Effect of an Educational Program on Nurses' Awareness Regarding Bioterrorism Preparedness

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ABSTRACT

Background: Bioterrorism is considered one of the recent global threats. Nurses should be ready because they are one of the first lines facing that. **Aim:** To examine the effect of an educational program on nurses' awareness regarding bioterrorism preparedness. **Design**: A quasi experimental pre/post-test research design. **Setting**: General Medical Center and Maternal and Child Health Care Center in Sakhaa, Kafr El-Sheikh City. **Sample**: A sample of convenience of 50 nurses. **Tool I:** A structured interview questionnaire in two parts. First part: Nurses' personal data. Second part: Nurses' knowledge regarding bioterrorism preparedness **Tool II**: Bioterrorism preparedness behavior and practices reported checklist included two parts. First part: Nurses reported behaviors during bioterrorism attack. Second part: Nurses reported practices during bioterrorism attack. **Tool III**: Nurses' bioterrorism management awareness scale. **Results**: 50% of nurses were in the age of 20-30 years, with mean 28.35±7.92 years. The good level of knowledge improved from 8% pre to 64% post program, the satisfactory reported behaviors and practices total score improved from 24% pre to 86% post program, and the high level of awareness improved from 16% pre to74% post program with a significant difference between the two phases of study at p≤0.001. **Conclusion:** The nurses' knowledge, practice and awareness regarding bioterrorism preparedness had improved after exposing to the educational program compared to their pre-program levels. **Recommendations:** Periodical up to date programs for enhancing the nurses` knowledge and skills about bioterrorism preparedness. Conducting larger risk assessment and disaster management plans in all (primary, secondary, and tertiary) health care organizations.

Keywords: Educational Program, Nurses' Awareness, Bioterrorism Preparedness.

Introduction:

Bioterrorism aims to produce death or disease in humans, animals, or plants through the intentional use of living microorganisms or their derived toxins. Bioterrorism could be declared or undeclared. Declared bioterrorism involves an announcement by the presence of a new released agent; leading to emerging many circumstances

which increase the responsibilities of the healthcare team to recognize the susceptible dangers from the pathogenicity of this uncommon agent. The first line of healthcare providers as physicians, nurses, and all the allied heath team usually expose to those infected patients with the unusual pathogen and to give them adequate information to manage the situation and avoid the unneeded fear and to reduce further exposure of people and healthcare providers as well (**Shaw, 2019 & WHO, 2020).**

The new technology helps in the emergence of new fatal weapons which makes the bioterrorism to be new shaped in many dimensions. In case of using in war, it can lead to unpredicted losses and high mortality (**Pejmankhah & Mirhaghi, 2018).** Therefore, the health care disaster teams need to be well prepared. Accessibility to updated information sources, efficient resources including the well trained personnel would reduce the mortality from the attacks of bioterrorism (**Adib, et al., 2017).**

The preparedness to bioterrorism is all the designed activities to maintain a proper control over any emergency situations come from this human made disasters and to make a framework for helping the risky persons to avoid or to be recovered from its bad impact. The optimum management of disasters is to be perfectly prepared to deal with the situation prior to, also to handle the problem during and after its occurrence (**Atakro et al., 2019).**

The reinforcement of medical team knowledge to diagnose and take rapid action toward these emergency events is the best way in facing bioterrorism (**Aghaei, & Nesami, 2013).** Nurses are the largest group of health care professionals as they are at the forefront of treatment during bioterrorism. Community Health Nurses (CHNs) can discover and face the bizarre signs and symptoms. CHNs can competently manage any actual or potential biological threats through the early detection or doubts of the presence of biological threats (**Abd-El Azeem et al., 2018**). Meanwhile, the nurses should have the needed knowledge to be able to face such phenomena and this type of threats should be included in the plan of disaster management (**Pourvakhshoori et al., 2017).** Nursing career awareness could increase the level of health security in any country because they are the most group should be aware about the bioterrorism. Many methods of education can be used to deliver bioterrorism information to empower nurses in such type of crises (**Agha & Nesam, 2018).**

Florence Nightingale in the Crimean War highlighted that nurses are historically linked to the provision of care during crises. Nurses are at the forefront of the disasters' response in any healthcare setting. The main goal of nurses' role during disaster is ensuring the highest achievable level of care through identifying, advocating, and caring for all the affected people throughout all disaster phases, including active participation in all levels of disaster from planning, preparedness,

implementation of activities and evaluation as well. (**Nyamathi et al., 2019**).

Significance of the study:

Primary healthcare is the first point of contact for individuals seeking healthcare services and is considered the foundation of a well-functioning healthcare system. It is a comprehensive and holistic approach to healthcare that focuses on the overall well-being of the individual, rather than just treating specific illnesses or conditions. Primary healthcare services are provided by healthcare professionals such as general practitioners, nurses, and community health workers and are typically delivered in a community setting, such as a community health center or a primary care clinic. These services include preventative care, such as immunizations and screenings, as well as the diagnosis and treatment of common illnesses and injuries. Additionally, primary healthcare providers also play a key role in coordinating care for individuals with chronic conditions and in providing education and support to help individuals manage their health. (**Van & Kidd, 2018**).

