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Review Article

Enhancing Online Learning: A Comparative Review of Multimedia and Instructional Booklet Approaches for Operating Room Staff Training of Radiological Safety

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ABSTRACT

Background: Online learning has become an integral part of modern education, offering flexibility and accessibility to learners worldwide. In the context of occupational hazards, ionizing radiation poses a considerable risk in operating rooms, potentially causing severe and irreversible harm to those working in these environments. This review study aimed to compare the effectiveness of multimedia and instructional booklet methods in educating Iranian operating room staff regarding radiation protection principles.

Methods: This review employed a comparative literature analysis. Relevant studies were identified using keywords like 'Radiation Safety Training,' 'Multimedia Learning,' 'Instructional Booklets,' 'Operating Room Staff,' 'E-learning in Healthcare,' and 'Comparative Educational Approaches.' These terms helped identify studies focusing on radiation safety and effective educational methods in medical contexts from journals indexed in scientific databases, including ScienceDirect, PubMed, Scopus, SID, Magiran, and Eric databases and the Google Scholar search engine, covering the time frame from 2014 to 2024. Articles that did not align with the research objective or were published as letters to the editor were excluded from the study. The articles were evaluated using the SANRA Checklist and reviewed by two education specialists.

Results: From the 36 articles identified, 16 were selected as relevant to educating Iranian operating room staff on the principles of radiation protection. The studies consistently demonstrated that multimedia training, encompassing elements such as videos, interactive simulations, and virtual reality, led to notable improvements in knowledge scores compared to traditional instructional booklets.

Conclusion: The research findings indicated the effectiveness of both educational methods. However, the multimedia approach increased awareness among the research participants more effectively than the other two methods. Therefore, based on the study results, this educational method is recommended for teaching topics related to radiation protection principles.

Keywords: Multimedia, Online, Teaching, Radiation Protection, Training, Books, Operating Rooms

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Introduction

One of the ongoing and concerning issues related to occupational health and safety is the presence of occupational hazards that can lead to various diseases, injuries, and job-related disabilities. In such cases, the natural physiological mechanisms are compromised, posing a threat to the health of the working individual (1, 2). A physical hazard in operating rooms is exposure to occupational radiation among staff (3). Radiation protection is an essential principle in the operating room due to the increasing use of radiation. Studies have shown that radiation safety knowledge is insufficient among operating room staff, and radiation-shielding devices are underutilized (4). A study involving 70 operating room nurses identified a positive correlation between radiation protection training and protective behavior (5). Raising awareness among medical staff about radiation protection would significantly reduce the exposure of both staff and patients during medical procedures involving fluoroscopy (6). In Iran, instructional booklets are a traditional and widely used method for self-learning. These booklets provide concise and easily understandable information on a specific topic, tailored for a specific target audience, addressing some of the shortcomings of thick and often challenging-to-understand books (7). On the other hand, with technological advancements and the emergence of new technologies, there is a growing interest in newer learner-centric methods for knowledge transfer and learning. Multimedia-based education is one form of electronic learning (e-learning). This type of education utilizes various media such as images, videos, audio, text, animations, and simulations to cater to different learning styles of learners (8, 9). Multimedia education employs various resources to offer diverse and engaging learning experiences, encouraging active participation in the learning process. This educational strategy has demonstrated benefits, including increased motivation for learning, enhancement of healthcare professionals' skills, and improvement in clinical competence (10). The decision between multimedia and instructional booklet approaches is pivotal in medicine (11). The main problem addressed in this study is the lack of adequate radiation safety knowledge and training among operating room staff. Despite the increasing use of radiation in medical procedures, many healthcare professionals remain unaware of proper safety protocols, which can lead to significant health risks for both staff and patients (11). Occupational radiation exposure poses serious health threats to medical staff, including long-term disabilities and increased cancer risk (12). Addressing this issue is crucial for safeguarding their health and well-being. Implementing effective training programs can bridge this gap, ensuring staff have the necessary skills and knowledge to minimize exposure (13).

