteristics of the participants

		N/%	Median (IQR: 25th-75th percentile)
Age			38.0 (27.0-45.0)
Gender	Female	59 (58.4)	
	Male	42 (41.6)	
Duty	Doctor	47 (46.5)	
	Nurse	41 (40.6)	
	EMT	6 (5.9)	
	Health officer	7 (6.9)	
Place of duty	Emergency service	74 (73.3)	
	Family medicine	27 (26.7)	
Duration of duty	1-5 years	36 (35.6)	
	6-10 years	12 (11.9)	
	11-15 years	12 (11.9)	
	16-20 years	9 (8.9)	
	21-25 years	16 (15.8)	
	25 years and above	16 (15.8)	

IQR: Interquartile range, EMT: Emergency medicine technician

Table 2. Questioning of the self-assessment of the knowledge and skills of the participants on Chemical Biological Radiological Nuclear Threats and the history of experiencing an incident (N=101)

Have you received CBRN training?	Yes	39 (38.6)
	No	62 (61.4)
Do you think you have sufficient knowledge and skill level about CBRN as a healthcare professional?	Yes	16 (15.8)
	No	85 (84.2)
Have you experienced and/or intervened in any CBRN incident in your occupational life?	Yes. I have, but I have not had any intervention	11 (10.9)
	Yes. I have and I have an intervention	12 (11.9)
	No. I have not	78 (77.2)

CBRN: Chemical Biological Radiological Nuclear Threat

Table 3. Questionnaire questions and correct response rates for the evaluation of the participants' level of knowledge about Chemical Biological Radiological and Nuclear Threats (N=101)

	Pre-test	Post-test
	Number and percentage of correct answers (N/%)	
1. In case of a CBRN incident which code is prescribed by the head of the HDP in the hospital?	68 (67.3)	102 (100)
2. In which of the following areas of the scene of CBRN is the healthcare professional assigned?	33 (32.7)	98 (96.1)
3. Which of the following are included in the definition of CBRN? (For each item it was asked to express as true or false)		
a. Use of dangerous and epidemic bacteria, viruses, and toxins as biological weapons	82 (81.2)	102 (100)
b. Nuclear station accidents	90 (89.1)	102 (100)
c. Tanker, truck, train, and ship accidents during transportation of chemicals	87 (86.1)	102 (100)

Table 3. Questionnaire questions and correct response rates for the evaluation of the participants' level of knowledge about Chemical Biological Radiological and Nuclear Threats (N=101) (continued)

	Pre-test	Post-test
	Number and percentage of correct answers (N/%)	
d. The technological accidents in scientific or industrial research laboratories	73 (72.3)	102 (100)
4. Which of the following is one of the institutions and organizations in our country concerning CBRN?	68 (67.3)	99 (97.1)
5. Hazard warning and alarm systems have been established to warn the public against danger and to ensure that necessary precautions are taken; which of the following statements about hazard warnings is incorrect?	76 (75.2)	98 (96.1)
6. The level of protection in CBRN incidents varies according to the hazard encountered; which of the following is applied when the highest level of protection of respiration and lower level of skin protection is required?	29 (28.7)	83 (81.4)
7. Which of the following is the level of protection used by the healthcare professional in the decontamination area?	24 (23.8)	80 (78.4)
8. Which of the following is the level of protection used by healthcare professionals in the area of low pollution?	26 (25.7)	92 (90.2)
9. Which of the following statements about decontamination is incorrect?	20 (19.8)	81 (79.4)
10. Which of the following statements about decontamination is incorrect?	12 (11.9)	86 (84.3)
11. Which of the following is not one of the precautions that should be required in a hospital following CBRN exposure?	64 (63.4)	100 (98.0)
12. Which of the following should be applied for exposure to nerve agents?	44 (43.6)	98 (96.1)
13. Which of the following chemical warfare agents is used as a nerve agent?	42 (41.6)	89 (87.3)
14. Which of the following is not one of the physiological effects of anesthetic gases?	28 (27.7)	54 (5.9)
15. Which of the following is the most effective route of entry for biological agents to achieve their goals?	74 (73.3)	94 (92.2)
16. Which of the following is the most potent toxin in the world?	59 (58.4)	96 (94.1)
17. Which level of protection is sufficient in case of exposure to biological agents?	26 (25.7)	82 (80.4)
18. Which of the following is not one of the viral agents used as a biological agent?	49 (48.5)	94 (92.2)
19. Which of the following is the leading cause of radiation damage?	30 (29.7)	84 (82.4)
20. Which of the following organs is not resistant to radiation?	36 (35.6)	80 (78.4)
21. Which of the following statements about radiation beams is incorrect?	52 (51.5)	79 (77.5)
22. Which of the following is the form of very high dose exposure in acute radiation syndrome?	21(20.8)	52 (51.0)