Bioterrorism poses a significant threat to citizens' health of worldwide and can be a disaster that requires specific preparations that go beyond normal medical disaster planning (**Chopra, et al., 2011**). In the present, the possibility of using biological weapons in terrorism is a real. The known Biological weapons included the use of infectious agents and toxins such as anthrax, smallpox, and sax toxin (**Anderson, 2012**).

Because the nurses did not frequently see patients who exposed to biological agents, the establishment of bioterrorism education program becomes very urgently crucial (**Anderson 2012; Lee, et al., 2008**). Recent research findings have revealed the poor level of nurses' knowledge regarding dealing with biological weapons (**Bork & Rega, 2012**). Although nurses are the first group faced the bioterrorism events and have more willing to treat its affected patients, their participation in preparedness has not been well evaluated (**Rebmann & Mohr, 2010; Grimes & Mendias, 2010**). So, the current study conducted aiming to examine the effect of bioterrorism education program on knowledge and practice of nurses.

Aim of The study:

To examine the effect of an educational program on nurses' awareness regarding bioterrorism preparedness through:

- Assess the nurses' knowledge, practices, and awareness regarding the concept of bioterrorism preparedness.
- Design and implement educational program regarding the concept of bioterrorism preparedness among the CHNs.
- Evaluate the effect of educational program on knowledge, practices, and awareness among CHNs regarding bioterrorism preparedness.

Research hypothesis:

Nurses will exhibit improvement in knowledge, practices, and awareness post exposing to educational program regarding bioterrorism

preparedness compared to their pre-program levels.

Operational definitions:

Awareness: Refers to the refining of Knowledge and practices regarding the concept of bioterrorism in health care.

Bioterrorism: Refers to the new emerging health biological hazards and risks facing the community which could be prevented by the community health nurses through understanding, analysis, early detection, and planning for management.

Subjects and Methods:

Research design: Quasi-experimental design one group pretest posttest. Quasi-experimental design establishes a relation of cause-and-effect between dependent and independent variables **(Thomas, 2021)**.

Setting: The study was conducted at Kafr El-Sheikh City. In two places, the General Medical Center and Maternal and Child Health Care Center in Sakhaa both are affiliated to Kafr El-Sheikh City. The medical center is two floor building divided each four has about 7 small rooms for clinics, nursing room, male and female toilets and buffet, and large waiting area for people in addition to small garden around. The Maternal and Child Health Care Center is two floor building has 5 small rooms for clinics, nursing room and toilets. The two center provide services for large sector of population in Kafr El-Sheikh city.

Sample type: Sample of Convenience, included all (50 nurses) working in the previous two

mentioned places and accepted to be included in the study.

Tools of data collection:

Tool 1: A Structured interview questionnaire designed in Arabic language by the researcher contained two parts.

First part: Nurses' personal data (age, educational qualifications, years of experience, attended educational training about bioterrorism, awareness of their health care organization bioterrorism preparedness/disaster plan & its content.

Second part: Nurses' knowledge regarding bioterrorism preparedness (pre / post program). It was designed based on the literature; **(Abdelfatah and Ahmed, 2019 and Abdelazeem et al., 2018)** contained (50 Multiple choice questions MCQs) the main items were; Bioterrorism concept and purposes (5 questions)**,** importance (10 questions), principles and teamwork (5 questions), preparation and management (15 questions), hospital plan (5 questions) and management steps (10 questions).

Regarding scoring of tool I: Correct answers scored (1) incorrect answer scored (zero). The total score was calculated (50) and categorized to levels as follows; good level of knowledge ≥65%, average level (50%-65%), and poor level (≤ 50%) of the total score.

Tool II: Bioterrorism preparedness behavior and practices reported checklist (pre/post), designed by researcher based on the steps to bioterrorism prepared (preparation practice) designed by the U. S. Department of Health and

Human services (**Center for Disease Control and Prevention, 2011**) as tendency to stay at work at the event, care and treat the probable victims at the event, cooperate with organization, personal protective clothing, participate in workshops, courses or in-service training courses, disinfect environment, confirmed bioterrorism reporting, isolate and removing patients from isolation, use of alcohol for hands and use of a negative pressure room for air born disease, included two parts.

First part: Nurses reported behaviors during bioterrorism attack, included (6 main behaviors) as (tendency to stay at work at the event of a bioterrorism or biological attack, tendency to care and treat the probable victims at the event of a bioterrorism or biological attack, and tendency to cooperate with the organization in biological defense plans). **Regarding scoring:** Score (1) was given to the positive response and score (zero) was given to the negative response. The total score was calculated and classified into satisfactory (≥60%) and unsatisfactory (<60%).

Second part: Nurses reported practices during bioterrorism attack. It included (5 main practices) as environmental disinfection, bioterrorism reporting, victim isolation and transferring from isolation, using personal protective equipment with hand disinfection procedures, and use of a negative pressure room for air born disease. **Regarding scoring:** Score (1) was given to the correctly done reported practice and score (zero) was given to the incorrect or not done. The total score was calculated and classified into satisfactory (≥60%) and unsatisfactory (<60%).