By comparing multimedia educational approaches with traditional instructional booklets, this research aimed to identify the most effective training method for enhancing understanding and compliance with radiation safety protocols. This could lead to better educational strategies tailored to the needs of healthcare professionals. The findings could also inform policy decisions regarding mandatory training programs in radiation safety, ultimately contributing to improved occupational health standards in Iran's healthcare system. Moreover, as technology advances, educational methodologies also change. This research explored how multimedia tools can improve learning experiences and outcomes, potentially establishing a benchmark for future training initiatives in the medical field.

Methods

Study Design

The present study is a literature review of research articles published in Persian and English-language scientific journals in Iran from 2014 to 2024. This ten-year timeframe allows for an in-depth analysis of the latest developments, trends, and advancements in various fields of study.

Search Strategies

Studies were searched using databases such as Science Direct, PubMed, Scopus, the ERIC database, and the Google Scholar search engine, as well as by looking for articles in the SID and Magiran databases.

To find articles focused on enhancing online learning for training operating room staff in radiation safety, various keywords were utilized: 'Radiation Safety Training,' 'Multimedia Learning,' 'Instructional Booklets,' 'Operating Room Staff,' 'E-learning in Healthcare,' and 'Comparative Educational Approaches.' These keywords helped identify relevant literature that addresses critical aspects of radiation safety and educational methodologies in medical settings.

Sampling

Inclusion criteria focused on full-text English and Persian language publications in the field of radiological safety training for operating room staff published in peer-reviewed academic journals. The selected articles were chosen from reputable journals, and the types of articles included semi-experimental studies, review studies, experimental studies, clinical trials, and descriptive studies. Gray literature and articles that contained only abstracts were excluded from the study.

Tools/Instruments

Two educational specialists reviewed the articles using the SANRA Checklist. Moreover, feedback from a peer with expertise in educational research was incorporated to enhance reliability.

Results

Out of the 36 articles retrieved from scientific databases, 16 interventions and descriptive and review articles that met the appropriate entry criteria were selected for examination. The article selection process is illustrated in Figure 1.