CBRN: Chemical Biological Radiological Nuclear Threat

When the pre and post-training test results over a total of 25 points were compared, the median score was 11.0 (8.8-13.0) before and 20.0 (18.0-22.0) after the training, and a significant difference was found between the two results (p<0.001). There was no difference in CBRN knowledge level score before and after the training according to gender (p=0.504 and p=0.414, respectively). Again, no significant difference was found in the CBRN questionnaire scores of the participants before and after the training according to their duties (p=0.896, p=0.327). While there was no significant difference between the pre-training CBRN scores of those working in the emergency department and family medicine (p=0.807), the CBRN scores of emergency service personnel were found to be higher in the post-training questionnaire (p=0.029). There was no significant difference in pre- and post-training CBRN knowledge scores according to the duration of duty (p=0.051 and p=0.380, respectively).

Discussion

In this study conducted to evaluate the level of CBRN knowledge and the effectiveness of the training, 58.4% of the participants were female, 41.6% were male, and the mean age was 38 years. The male-female ratio and median age were consistent with similar studies [8, 9]. There was no significant difference in the CBRN knowledge level scores of the participants before the training regarding gender and duty. Gurler et al. [9] and Ayvazoglu et al. [10] found that CBRN knowledge levels did not differ significantly according to gender in their studies. In the study of Dincer and Kumru [11], which investigated the preparedness of health personnel for disasters and emergencies, it was found that gender did not cause a significant difference in readiness for disasters and emergencies. The findings obtained from this study are in parallel with the results in the literature.

In this study, 38.6% of the participants stated that they had received CBRN training before. Dönmez [12] said that 38.2% of the participants received CBRN training in the study conducted with emergency medical personnel, and Kaynak [13] stated that 54.7% of the participants received basic CBRN training in 2020. Öner [14] reported that 46.9% of the participants received CBRN training in the thesis study to determine the level of knowledge about CBRN of family physicians and 112 emergency and first aid healthcare personnel. So, the rate of CBRN training in this study is similar to previous studies.

84.2% of the participants in this study thought that they needed more knowledge and experience on CBRN. 77.2% had not experienced any CBRN incident nor practiced any intervention. In the study of Günenç [15], 75.6% of the participants reported that they had not experienced a CBRN incident. Similarly, Eyison et al. [1] found that most of the participants had not experienced a CBRN incident. The cold area at the scene of CBRN exposure is the clean area that has never been affected by the event. It is the location of healthcare personnel with personal protective equipment and ambulances. In our study, for the question about basic CBRN knowledge level, “The code given by the head of the HDP; code orange,” the correct answer ratio was 67.3%, and the correct answer ratio to the question “In which area do health personnel work at the CBRN incident site; cold area” is 32.7%. There are limited studies in the literature on CBRN preparedness and knowledge level of hospitals and emergency services, and there is no study that we can compare the findings of our research.