Regarding Scoring of tool II: The overall Checklist total score was calculated and classified into satisfactory (≥60%) and unsatisfactory (<60%).

Tool III: Nurses' bioterrorism management awareness scale (pre/post): 3-Point rating scale disagree, neutral & agree, adopted from (**Eslim, 2007**) to assess the organizational management plan. This tool was back translated to English to keep the words' accuracy of meaning, included (53 items) divided into five domains as follow: information field (13 items), communications system role (10 items), leadership skills (10 items), establishing teamwork (10 items), and planning field (10 items).

Scorring: Disagree scored (0), neutral scored (1) & agree scored (2). The total score was (106) < 60% of the total score was considered low level of awareness about bioterrorism management, while 60 % or higher was considered a high level.

Validity and reliability:

Content validity of the tools was performed by five experts in the field of nursing administration, and community health nursing, based on the experts' responses and pilot study of the questionnaire, checklists and scale were adjusted and finalized.

Tools' reliability done using Cronbach Alpha test, tool I=0.724, tool II= 0.97, and tool III ranged from 0.620 to 0.868.

Pilot study: In order to test the clarity, comprehensiveness, applicability, and relevance of the study tools, and feasibility of the research process. It was done on 10% (five nurses) at the previous setting. These subjects were included in the study sample as no much modification needed to be done on the used tools. The estimated time for filling in the tools was 20-30 minutes.

Ethical considerations:

The research proposal was approved by the ethical committee of the Faculty of Nursing, Kafr El-Sheikh University. The necessary approval was obtained from the Health Administrators of Kafr El-Sheikh Governorate Health authority to carry out the study. Nurses were informed about the purpose and importance of the study. They also informed about their right of acceptance to participate in the study or not. Strict confidentiality was ensured for all provided information. Verbal consent was obtained from each nurse who agreed to participate before data collection.

Field work:

1-The preparatory and assessment phase:

Reviewing the available literature and studies related to the topic of study using textbooks, evidence-based articles, internet periodicals, and journals. The study tools were designed, revised and validated. Pre-test was used to specify the staff nurses' baseline of knowledge, practices, and awareness about bioterrorism preparedness. The first step in constructing the current program was the statement of the

educational objectives. These objectives were derived from the needs assessment. Data was collected using a written questionnaire which took 30 minutes. The researcher was making the needed guidance and clarifications.

2- Planning phase:

The overall goal of the educational program: The program was aiming to improve knowledge, practices, and awareness among CHNs regarding bioterrorism preparedness.

After baseline assessment was completed, the researcher set the educational program objectives (general and specific), the content and methods of teaching was selected after careful study of nurses' needs. The subject materials were organized according to needs' priority. The selection of teaching methods was carried out according to the subjects and the educational principles. The methods used were lectures, posters, and audiovisual aids. Teaching aids used to help for the attainment of the objectives were booklet and power point presentation.

3- Implementation phase:

The program was conducted during the period from March to May, 2021.

The nurses divided into small groups each small group members ranged between (4-7 nurses) according to the work load.

The duration of the program was four days, one session every day, and one hour for each session. The program was implemented two times for two

training groups held in the two mentioned clinical setting, in a quite well organized room in the second floor with proper ventilation, electricity source for the researcher's personal computer.

The program content includes the following: Bioterrorism concept and purpose, importance of bioterrorism preparedness, principles, teamwork during of bioterrorism preparedness, preparation phases, preparedness plan and management phases of bioterrorism. The program also includes nurses' preparedness behaviors and nurses' practice during bioterrorism attack. Furthermore, it covers the management process of bioterrorism preparedness including the role of information, communication system, leadership skills, teamwork, and planning for managing the bioterrorism attack.

4- Evaluation phase:

By the end of the program, data on nurses' knowledge, practices of bioterrorism preparedness and awareness of the bioterrorism management plan were collected immediate post program and compared with the pretest results. The evaluation was planned to determine the extent to which they have acquired knowledge, practices, and awareness about Bioterrorism preparedness.

Statistical design:

Data entry and statistical analysis were done using SPSS 20.0. Descriptive statistics were presented in form of frequencies and percentages for qualitative variables, and mean and standard deviation for the quantitative variables. Chi-square

X^2 used to compare the qualitative category variables. Pearson r correlation coefficient was used to assess the inter-rater reliability of the study instrument. The level of significance was considered at $p \leq 0.05$.

Results

Table 1: Shows 50% of the nurses aged 20-<30 years, with mean age (28.4±7.9), 62% had secondary school nursing diploma. 52% had (5 to 10) experience years with a mean (7.4±2.2 years). 78% did not have educational programs about bioterrorism, and 76% did not know the hospital plan or its content regarding bioterrorism preparedness.

Table 2: Reveals around (10%-20%) of nurses had correct information pre-program, which improved to (70%- 88%) post program intervention regarding the included six main items of knowledge about bioterrorism preparedness at $p \leq 0.001$.