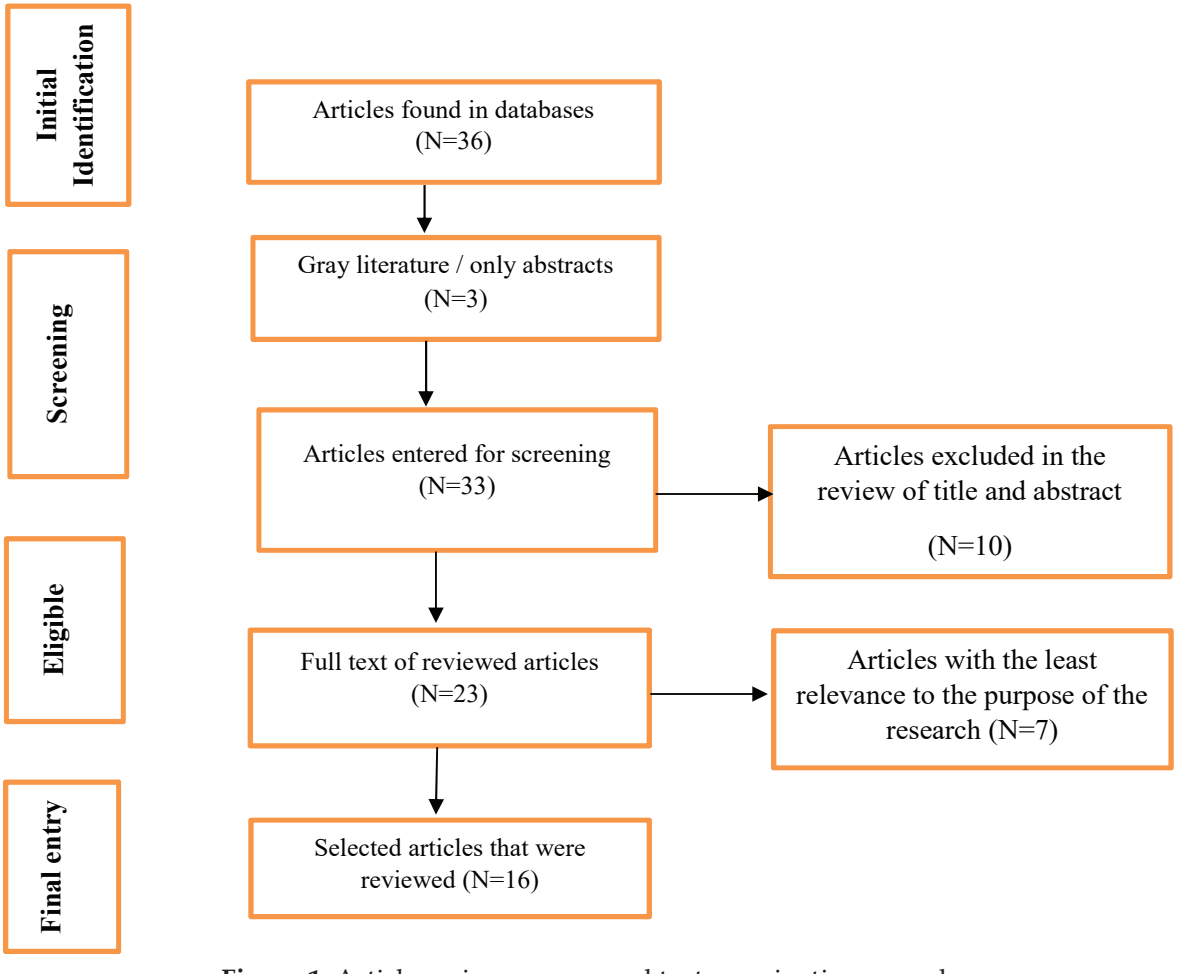

Figure 1: Article review process and text examination procedure

All relevant articles published within the specified timeframe were included in the study. Articles that did not align with the research objectives or whose full texts were unavailable, including letters to the editor, were excluded. After applying the inclusion criteria, the full texts of the selected articles were reviewed, and a summary was prepared that included the primary researcher's name, publication year, study population, and study results (Figure 1).

In this study, 16 articles meeting the criteria related to multimedia versus instructional booklet approaches in radiological safety training for operating room staff were selected, and their results were discussed. The included studies encompass a variety of research designs, with semi-experimental studies being the most common (six articles), followed by clinical trials (three articles). Additionally, there were two randomized controlled experimental studies, one cluster randomized trial, one experimental study, two review studies, and three descriptive studies. In terms of geographical distribution, Iran had the highest number of studies (six articles), reflecting a strong research focus on nursing education and professional development in the country. Other studies originated from Taiwan (two articles), Egypt (two articles), the USA (one article), the United Kingdom (one article), Saudi Arabia (one article), China (one article), and Japan (one article). The results of the studies are detailed in Table 1.

The results of 16 studies on radiation safety training for healthcare professionals emphasize the significance of diverse educational approaches in improving knowledge and practices. Comprehensive strategies for radiation safety education were found to significantly enhance the qualifications and competencies of medical professionals, ensuring adherence to strict guidelines (11). Training courses were positively associated with improved knowledge and performance among radiologists and operating room staff (16). Innovative methods, such as visualizing 3D and 4D radiation dispersion, enhanced the understanding of invisible radiation hazards (17). Multimedia training outperformed traditional lectures in raising awareness and attitudes among nurses (18), while online multimedia education significantly improved knowledge and performance in intensive care settings (19). Studies also highlighted the cost-effectiveness and flexibility of online education for healthcare professionals (23). Both multimedia and lecture-based teaching methods effectively enhanced knowledge in emergency triage, though no significant difference was observed between them. Virtual reality emerged as a promising tool for providing hands-on experience without radiation exposure (24). Multimedia training also improved learning outcomes, satisfaction, and knowledge retention in pain assessment and bioterrorism awareness (25). Social media-based virtual education demonstrated its potential to increase awareness and performance regarding X-ray protection. Educational booklets were found to significantly improve knowledge and behavior regarding radiation safety management among nurses (27). However, electronic learning surpassed traditional booklets due to its interactive nature, leading to better knowledge acquisition and retention (7). Despite these advancements, some studies revealed insufficient awareness and practices regarding radiation protection among healthcare personnel, highlighting the need for enhanced educational programs (22). These findings highlight the critical role of tailored educational approaches—from multimedia tools to virtual reality—in fostering a safety culture and improving radiation protection practices across healthcare settings.