For the question “Evaluate the given events in terms of CBRN events,” 81.2% of the participants thought that bacteria, viruses, and toxins that are the agents of dangerous and epidemic diseases could be used as biological warfare agents, 89.1%, 86.1%, and 72.3% thought nuclear station accidents, transportation of chemical CBRN agents and technological accidents in scientific or industrial research laboratories pose CBRN risk, respectively. It was observed that there was no significant difference in the CBRN risk perception of the participants in terms of age, gender, duty period, and occupational groups and that their risk perception was high. In the study by Kaynak [13] in 2020, the correct answer rates for similar statements ranged between 64-96%. The correct answer rates are over 50% in the questions about the institutions and organizations concerning CBRN and hazard warning signs in our country. The most critical step in approaching CBRN incidents is decontamination and using PPE. In our study,

the correct answer rates to the 6th, 7th, and 8th questions about protection levels were 28.7%, 23.7%, and 25.7%, respectively. We have not encountered a study in the literature to compare the results of this study. The correct answer rates of the participants to the 9th, 10th, and 11th questions about decontamination were 19.8%, 11.9%, and 63.4%. The knowledge level of the participants about decontamination and methods is found to be low. In his study conducted on emergency service personnel, Günenç [15] found that the rates of correct answers to the abovementioned questions were 53%, 70%, and 65%, respectively. The high knowledge rates in this study may be due to the study population, and the participants may have had more CBRN training.

The rates of correct answers for questions 12, 13, and 14 about the symptoms and signs that can be seen after exposure to chemical agents are 43.6%, 41.6%, and 27.7%. In the study of Kaynak [13], the correct response rate of the participants to the question “Atropine is administered in CBRN cases exposed to nerve agents,” which is similar to the 12th question of this study, was 44%, in accordance with this study. These studies show that especially the healthcare personnel involved in CBRN incidents were aware of the CBRN hazard, but the knowledge of the medical approaches still needs improvement.

The correct response rates of the participants to questions 15, 16, 17, and 18 about biological agents, the most effective route of entry into the body, and levels of protection were 73.3%, 58.4%, 25.7%, and 48.5%, respectively. In the study of Demirag et al. [16], the correct response rate to the question “C level protection is applied with type C clothing in biological agent exposure” was found to be 44.5%, and 96.3% of the students answered the question about the ways of entry of biological agents into the body correctly. In the study conducted by Günenç [15], 91% of the students had the correct answer to the question “What are the routes of entry of biological agents into the body?” and 67% of the students had the correct answer to the question “Clostridium botulinum is the strongest known toxin.” Our findings are similar to the studies mentioned above. However, the correct answer rate was found to be low in the question about the level of protection. As observed in the COVID-19 pandemic, healthcare personnel who intervene in CBRN incidents should wear PPE and have knowledge and skills about PPE because they are at high risk [17, 18].

The level of knowledge of the participants about radiation beams and their properties, affected organ structures, and acute radiation syndrome was evaluated in the 19th, 20th, 21st, and 22nd questions. The correct answer rates were 29.7%, 35.6%, 51.5%, and 20.8%. The knowledge level of the participants is considered to be low, but there is no comparable data in the literature. In this study, it was found that the basic CBRN knowledge level of the participants was low in the pre-test. Ayvazoğlu [10] found that the CBRN knowledge level of state hospital personnel and university students was intermediate in his study. In most of the studies conducted in our country and abroad, it has been observed that nurses have inadequate knowledge about what to do about CBRN threats and hazards, need training, and are worried about themselves, their families, and society [19] Woude et al. [20] also found that basic education and training on CBRN were lacking. Due to the lack of training, it was stated that healthcare personnel had problems with issues such as how to intervene in CBRN situations. The findings obtained from the literature and this study show that individuals consisting of healthcare personnel have low levels of CBRN knowledge.