Figure 1: Shows 8% of nurses had a good level of knowledge pre-program which improved to 64% post program about bioterrorism preparedness with a significant difference between the two phases of study at $p \leq 0.001$.

Table 3: Shows a significant difference between the two study phases regarding nurses' behavior levels as the satisfactory level of behavior represented (20%- 82% pre/post respectively) and a significant difference between the two study phases regarding nurses' practices levels as the satisfactory level of practices represented (26%,

92% pre / post respectively) and the overall total score of both behavior and practice reported checklist represented (24%, 86% pre / post respectively) at p≤0.001.

Table 4: Displays a significant difference between nurses' awareness regarding all the studied five domains about bioterrorism preparedness, pre and post program at p≤0.001.

Figure 2: Shows the high level of awareness among nurses represented (16%, 74% respectively)

pre / post program with a significant difference between the two phases of study at p≤0.001.

Table 5: Displays a significant positive correlation between total nurses' knowledge, practices, and awareness of bioterrorism preparedness' post program intervention at p≤0.001.

Table 1. Nurses' demographic characteristics (n=50)

Demographic characteristics	N	%
Age (Years)		
20 – 30	25	50.0
30 – 40	14	28.0
>40	11	22.0
Mean ±SD	28.4 ± 7.9	
Nurses' qualifications		
Secondary school Diploma in nursing	31	62.0
Technical Institute Diploma with specialist	13	26.0
Bachelor in nursing	6	12.0
Years of experiences		
<5	14	28.0
5 – 10	26	52.0
>10	10	20.0
Mean ±SD	7.4 ± 2.2	
Previous participation in educational training about bioterrorism		
Yes	11	22.0
No	39	78.0
Do you know the plan & content of hospital bioterrorism preparedness?		
Yes	12	24.0
No	38	76.0

Table 2. Comparison between the Nurses' information about bioterrorism pre and post intervention (n=50)

| The 6 main items of knowledge	Pre – Intervention		Post – Intervention		Chi – Square	
	Incorrect	Correct	Incorrect	Correct	X^2	P
	%	%	%	%		
Bioterrorism preparedness concept and purpose	84.0	16.0	12.0	88.0	51.923	<0.001**
Importance of bioterrorism preparedness	80.0	20.0	24.0	76.0	31.410	<0.001**
Principles &Teamwork in bioterrorism preparedness	82.0	18.0	16.0	84.0	43.577	<0.001**
Preparation & management phases of preparedness	88.0	12.0	36.0	64.0	28.692	<0.001**
Bioterrorism preparedness hospital plan	84.0	16.0	28.0	72.0	31.818	<0.001**
Management steps of bioterrorism	90.0	10.0	20.0	80.0	49.494	<0.001**
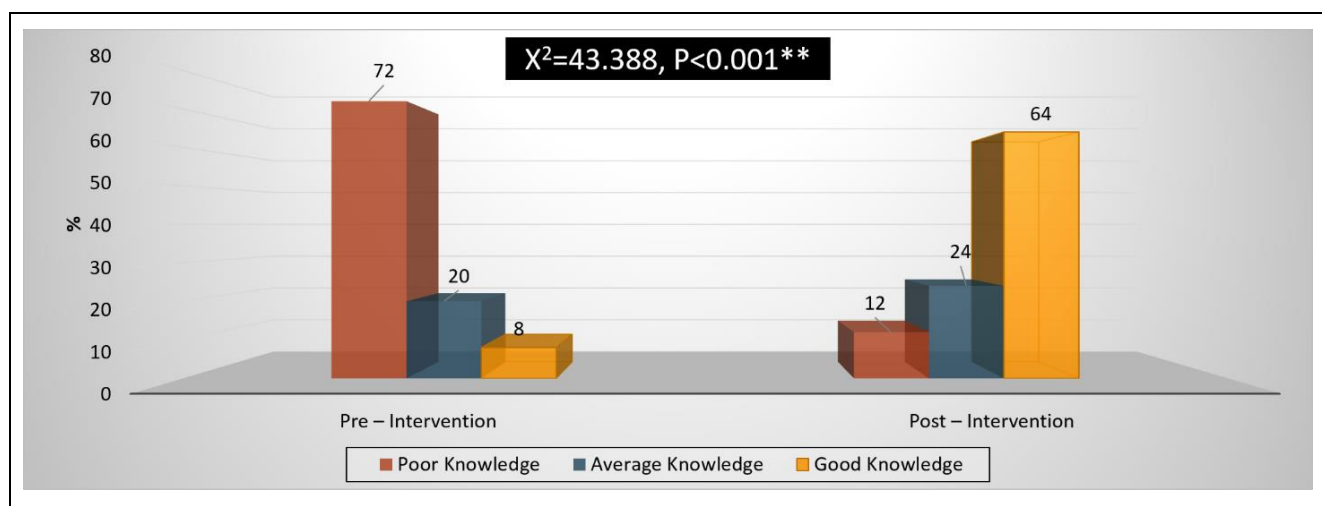
Figure 1. Comparison between the nurses' knowledge levels pre and post intervention (n=50)