Discussion

This review study compared and determined the impact of training on radiation protection principles using two methods: multimedia and instructional booklet, on the awareness of operating room staff. The identified significant disparity in mean knowledge scores post-intervention between the control groups, particularly those exposed to multimedia training in most intervention

Table 1: Summary of the study results

	Author(s)	Type of Study	Population	Results	Country	Year
1	Ajorlou **and** colleagues (14)	Semi-experimental study	50 nurses working in emergency departments or crisis committees	In this study, multimedia and lecture-based teaching methods enhanced the knowledge of military nurses in the triage field for casualties in biological disasters. However, the significant difference between these two methods in increasing knowledge was not observed.	Iran	2024
2	Gomarverdi and colleagues (15)	Cluster randomized trial	ICU nurses from two different hospitals (n=15 in the experimental group)	The multi-component educational intervention significantly improved ICU nurses' knowledge and adherence to standard precautions.	Iran	2024
3	Martin and colleagues (11)	Review study	Health professionals	Implementing a comprehensive strategy for radiation safety education and training has been recognized as a pivotal factor in enhancing the qualifications and competency of medical professionals. This approach ensures adherence to stringent guidelines, promoting excellence and safety in ionizing radiation for medical purposes.	USA	2022
4	Keshtkar and colleagues (16)	Semi-experimental study	328 radiologists and operating room personnel of educational hospitals	The study revealed significant associations between the completion of radiation protection training courses and knowledge and personnel performance. Furthermore, a meaningful correlation was identified between awareness of radiation protection principles and performance.	Iran	2021
5	Fujibuchi (17)	Experimental study	Operating room personnel	The study revealed that visualizing 3D and 4D scattered radiation distributions within radiological examination rooms facilitated a deeper understanding of the dispersion of invisible radiation. The findings suggested that this visualization method effectively educates individuals about radiation protection.	Japan	2021
6	Thabet and colleagues (18)	Semi-experimental study	45 pediatric nurses	The study results indicated a notable enhancement in the level of awareness and attitude within the multimedia group compared to the lecture group.	Egypt	2021

	Author(s)	Type of Study	Population	Results	Country	Year
7	Haghighi-moghadam and col-leagues (19)	Clinical trial	80 nurses	Online education in the multimedia format used in this study has had a positive and significant impact on nurses' knowledge and performance in implementing the CAM-ICU criterion in the intensive care unit.	Iran	2021
8	Purteimure and colleagues (20)	Semi-experimental study	58 nurses of the pediatric intensive care unit	The study demonstrated that multimedia education positively and significantly impacted pediatric intensive care nurses' use of personal protective equipment. It played an effective role in improving and safer implementing procedures.	Iran	2021
9	Chang and colleagues (21)	Randomized controlled experimental study	Senior nursing students at a private university in Taiwan (n = 66)	The e-book group showed significantly higher scores in sexual harassment prevention knowledge ($p<0.05$), prevention strategies ($p<0.01$), and ARCS motivation ($p<0.001$) compared to the control group.	Taiwan	2021
10	Salah Eldeen and colleagues (22)	Descriptive	195 medical staff working in diagnostic radiology, clinical oncology, and nuclear medicine departments	The study's results showed that the average awareness of employees in each of the three sectors regarding radiation protection methods was 51.3%, and the safe performance against ionizing radiation was 18%. The findings indicate that the awareness and performance of healthcare personnel regarding protection against ionizing radiation in some departments are not sufficiently satisfactory, highlighting the need for educational programs to enhance their awareness and performance in this area.	Egypt	2020
11	Alghamdi and colleagues (23)	Descriptive study	196 healthcare professionals	Online education can offer a cost-effective and efficient way to deliver targeted training, reducing the need for physical infrastructure and allowing professionals to learn at their own pace.	Saudi Arabia	2020
12	Cryer and colleagues (24)	Review study	Health care professionals	Virtual reality is proposed to allow workers to explore an accurate representation of the area and gain experience without undue radiation exposure.	United King-dom	2019

