Effect of Training Program about Occupational Health Hazards on Nurses' practice

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Abstract

Background: Healthcare workers operate in an environment that is considered to be one of the most hazardous occupational settings, with possible negative impacts nurses′ practice. Aim of study: to assess the effect of occupational health hazards training program on nurses' practice. Subjects and Methods: Setting: The study was conducted in all inpatient departments of Belbeis Central Hospital El-Sharkia Governorate, Egypt. Design: A quasi-experimental research design. Sample: All available staff nurses (n=130) in the inpatient departments. Tools: two tools were used in data collection: Health hazard knowledge questionnaire, Observation Checklists. Results: Overall, 97.7% of the staff nurses reported exposure to at least one type of occupational hazards. The use of PPE increased from 23.1% pre-intervention phase to 92.3% post-intervention. Conclusion: Staff nurses′ knowledge and practices significantly improved after the program intervention . Recommendations: Applying the training program in similar settings, with continuing education for staff nurses. The hospital administration should correct any deficiencies that could pose occupational hazards to nurses and employees.

Keywords: Occupational health hazards, Practice, Staff nurses, Training program

Introduction

Effective training is a crucial element of effective performance. Its purpose in the work situation is to develop the abilities of the individual and to satisfy the current and future workforce needs at the organization. The main aim of any training will be to achieve some kind of change in knowledge, skills, experience or attitudes that enhances the effectiveness of the employee and thereby improves the economic performance of the country **(Hanon et al., 2022).**

Each year three million healthcare workers (HCW) are exposed to blood borne pathogens through a percutaneous route; two million are known to be exposed to hepatitis B, 900,000 to hepatitis C, and 170,000 to HIV. However, underreporting of injuries can reach 40-75%, so there may be many more unreported cases *(ISO, 2020)*. The National Institute for Occupational Safety and Health (NIOSH) estimated that each year about 100,000 people die due to occupational hazards *(Wyatt et al., 2016)*.

Nurses constitute the largest of the categories of healcare providers in various healthcare services and settings *(Abdi Zarrini et al., 2018)*. Nonetheless, they are the category most likely to be exposed to various workplace hazards *(Opoku et al., 2023)*. The problem is very evident in developing countries where safety practices are often not followed *(Tawiah et al., 2022)*.

Healthcare workers operate in an environment that is considered to be one of the most hazardous occupational settings. In addition to the usual workplace related exposures, healthcare workers encounter diverse hazards due to their work-related activities *(Thirunavukkarasu et al., 2021)*.

Occupational hazard refers to long and short-term risks related to the work environment. Short-term risks may include physical injury, while long-term risks may be increased risk of developing cancer or heart disease *(Huei et al., 2020)*.

The success and the good performance of the health institutions depend, among other factors, on healthy workers who are motivated for the work. The quality of the care and the production of workers who are stressed and/or have occupational illnesses are compromised, as are the institutions, as these cease to provide quality services, due to the high rates of absenteeism and medical leave *(Eliyana and Anwar, 2022)*.

Knowledge, attitudes, and practices make up the dynamic system of life at work. Safe work practices depend on knowledge about the danger and harmful effect of those hazards *(Yesilgul, 2018)*. Nursing staff are in face of relatively weak work environment, high mental and physical pressure, irregular scheduling or shifting, limited job promotion, and social-emotional pressures in connection with the patients and partners and they are dissatisfied from their job and want to have optimal working environments *(Ogbuabor et al., 2022)*.

The problem of occupational hazards among workers in hospital setting is known and several studies have been conducted, and findings published. Meanwhile, much improvement in the workers' health protection has been made in developed countries in the field of industrial hygiene and safety, and occupational medicine, compared to developing and underdeveloped countries. Data on occupational hazards among healthcare workers and their mitigation measures remain scarce in most developing countries *(Denge and Rakhudu, 2022)*.

Having adequate knowledge on hospital workplace hazards and risks, being aware of preventives measures and best practices regarding occupational hazards can help hospital workers to perform better and also help the managers to provide safe working environment for hospital workers *(Olorunfemi et al., 2022)*.

In many studies, it has been reported that there is a relationship between nurses' knowledge and attitudes and the implementation of standard precautions in hospitals *(Oshodi et al., 2019; Jemal et al., 2020)*. The performance of nurses, who constitute a large part of the healthcare industry workforce, is important for both the organization and those receiving the service *(Bhatti et al., 2018; Tong, 2018)*. The performance of nurses is reported to be a priority in the delivery of quality healthcare. The job performance of nurses is a priority issue in delivering quality healthcare services *(Sarıköse and Göktepe, 2022)*.

Significance of the study:

Occupational hazards among hospital workers and care providers constitute a major problem worldwide. Although high levels of protection are provided to these employees in developed countries, it is still lagging in less developed countries, with a paucity of relevant data. A high level of knowledge and awareness about hospital workplace hazards and related preventives measures can help ensure a safe work environment for hospital workers.

Nurses, like every member of the healthcare team, expect to work in safe settings abiding with all recommend standards developed to promote occupational safety. Engaging nurses in relevant

training programs is expected to provide them with needed knowledge and improve their performance regarding protection. This would have a positive impact on their practice, with subsequent improvement of the quality of care they provide.