Table 3. Comparison between Nurses' behaviors and practices levels pre and post intervention (n=50)

Behaviors and practices' levels	Pre – Intervention		Post – Intervention		Chi – Square	
	N	%	N	%	X^2	P
Nurses' behaviors total scores						
Unsatisfactory	40	80.0	9	18.0	38.455	<0.001**
Satisfactory	10	20.0	41	82.0		
Nurses' practice total scores						
Unsatisfactory	37	74.0	4	8.0	45.018	<0.001**
Satisfactory	13	26.0	46	92.0		
Behaviors and practices' levels						
Unsatisfactory	38	76.0	7	14.0	38.828	<0.001**
Satisfactory	12	24.0	43	86.0		

Table 4. Comparison between Nurses' awareness about bioterrorism pre and post intervention (n=50)

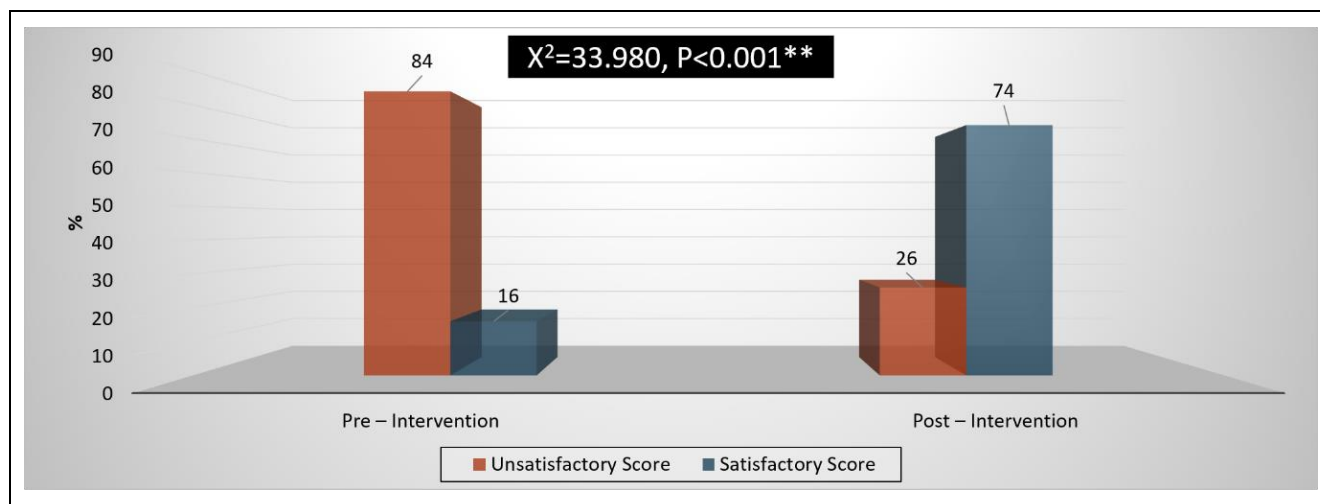| Items	Pre – Intervention			Post – Intervention			Chi – Square / Fisher's exact test	
	Disagree	Neutral	Agree	Disagree	Neutral	Agree	X^2	P
	%	%	%	%	%	%		
Information and its role in bioterrorism preparedness	60.0	24.0	20.0	0.0	24.0	76.0	46.311	<0.001**
Communication system and its role in bioterrorism preparedness	78.0	12.0	10.0	6.0	20.0	74.0	56.238	<0.001**
Leadership skills and its role in bioterrorism preparedness	80.0	16.0	4.0	2.0	18.0	80.0	71.537	<0.001**
Establishing team work and its role in bioterrorism preparedness	62.0	24.0	14.0	0.0	34.0	66.0	48.762	<0.001**
Planning and its role in bioterrorism preparedness	64.0	32.0	4.0	4.0	22.0	74.0	58.806	<0.001**

Figure 2. Comparison between nurses' awareness levels pre and post intervention (n=50)

Table 5. Correlation between Nurses' knowledge with practice and awareness total scores pre and post intervention (n=50)

Total scores	Knowledge		Practice		Awareness	
	r	p	r	p	r	p
Pre – Intervention						
Knowledge	-	-	0.076	0.600	0.113	0.433
Practice	0.076	0.600	-	-	0.048	0.741
Awareness	0.113	0.433	0.048	0.741	-	-
Post – Intervention						
Knowledge	-	-	0.393	0.005*	0.541	<0.001**
Practice	0.393	0.005*	-	-	0.303	0.033*
Awareness	0.541	<0.001**	0.303	0.033*	-	-

Discussion:

The ability to respond efficiently to any bioterrorism attack and its consequences has become a challenge that necessitates a massive national effort. Decreases in morbidity and mortality can be accomplished by prompt medical responses, which need planning, preparation, and continuous training **Clinical Laboratory, Preparedness and response guide, (2016).**

Physicians, nurses, paramedics, and laboratory technicians could be the first healthcare `providers exposed to patients with unusual diseases **Nofal et al., (2021).** So, this study aimed to examine the effect of an educational program on nurses' awareness regarding bioterrorism preparedness.