	Author(s)	Type of Study	Population	Results	Country	Year
13	Tsung-Lan chu and colleagues 25))	Semi-experimental study	68 Nurses	Based on the results of this study, it can be concluded that multimedia training positively impacted learning pain assessment in new nurses. A comparison of satisfaction scores showed that nurses who received multimedia training had higher satisfaction scores than the control group, which was statistically significant. Additionally, nurses' knowledge of pain assessment in the intervention group was significantly higher than the control group. These results indicate that the use of multimedia methods, along with classroom training and lectures, leads to increased satisfaction scores and improved knowledge of nurses in pain assessment.	Taiwan	2019
14	Jannati Esfahani and colleagues (26)	Descriptive	12 Physician (six general practitioners and six non-radiologist specialists)	Teaching radiation protection as a meaningful continuing education program has a significant impact on increasing the radiation knowledge of physicians. It can contribute to improving radiation protection practices in their professional activities.	Iran	2018
15	Lee and colleagues (27)	Clinical trial	42 nurses of the special care department	Using an educational booklet in radiation safety training has positively and meaningfully impacted nurses in the special care unit. Compared to the control group, the educated group showed improved knowledge and behavior regarding radiation safety management and awareness of radiation hazards. These changes were statistically significant. The results indicate that an educational booklet, as an effective teaching tool, can contribute to enhancing knowledge and changing behavior in the field of radiation safety management, and increasing awareness of radiation hazards among nurses in the special care unit.	China	2017
16	Badiei and colleagues (7)	Clinical trial	123 nurses from the internal medicine and endocrinology units	The findings of the study suggest that electronic learning enhances knowledge acquisition and retention to a greater extent compared to booklets. Advocates argue that electronic learning surpasses traditional methods because it provides suitable interactions and visually captivating virtual environments, stimulating learning and enhancing retention.	Iran	2016

studies, underscores multimedia-based educational methods' potential impact and effectiveness. This observation suggests that multimedia training has a notable influence on improving the knowledge levels of the operating room staff compared to traditional methods or control groups. In line with these findings, Badiee and colleagues demonstrated that electronic training can significantly enhance nurses' knowledge compared to the control group. Furthermore, the results indicated a more favorable retention rate following electronic training (7). Online learning provides unparalleled accessibility, allowing operating room staff to engage in training regardless of their geographical location or work schedule. This flexibility is crucial for healthcare professionals, enabling them to acquire knowledge at their own pace without disrupting their work commitments (28, 29). Online learning often incorporates multimedia elements such as videos, interactive simulations, and virtual reality. These multimedia methods enhance engagement and understanding by providing a dynamic and immersive learning experience. Compared to traditional training booklets, online learning can deliver content in a more visually stimulating and memorable way (30). Cryer and colleagues proposed virtual reality to enable workers to explore an accurate representation of the area. Virtual reality allows workers to gain experience without undue radiation exposure (24).

Online platforms allow for the customization of learning content based on individual needs and learning styles. Operating room staff may have varied levels of expertise and preferences for learning. Online modules can be tailored to cater to these differences, ensuring a more personalized and effective learning experience (29). Online learning platforms often include real-time assessment tools and feedback mechanisms. This allows operating room staff to receive immediate feedback on their understanding of radiation protection principles. The ability to track progress and promptly address misconceptions contributes to a more effective learning process compared to traditional booklets (31). Alghamdi and colleagues emphasized that online education can provide a cost-effective and efficient method for targeted training. This approach reduces the reliance on physical infrastructure and enables professionals to learn at their own pace (23).

Online learning eliminates the need for printing and distributing physical booklets, reducing costs associated with training materials. Additionally, the accessibility of online courses minimizes the need for travel and venue expenses, making it a cost-effective option for both the institution and the staff. In a rapidly evolving field like healthcare, the importance of up-to-date information cannot be overstated. Online learning platforms can easily update content to reflect the latest advancements in radiation protection principles. This ensures that operating room staff have the most current and relevant knowledge (30, 32). Purteimure and colleagues demonstrated a significant and positive impact of multimedia-based training on increasing the use of personal protective equipment by pediatric intensive care unit nurses. It played an effective role in the better and safer implementation of procedures (20)ÿ ÿ©uSz\^. Online learning platforms often incorporate learning analytics, allowing administrators to track participants' progress and identify areas requiring additional focus. This data-driven approach enables institutions to continuously refine and improve the training program, ensuring its ongoing effectiveness (32).