The finding of a significant difference between the results before and after the training regarding the level of knowledge reveals the importance of training. The post-training score of those working in the emergency service was higher than those working in family medicine. This finding may be related to the fact that those working in the emergency department show more motivation for CBRN-related training and have a higher rate of encountering CBRN events. Gurler et al. [9] found that the pre-test and post-test results were compared, and a significant difference was found in knowledge levels after the training. They emphasized the importance of training programs to raise awareness about basic first aid and CBRN in their study and noted that the increased level of knowledge as a result of the training would prevent irreversible situations by intervening in a possible event on time. Kako et al. [21]

reported that scenario-based training models could significantly contribute to increasing the knowledge of emergency healthcare personnel and closing the gap in this field. Li et al. [5] emphasized that the challenges and complexities of intervention in Nuclear, Biological, and Chemical incidents should be realized, and cooperation between national security agencies, military/local/regional, health service providers, professional medical communities, military and local communities should be established as early as possible. It was highlighted that coordination of intervention to Nuclear, Biological, and Chemical incidents should be established, practical training and exercises should be conducted, and a continuous and integrated response system should be conducted.

As a result, this study and other similar studies indicate that training programs will significantly contribute to improving knowledge and skills. Therefore, intra-institutional CBRN coordination should be developed, and knowledge and awareness should be increased through repeated training and drills.

Conflict of interest: No conflict of interest was declared by the author.

References

1. Eyison RK, Pakdemirli A, Aydin E, et al. Evaluation of the medical chemical, biological, radiological, and nuclear awareness level of emergency healthcare professionalss serving on different centres. J Basic Clin Health Sci 2020;4:174-179. https://doi.org/10.30621/jbachs.2020.1037
2. AFAD, T.C. İçişleri Bakannlığı Afet ve Acil Durum Yönetimi Başkanlığı KBRN Terimler Sözlüğü. Erişim adresi: https://www.afad.gov.tr/kbrn-sozlugu. Erişim tarihi Ocak, 2021
3. T.C. Milli Eğitim Bakanlığı, Acil Sağlık Hizmetleri, Kimyasal Biyolojik Radyasyon Ve Nükleer (KBRN) Tehlikelerde Acil Yardım 725TTT154, Ankara 2011. Available at: http://megep.meb.gov.tr/mte_program_modul/moduller_pdf/Kimyasal,Biyolojik,Radyasyonve%nükller tehlikelerde acil yardım.pdf. Accessed 2011
4. 3033 Sayılı Kimyasal, B., Radyolojik, Nükleer (KBRN) Tehdit ve Tehlikelere Dair Görev Yönetmeliği. Available at: https://www.resmigazete.gov.tr/eskiler/2020/10/20201001-3.pdf. Accessed September 30, 2020
5. Li HL, Tang WJ, Ma YK, Jia JM, Dang RL, Qiu EC. Emergency response to nuclear, biological and chemical incidents: challenges and countermeasures. Mil Med Res 2015;2:19. https://doi.org/10.1186/s40779-015-0044-3
6. Veenema TG. Chemical and biological terrorism preparedness for staff development specialists. J Nurses Staff Dev 2003;19:218-225. https://doi.org/10.1097/00124645-200309000-00001
7. Kotora JG. An assessment of chemical, biological, radiologic, nuclear, and explosive preparedness among emergency department healthcare providers in an inner city emergency department. Am J Disaster Med 2015;10:189-204. https://doi.org/10.5055/ajdm.2015.0202
8. Çıtlık Sarıtaş S, Kızıl AB, Sarıtaş S. Acil servis hemşirelerinin biyoterörizm konusundaki bilgi ve görüşleri. Bozok Tıp Dergisi 2013;3:29-36. Available at: https://dergipark.org.tr/tr/pub/bozoktip/issue/3783/50525#article_cite. Accessed June 01, 2013
9. Gürler M, Gürsoy G, Çiftçi H, Salar H. Kimyasal, biyolojik, radyasyon ve nükleer risklere karşı korunmada farkındalık oluşturma ve temel ilk yardım eğitimi etkinliklerinin değerlendirilmesi. BSJ Health Sci 2021;4:63-68. https://doi.org/10.19127/bshealthscience.816643
10. Ayvazoğlu G. KBRN için hazırlık ve gönüllülük düzeyi belirleme çalışması, Gümüşhane ili örneği. Yüksek Lisans Tezi. Gümüşhane Üniversitesi, Sosyal Bilimler Enstitüsü, Afet Yönetimi Anabilim Dalı, Gümüşhane, 2015.
11. Dinçer S, Kumru S. Afet ve acil durumlar için sağlık personelinin hazırlıklı olma durumu. Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi 2021;10:32-43. https://doi.org/10.37989/gumussagbil.790884
12. Dönmez A. Acil tıp çalışanlarının (KBRN) kimyasal, biyolojik, radyolojik, nükleer kazalara karşı ilgi, bilgi ve tutum durumu araştırması. Doktora Tezi. Bezmialem Vakıf Üniversitesi Sağlık Bilimleri Enstitüsü, İstanbul, 2019.
13. Kaynak C. Örnek bir hastane afet ekibinin doğal afetler sonrasında ortaya çıkabilecek kbrn (kimyasal, biyolojik, radyoaktif, nükleer) tehlikeler ile ilgili bilgi düzeylerinin ölçülmesi. Yüksek Lisans Tezi. Çanakkale Onsekiz Mart Üniversitesi Fen Bilimleri Enstitüsü, Çanakkale, 2020.
14. Öner U. Birinci basamak sağlık hizmeti veren aile hekimleri ile 112 acil ve ilkyardım sağlık çalışanlarının kbrn hakkında bilgi düzeyi. Tıpta Uzmanlık Tezi. T.C. Sağlık Bakanlığı Sağlık Bilimleri Üniversitesi Kayseri Şehir Hastanesi, Kayseri, 2020.