The results of the present study showed the sample characteristics of young age nurses with a mean score 28.35±7.92 years, years of experience

mean score was 7.36±2.23 years, near two thirds of the studied nurses graduated from secondary nursing schools. More than three quarters of them did not attend training courses regarding bioterrorism and they did not know about their hospital plan regarding the bioterrorism preparedness. This young age could be rationalized as two third of the sample graduated from secondary nursing schools, so they started their nursing career very early in their professional life, this also evidenced with their few years of experience.

This result was congruent with **Abd El Fatah and Ahmed,** (**2019),** who studied "Effect of educational program on nurses` knowledge and awareness of bioterrorism preparedness" on 36 staff nurses in Tanta city at Egypt and found that the majority of participants' age ranged between 21-30 years with mean score 28.55± 6.478. Also, more than half of subjects had 5-10 years of experiences.

These findings were similar to **Nofal et al.,** (**2021),** who studied the "Knowledge and preparedness of health care providers towards bioterrorism." and reported similar age of their study participant, near half of sample was less than 30 years of age with most of them were below ten years of experience, 79.4% of participants did not have previous training about bioterrorism preparedness.

Along with these findings, that of **Chimenya,** (**2018),** who studied "Hospital emergency and bioterrorism preparedness: A study

of Lutheran Hospital" Northern Namibia in which found that (63.7%) did not know whether their hospital had a bioterrorism prepared plan or not, of those who had indicated that the hospital had a bioterrorism prepared plan, 82.4% of them indicated that they were not familiar with the plan contents, while 17.6 % indicated that they were familiar with the content.

The results from the present study revealed that respondents had poor bioterrorism preparedness knowledge related to all bioterrorism preparedness knowledge elements particularly regarding management phases of bioterrorism, preparation phases of bioterrorism preparedness, principles of bioterrorism preparedness, bioterrorism concept, purpose of preparedness, and bioterrorism preparedness hospital plan. This poor knowledge might be referred to the studied nurses' qualification, as near to two thirds of them had a secondary nursing school diploma, so the disaster management might not be included in depth in their curriculum, their young age and fewer years of experience during which they did not exposed to such threat training. On the other side, most of them reported that they did not attend any training courses about bioterrorism nor had awareness about their hospital plans of bioterrorism preparedness.

The results of the present study were in the same line with **Larrimore et al.,** (**2020)** who studied "Knowledge and awareness concerning chemical and biological terrorism: Continuing education implications" and found the participant

had poor bioterrorism preparedness knowledge related to detecting diseases and most nurses had limited knowledge about bioterrorism preparedness. Participant answered correctly less than one quarter of the knowledge questions. Also, less than one quarter of the participants stated having confidence to provide health care in an assumed chemical terrorism situation.

These findings were similar to **Nofal, et al., (2021),** who report that among a total of 1030 participants were included in the final data analysis. The mean knowledge score in the basic concepts of bioterrorism and introductory clinical presentations of bioterrorism-related agents was 4.92±1.86 out of 12 points, and the mean knowledge score of 22.80±3.92 out of 38 in the bioterrorism preparedness and governing policies and procedures.

The comparison between nurses' knowledge pre and post program shows a significant difference between the nurses' knowledge post program compared to their preprogram levels. This finding might be referred to the positive effect of educational program that handle the concept of bioterrorism from all dimensions, the use of illustrative teaching aids, and the handout distributed on the studied nurses. Many studies had supported the positive effect of education on the nurses' knowledge in all areas of bioterrorism such as the concept and nature of bioterrorism, the bioterrorism causal factors, the release of bioterrorism factors, bioterrorism detection, and decontamination of victims **(Lee et**

al., 2008; Bork & Rega, 2012; Jacobson et al., 2010; Rebman & Mohr, 2008; Nyamathi, et al., 2010; Thomas, 2008; Ashford, 2003). These findings strongly supported the research hypothesis.

Regarding to nurses' practices about bioterrorism preparedness, the present study revealed a significant difference post program implementation compared to their pre intervention level of behavior. This behavior improvement might be inferred to the improved knowledge among nurses. These findings and interpretation were agreed with **Pesik et al., (2019),** who studied "Terrorism and the ethics of emergency medical care" and stated the same interpretation that higher knowledge of nurses' staff increased their tendency to respond in bioterrorist attacks. Thus, training was increasing their enthusiasm for relief the contaminated areas.

This finding was contradicting with **Ali et al., (2018),** who studied "Knowledge and practices of Iranian red crescent society volunteers in dealing with bioterrorist attacks", in Iran and found studied nurses would stay at work during a bioterrorist attack, they had the tendency to cooperate with the responsible organizations and they would participate if protective equipment were available. In addition, the studied nurses were willing to take care of the probable victims of bioterrorism attacks. These findings supported the research hypothesis.

Regarding to nurses' awareness about bioterrorism management, most of the nurses did

not agree with bioterrorism preparedness plan in respect to the whole element of the management. In comparison, most of them agreed with all elements of the management plan particularly the leadership skills and its role in bioterrorism, communication system and its role in bioterrorism pre-education program, with statistically significant differences between the two study phases. These findings may reflect the knowledge and practice improvement and the positive effect of education program on the nurses' awareness with all aspects of studied phenomena.