This review study evaluated the impact of two training methods—multimedia and instructional booklets—on the awareness of operating room staff regarding radiation protection principles. The findings revealed a significant improvement in knowledge scores among those who received multimedia training compared to control groups, highlighting the effectiveness of multimedia-based educational approaches. Additionally, electronic training was shown to enhance knowledge retention and accessibility, allowing staff to learn at their own pace without disrupting their work

schedules. Online learning platforms offer dynamic and immersive experiences catering to individual learning styles while providing real-time assessments and feedback.

Limitations and Suggestions

While the ten-year timeframe of this review provides a comprehensive overview of recent developments, trends, and advancements in radiological safety training, it is essential to note that the study's scope is limited to articles published in Persian and English-language scientific journals published in Iran. This geographic and language restriction may result in potentially omitting relevant research outside these parameters. The exclusion of articles in languages other than Persian and English may limit the inclusivity of the review, potentially overlooking valuable contributions from non-English-speaking regions. Additionally, the diversity in the study designs, encompassing semi-experimental, review, experimental, clinical trials, and descriptive studies, while providing a breadth of perspectives, may pose challenges in directly comparing and synthesizing findings across different methodologies.

To enhance the robustness of future studies, researchers may consider incorporating a longitudinal component to assess the long-term retention and application of knowledge gained through multimedia training. Follow-up assessments conducted weeks or months after the intervention could provide insights into the sustainability of the observed improvements in knowledge scores. Furthermore, investigating the correlation between increased knowledge scores and actual on-the-job practices could offer a more comprehensive understanding of the practical implications of multimedia-based education in radiation protection. Additionally, exploring the perspectives and feedback of participants regarding the effectiveness and user-friendliness of the multimedia tools employed could contribute valuable insights for refining and optimizing educational interventions.

Conclusion

Most reviewed studies indicated online learning is more effective in teaching radiation protection principles than traditional methods, including booklets. The accessibility, multimedia richness, tailored learning experience, real-time assessment, cost-effectiveness, currency of content, and learning analytics contribute to the superiority of online learning in providing comprehensive and impactful education for operating room staff in the context of radiation protection.

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Authors' Contribution

AN and TA designed the study, drafted the manuscript and collected the data. Both authors analyzed the data and finalized the manuscript. All authors reviewed the manuscript and approved the final version. They take full responsibility for the content and writing of this article.

Conflict of Interest

There is nothing to declare.

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Availability of Data and Materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

1 Stamatopoulou-Robbins S. Occupational hazards. Comparative Studies of South Asia, Africa and the Middle East. 2014;34(3):476-96 .doi:10.1215/1089201X-2826049.

2 Rai R, El-Zaemey S, Dorji N, Rai BD, Fritschi L. Exposure to Occupational

Hazards among Health Care Workers in Low- and Middle-Income Countries: A Scoping Review. Int J Environ Res Public Health. 2021;18(5):2603. doi: 10.3390/ijerph18052603. PubMed PMID: 33807727; PubMed Central PMCID: PMC7967386.

3 Ko S, Chung HH, Cho SB, Jin YW, Kim KP, Ha M, Bang YJ, Ha YW, Lee WJ. Occupational radiation exposure and its health effects on interventional medical workers: study protocol for a prospective cohort study. BMJ Open. 2017;7(12):e018333. doi: 10.1136/bmjopen-2017-018333. PubMed PMID: 29248885; PubMed Central PMCID: PMC5778344.

4 Rosen EM, Day R, Singh VK. New approaches to radiation protection. Front Oncol. 2015;4:381. doi: 10.3389/fonc.2014.00381. PubMed PMID: 25653923; PubMed Central PMCID: PMC4299410.

5 Imani B, Vanaki Z, Mohamdkhan Kermanshahi S, Karampourian A. The correlation between nurses' clinical competency and emotional intelligence in nurses of health care units in Hamadan University of Medical Sciences hospitals. Nursing Management Quarterly. 2018;7(3):27-34. Available from: http://ijnv.ir/article-1-553-en.html.