15. Günenç ND. Hastanenin özellik arz eden riskli birimlerinde (acil, yoğun bakım, görüntüleme merkezi) çalışan personelin KBRN tehlikesine karşı korunma bilgi düzeyinin araştırılması. Yüksek Lisans Tezi. Bezmialem Vakıf Üniversitesi Sağlık Bilimleri Enstitüsü, İstanbul, 2022.
16. Demirağ H, Hintistan S, Doğan ES, Cin A, Tuncay B. Paramedik öğrencilerinin biyoterörizm ile biyolojik ajanlara ilişkin bilgi ve görüşlerinin incelenmesi. Düzce Üniversitesi Sağlık Bilimleri Enstitüsü Dergisi 2019;9:49-56. https://doi.org/10.33631/duzcesbed.498337
17. Pakdemirli A. Sağlık çalişanlari için kişisel koruyucu ekipman kullanımı. Jinekoloji-Obstetrik ve Neonatoloji Tıp Dergisi 2021;18:834-839. https://doi.org/10.38136/jgon.946506
18. Yıldırım S, Demircan S, Küp Aylıkçı N. Kimyasal, biyoojik, radyolojik, nükleer olaylarina karşi hastane öncesi acil sağlik hizmetleri çalişanlarinin kişisel koruyucu donanim kullanimi, bilgi ve beceri durumu: Adana ili örneği. Hastane Öncesi Dergisi 2021;6:381-392. https://doi.org/10.54409/hod.1002941
19. Aslan D, Esin M. Hemşirelik öğrencileri için kimyasal, biyolojik, radyolojik, nükleer tehlikeler bilgi, tutum ve öz yeterlilik ölçeklerinin geliştirilmesi. Sağlık Bilimlerinde İleri Araştırmalar Dergisi 2021;4:20-30. https://doi.org/10.26650/JARHS2021-815682
20. Van der Woude I, de Cock JS, Bierens JJLM, Christiaanse JC. TAP CBRN preparedness: knowledge, training and networks. Prehosp Disaster Med 2008;23:65-69. https://doi.org/10.1017/s1049023x00021270
21. Kako M, Hammad K, Mitani S, Arbon P. Existing approaches to chemical, biological, radiological, and nuclear (CBRN) education and training for health professionalss: findings from an integrative literature review. Prehosp Disaster Med 2018;33:182-190. https://doi.org/10.1017/S1049023X18000043

Ethics committee approval: The ethics committee approval was obtained from Health Sciences University, Ankara, Dr. Abdurrahman Yurtarslan Oncology Training and Research Hospital (ethical approval date: 23.06.2021 and number: 2021-06/1234)