These findings were supported by **Abd El Azeem et al., (2018),** who studied "Awareness of hospital bioterrorism plan among health team members" in A University Hospital" and mentioned a statistically significant difference between nurses` awareness regarding the hospital bioterrorism preparedness pre and post educational program. Preprogram approximately two thirds of nurses was agreed that plan and information have a certain role in bioterrorism preparation. On other hand, less than half of them were unaware the leadership and teamwork skills have a role in bioterrorism preparation while post program, the great majority of them become aware about that the communication and information have a great role in bioterrorism preparation.

Also, **Nates, (2019)** supported the study results in the study "Combined external and internal hospital bioterrorism prepared: Impact and response" in a Houston trauma center intensive care as found that the highest nurses` average was

for the role of information and planning followed by the role of communication system in bioterrorism prepared. On the other hand, the lowest average was for the role of teamwork and the role of leadership in bioterrorism preparedness. The researcher believed that the lack of awareness about the bioterrorism preparedness plan, due to the shortage of the required knowledge and capacity would lead to inability to bioterrorism prepared even if there is a written plan. This plan should be regularly updated, and the staff should be trained through simulation frequently in the hospital. These findings supported the research hypothesis.

Concerning correlation between nurses' knowledge, practices and awareness scores regarding bioterrorism preparedness, there was a significant positive correlation between total nurses' knowledge, practices, and awareness scores post program intervention. This finding might reflect the interrelationship between the three dimensions; thus, the improvement in nurses' knowledge led to awareness and practices' improvement that could be used in the reinforcement of the nurses' awareness regarding the bioterrorism preparedness. This result agreed with the study done by (**Ronald and Michael, 2018),** in the study "Preparedness for emergency response: Guidelines for the emergency planning process" and reported a positive correlation between total nurses` knowledge, practices, and awareness scores pre and post program.

Conclusion:

After exposing to the bioterrorism educational program, the nurses exhibited an obvious improvement in knowledge, practice, and awareness regarding the bioterrorism preparedness compared to their pre-program levels.

Recommendation:

- Elevating the knowledge, practices and awareness of health care providers and training them in the field of biological defense to achieve more efficient battle against probable and emergency bioterrorism attacks.

- Enhancing knowledge and skills regarding facing bioterrorism using workshops and simulations and periodical testing for nurses.

- Accessibility of bioterrorism management plans in all (primary, secondary, and tertiary) health organizations for all staff.

- Integration of the bioterrorism preparedness in the educational curriculums in universities and in continuous education programs.

- Updating the disaster committee regularly with all new in the field for proper planning.

References:

Abd El-Fatah, R. & Ahmed, S. (2019): Effect of Educational Program on Nurses` Knowledge and Awareness of Bioterrorism preparedness, 1 (2), M. Nursing Journal (MNJ) 135: 159

Abdelazeem, H. Adam, S. and Mohamed, G. (2018): Awareness of Hospital bioterrorism Plan among Health Team Members in A University Hospital. Life Science Journal; 8(2)

Adib J, Nehrir B, Vafadar Z. (2017): Effect of educational workshops on improving critical thinking skills in nursing student. J Nurs Educ. 2017; 6 (21):1–8.

Agha, N. &Nesam, M. (2018): Bioterrorism education effect on knowledge and practices of nurses. J Emerg Trauma Shock. 2018; 6(2):78-82

Aghaei, N., & Nesami, M. B. (2013): Bioterrorism education effect on knowledge and attitudes of nurses. *Journal of emergencies, trauma, and shock*, 6(2), 78–82. https://doi.org/10.4103/0974-2700.110747.

Ali, S. Hamzeh, S. Toorchi, M. & Sefidi, Y. (2018): Knowledge and practices of Iranian Red Crescent Society Volunteers in Dealing with Bioterrorist attacks. Emergency J. 2018; 3(1): 1-5

Anderson PD. (2012): Bioterrorism: Toxins as weapons. *J Pharm Pract.* 2012;25:121–9.

Ashford DA, Kaiser RM, Bales ME, Shutt K, Patrawalla A, McShan A, et al (2003): Planning against biological terrorism: Lessons from outbreak investigations. *Emerg Infect Dis.* 2003;9:515–9.

Atakro, C. Addo, S. Aboagye, J. Blay, A. Gyarteng, K. & Menlah, A. (2019): Nurses' and medical officers' knowledge, attitude, and preparedness toward potential bioterrorism attacks. SAGE Open Nurs.2019;5:2377960819844378. https://doi.org/ 10. 1177/ 23779 60819 844378 (Epub 2019/05/03 PubMed PMID: 33415237; Pub Med Central PMCID: PMCPMC7774386).

Bork CE, Rega PP.(2012): An assessment of nurses' knowledge of botulism. *Public Health Nurs.* 2012;29:168–74.