6 Hobbs JB, Goldstein N, Lind KE, Elder D, Dodd GD 3rd, Borgstede JP. Physician Knowledge of Radiation Exposure and Risk in Medical Imaging. J Am Coll Radiol. 2018;15(1 Pt A):34-43. doi: 10.1016/j.jacr.2017.08.034. PubMed PMID: 29100884.

7 Badiei M, Gharib M, Zolfaghari M, Mojtahedzadeh R. Comparing nurses' knowledge retention following electronic continuous education and educational booklet: a controlled trial study. Med J Islam Repub Iran. 2016;30:364. PubMed PMID: 27493908; PubMed Central PMCID: PMC4972056.

8 Khamparia A, Pandey B. Impact of interactive multimedia in E-learning technologies: Role of multimedia in E-learning. Digital multimedia: concepts, methodologies, tools, and applications: IGI Global; 2018. p. 1087-110. Available from: https://www.igi-global.com/chapter/impact-of-interactive-multimedia-in-e-learning-technologies/189518.

9 Ongor M, Uslusoy EC. The effect of multimedia-based education in e-learning on nursing students' academic success and motivation: A randomised controlled study. Nurse Educ Pract. 2023;71:103686. doi: 10.1016/j.nepr.2023.103686. PubMed PMID: 37441919.

10 Mayer RE. Using multimedia for e-learning. Journal of computer assisted learning. 2017;33(5):403-23. doi: 10.1111/jcal.12197.

11 Martin CJ, Vassileva J, Vano E, Mahesh M, Ebdon-Jackson S, Ng KH, Frush DP, Loose R, Damilakis J. Unintended and accidental medical radiation exposures in radiology: guidelines on investigation and prevention. J Radiol Prot. 2017;37(4):883-906. doi: 10.1088/1361-6498/aa881e. PubMed PMID: 28836506.

12 Allam SME, Algany MMA, Khider YIA. Radiation safety compliance awareness among healthcare workers exposed to ionizing radiation. BMC Nurs. 2024;23(1):208. doi: 10.1186/s12912-024-01858-4. PubMed PMID: 38539157; PubMed Central PMCID: PMC10967037.

13 Martin CJ, Marengo M, Vassileva J, Giammarile F, Poli GL, Marks P. Guidance on prevention of unintended and accidental radiation exposures in nuclear medicine. J Radiol Prot. 2019;39(3):665-695. doi: 10.1088/1361-6498/ab19d8. PubMed PMID: 30991380.

14 Ajorlou E, Habibi H, Pishgooie SAH, Seyedi R. Comparative Evaluation of Multi-Media and Lecture Based Learning on Military Nurses' Knowledge in Triage of Biological Disasters. Military Caring Sciences. 2020;7(4):319-29. doi: 10.52547/mcs.7.4.319.

15 Gomarverdi S, Khatiban M, Bikmoradi A, Soltanian AR. Effects of a multi-component educational intervention on

nurses' knowledge and adherence to standard precautions in intensive care units. J Infect Prev. 2019;20(2):83-90. doi: 10.1177/1757177419830780. PubMed PMID: 30944592; PubMed Central PMCID: PMC6437335.

16 Keshtkar M, Masoumi H. Evaluation of knowledge and practice of radiographers and operating room personnel about radiation protection: importance of training courses. Frontiers in Biomedical Technologies. 2021;8(4):311-316 .doi. org/10.18502/fbt.v8i4.7759.

17 Fujibuchi T, Ueda K, Kadoyanagi S, Ueno D, Nakamura C. [Examination of Application to Radiation Protection Education by Four-dimensional Visualization of Scatter Distribution in Radiological Examination Using Virtual Reality]. Nihon Hoshasen Gijutsu Gakkai Zasshi. 2019;75(11):1297-1307. Japanese. doi: 10.6009/jjrt.2019_JSRT_75.11.1297. PubMed PMID: 31748455.

18 Mohamed Thabet A, Bahig Anwr D, Ahmed Sayed Z, Mohamed Ahmed Ayed M. Effect of an Educational Program through a Lecture versus Multimedia Methods on PediatricNurses' Knowledge and Attitude regarding Acute Pain Manageme. Egyptian Journal of Health Care. 2021;12(3):86-101. doi: 10.21608/ejhc.2021.185985.

19 Haghighimoghadam Y, Ahmadzadeh J, Rezapanah A. A comparative study of using multimedia and traditional methods on nurses' knowledge and performance in applying the cam-icu criterion in the patients admitted to intensive care units of educational-medical centers of khoy university of medical sciences in 2020-2021. Nursing And Midwifery Journal. 2022;19(12):964-75 doi:10.52547/unmf.19.12.964. [In Persian]

20 Purteimure S, Mohammadpuri M, Zeynali J, Ghanipour Badelbuu S. The effect of multimedia training on the observance of aseptic principles and the use of personal protective equipment in neonatal intensive care units among nurses working in Shahid Motahari hospital in Urmia in 2019. Nursing and Midwifery Journal. 2021;19(7):558-67. doi: 10.52547/unmf.19.7.5. [In Persian]

21 Chang TS, Teng YK, Chien SY, Tzeng YL. Use of an interactive multimedia e-book to improve nursing students'' sexual harassment prevention knowledge, prevention strategies, coping behavior, and learning motivation: A randomized controlled study. Nurse Educ Today. 2021;105:104883. doi: 10.1016/j.nedt.2021.104883. PubMed PMID: 34218069.

22 NG SE, SA F. Assessment of awareness and practice of ionizing radiation protection procedures among exposed health care workers. Egyptian Journal of Occupational Medicine. 2020;44(1):529-44. doi: 10.21608/ejom.2020.67771.

23 Alghamdi A, Alsharari Z, Almatari M, Alkhalailah M, Alamri S, Alghamdi A, et al. Radiation risk awareness among health care professionals: an online survey. Journal of Radiology Nursing. 2020;39(2):132-8. doi:10.1016/j.jradnu.2019.11.004.

24 Cryer A, Kapellmann-Zafra G, Abrego-Hernández S, Marin-Reyes H, French R, editors. Advantages of virtual reality in the teaching and training of radiation protection during interventions in harsh environments. 2019 24th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA); 2019: IEEE.

25 Chu TL, Wang J, Lin HL, Lee HF, Lin CT, Chieh LY, Sung YC, Lin YE. Multimedia-assisted instruction on pain assessment learning of new nurses: a quasi-experimental study. BMC Med Educ. 2019;19(1):68. doi: 10.1186/s12909-019-1496-z. PubMed PMID: 30832632; PubMed Central PMCID: PMC6398238.

26 Janati Esfahani A, Mehrabi R, Gheibi N, Paydar R, Aliakbari M, Bagheri FS, et al. The Effectiveness of a Radiation Safety Training Program in Increasing the Radiation Safety Knowledge of Physicians: A Pilot Study. The Journal

of Qazvin University of Medical Sciences. 2020;24(1):32-43. doi: 10.32598/JQUMS.24.1.4.

27 Lee JE, Kim SH. Effects of radiation safety management education with the use of a booklet for intensive care unit nurses. J Korean Crit Care Nurs. 2017;10(2):1-13 .doi: 10.0000/jkccn.2017.10.2.1

28 Singh V, Thurman A. How many ways can we define online learning? A systematic literature review of definitions of online learning (1988-2018). American Journal of Distance Education. 2019;33(4):289-306 doi:10.1080/08923647.2019.1663082.

29 O'Doherty D, Dromey M, Lougheed J, Hannigan A, Last J, McGrath D. Barriers and solutions to online learning in medical education - an integrative review. BMC Med Educ. 2018;18(1):130. doi: 10.1186/s12909-018-1240-0. PubMed PMID: 29880045; PubMed Central PMCID: PMC5992716.

30 Liu Q, Peng W, Zhang F, Hu R, Li Y, Yan W. The Effectiveness of Blended Learning in Health Professions: Systematic Review and Meta-Analysis. J Med Internet Res. 2016;18(1):e2. doi: 10.2196/jmir.4807. PubMed PMID: 26729058; PubMed Central PMCID: PMC4717286.

31 Hodges CB, Moore S, Lockee BB, Trust T, Bond MA. The difference between emergency remote teaching and online learning. 2020. Available from: https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning.

32 Simonson M, Zvacek SM, Smaldino S. Teaching and learning at a distance: Foundations of distance education 7th edition. US: IAP; 2019.