Center for Disease Control and Prevention (2011): Public Health Emergency Response Guide for State, Local, and Tribal Public Health Directors, U. S. Department of Health and Human Serveices. Version 2.0. https://emergency.cdc.gov/planning/pdf/cdcresp onseguide.pdf

Chimenya, T. (2018): Hospital emergency and bioterrorism preparedness: a study of Lutheran Hospital, Northern Namibia Published Masters in bioterrorism Management. Bioterrorism Management Training and Education Center for Africa at the University of the Free State p. 44-54

Chopra K, Conde-Green A, Folstein MK, Knepp EK, Christy MR, Singh DP. (2011): Bioterrorism: Preparing the plastic surgeon. *Eplasty.* 11:47.

Clinical Laboratory, Preparedness and response guide (2021). 8 /1/ 2016. In Nofal et al. (2021): Knowledge and preparedness of healthcare providers towards bioterrorism. BMC Health Serv Res. 2021; 21(1):426.

Eslim, W. (2007): Schemas of crisis management in the Palestinian Governmental institutions: A field survey on the Palestinian Ministry of Finance in Gaza. Critical Care Medicine; 3(8)25-36

Grimes DE, Mendias EP. (2010): Nurses› intentions to respond to bioterrorism and other infectious disease emergencies. *Nurs Outlook.* 58:10–6

Jacobson HE, Soto Mas F, Hsu CE, Turley JP, Miller J, Kim M. (2010): Self-assessed emergency readiness and training needs of nurses in rural Texas. *Public Health Nurs.* 27:41–8.

Larrimore, K. (2020): Knowledge and awareness concerning chemical and biological terrorism: continuing education implications. J Contin Educ Nurs. 2020; 33(6):253– 218.

Lee H, Chun BC, Yi SE, Oh HS, Wang SJ, Sohn JW, et al. (2008): Education of bioterrorism preparedness and response in healthcare-associated colleges-Current status and learning objectives development. *J Prev Med Public Health.* 41:225–31.

Nates, J. (2019): Combined external and internal hospital bioterrorism prepared: Impact and response in a Houston trauma center intensive care unit. Crit Care Med; 32(3)686-690.

Nofal, A. Al-Fayyad, I. Al-Jerian, N. Alowais, J. Al-Marshady, M. & Khan, A. (2021): Knowledge and preparedness of healthcare providers towards bioterrorism. BMC Health Serv Res. 2021; 21(1):426.

Nyamathi AM, Casillas A, King ML, Gresham L, Pierce E, Farb D, et al. (2010): Computerized bioterrorism education and training for nurses on bioterrorism attack agents. *J Contin Educ Nurs.* 41:375–84.

Nyamathi, A. Casillas, A. King, M. Gresham, L. Pierce, E. & Farb, D, (2019): Computerized bioterrorism education and training for nurses on bioterrorism attack agents. J ContinEducNurs. 2019; 41(8):375–84.

Pejmankhah, S, & Mirhaghi, A. (2018): Effect of bioterrorism training through lecture and educational pamphlet on knowledge of medical staff in hospitals of Iranshahr, Iran in 2018). J Health Syst Res. 2018; 8(7):1255–62.

Pesik, N. Keim, M. & Iserson, K. (2019): Terrorism and the ethics of emergency medical care. Ann Emerg Med. 2019); 37(6):6426.

Pourvakhshoori, S. Khankeh, H. Mohammadi, F. (2017): Emergency and disaster

preparedness in nurses: a concept analysis. J Holist Nurs Midwifery. 2017; 27(1):35–43.

Purohit, S. & Mantri, D. (2018): Facilitation of Spatial Database Model for Disaster Management. International Journal of Modeling and Optimization vol.2 no.4 p. 472.

Rebmann T, Mohr LB. (2008): Missouri nurses' bioterrorism preparedness. *Biosecur Bioterror.* 6:243–51.

Rebmann T, Mohr LB. (2010): Bioterrorism knowledge and educational participation of nurses in Missouri. *J Contin Educ Nurs.* ; 41:67–76.

Ronald, W. & Michael, K. (2018): Preparedness for Emergency Response; Guidelines for the Emergency Planning Process. Disasters; 27(4):336-350

Shaw, K. (2019): SARS outbreak and its impact on infection control practices. Public Health 2019 Jan1; 120 (1):8–14. https://doi.org/10.1016/j. puhe.2005.10.002

Texas Health Resources (2018): Critical Care extra. Critical Care Nurse Journal**.;** 101 (5):32.

Thomas JR. (2008). Self-study: An effective method for bioterrorism training in the OR. *AORN J.;* 87:915–24. [PubMed] [Google Scholar]

Thomas, L. (2021). An introduction to quasi-experimental research. Scriber. Available at: https://www.scribbr.nl/onderzoeksmethoden/quasi-experimenteel/

Van Weel, C., & Kidd, M. R. (2018). Why strengthening primary health care is essential to achieving universal health coverage. CMAJ, 190(15), E463-E466.

World Health Organization (2020): First data on stability and resistance of SARS Coronavirus compiled by members of WHO laboratory network. 2020. Available from: http://www.who.int/ csr/sars/survival.