Aim of the study:

The aim of this study was to assess the effect of occupational health hazards training program on nurses' practice at Blbies Centeral HospitaL, El-Sharkia Governorate, Egypt.

Research objectives:

1. Assess nurses' knowledge regarding occupational health hazards throughout the program.
2. Measure nurses' practice regarding occupational health hazards throughout the program.
3. Design and implement an occupational health hazards training program based on assessment data.
4. Evaluate the effect of occupational health hazards training program on nurses' practice.

Research hypothesis

There will be an improvement in nurses' knowledge and practice regarding occupational health hazards, after implementing the training program.

Subjects and methods:

Research design:

Quasi-experimental one group pretest-posttest design was utilized to fulfill the aim of the study.

Study setting:

The study was conducted in all inpatient departments of Belbeis Central Hospital, affiliated to the Ministry of Health in El-Sharkia Governorat**,** Egypt.

Study subjects:

The study population consisted of all available staff nurses working in the inpatient departments of the study setting at the time of the study. Their total number was 130 nurses. This sample size was larger enough to demonstrate post-intervention improvements in their knowledge, practice, and QWL with a moderate effect size (Odds Ratio 2.1) at 95% level of confidence and 80% study power, and accounting for an expected dropout rate of about 10%.

Inclusion criteria:

*   All three of the nursing specialties—technical, bachelor's, and diploma—were covered,
*   Both sexes,
*   Possessing a minimum of one year of experience and
*   Agree to participate in the research.

Tools of data collection:

To fulfill the purpose of this study, two tools were used for data collection as follows:

Tool I: Self-administered questionnaire: This tool aim was to assess the knowledge of nurses regarding hazards facing them during their work and the different methods of protection from these hazards. It was adapted from *Abed-El-Aziz (2010)*. The questionnaire consists of the three main parts as following:

Part I: This was for participants' personal data such as age, gender, marital status, nursing qualification, as well as the work department, daily working hours, and experience years.

Part II: This part covered job characteristics of studied nurses and asked them about their exposure to different occupational hazards. It consists of 40 items grouped under five domains Use of Personal Protective Equipment (PPE) (5 items), Exposure to ergonomic hazards at work (6 items), Exposure to various types of occupational hazards(14 items), Experience of pain at work (10 items) and Overall exposure to occupational hazards during hospital work(5items).

***Part III*:** This was intended to assess staff nurses' knowledge of the various occupational hazards associated with hospital work and related preventive measures. It consisted of 26 multiple choice questions (MCQ) covering general occupational hazards (2 items), physical hazards (2 items), biological hazards (5 items), disinfection and sterilization (3 items), safe waste disposal (1 item), dealing with hazardous exposures (7 items), psychological hazards (3 items), and social hazards (3 items).

Scoring system: Each item is scored one when the answer is correct and zero when incorrect. The totals of each area and for the total questionnaire were summed-up and converted into percentage scores. The staff nurse's knowledge was considered satisfactory if the percentage score was 60% or more, and unsatisfactory if less than 60%.

Tool II: An observation check list: It was adapted by **(Abed- EL Aziz, 2010)** to measure the nurse's practice regarding methods of protection related to hazards ,it consists 57 items of grouped under nine domains, performance categories with items checked as (done) or (not done) as follow, Hand washing (16) items, gloving (11 item), eye protection (1 item), masking (2 item), personal hygiene (7item), cleaning instrument (4 item), Dealing with sharps (8 item), Safe movement when lifting (10 item).

***Scoring* system**: In each of the observation checklists, the items "not done" and "done" were scored "0" and "1", respectively. The items "not applicable" were not scored and were discounted from the totals, the scores of the items were summed-up and the totals divided by the number of corresponding items. These were then converted into percentage scores. The staff nurse's practice was considered adequate if the percentage score was 60% or higher and inadequate if less than 60%.

Content validity& Reliability:

Once prepared, the data collection forms were presented to a jury group consisting of five experts for face and content validation. These included five professors of Nursing Administration at the Faculty of Nursing, Zagazig University. A face and content validity sheet was used for this purpose. It included one section for their general or overall opinion about the form and the relevance of each item, and another section to express their opinions and comments on the tools applicability, comprehensiveness, and understandability, and any suggestion for modification*.*

The reliability of scales used in the data collection forms (Occupational health hazards and practice was done through examining their internal consistency. They demonstrated high levels of reliability. For Occupational health hazard (0.925) and Practice (0.862).

Fieldwork

The fieldwork was achieved through three phases namely: preparation, implementation, and evaluation phases *.*

Preparation phase: After finalization of the data collection tools, and obtaining required official permissions to collect the data, the researcher started the actual process of data collection. The researcher introduced herself to the staff nurses, explained the aim of the study and its procedures. Then, she asked for their informed consent to participate in the study and for their cooperation after informing them about their rights to participate or refuse participation*.*

Those who provided their informed consent to participate were given the data collection tools (I) along with clear instructions about how to fill them in. The researcher was present at all time to respond to any queries. The filled forms were then collected, and the researcher checked each questionnaire to ensure completeness of the data filling. The average time taken by each staff nurse to fill in the form was twenty minutes.

Implementation phase: Each staff nurse was observed while performing the steps of various

preventive measures using the observation checklists (Tool II). The checklists were filled-in by the researcher while observing each staff nurse individually. This required her attendance in the clinical area for long durations of time. The observation span was three hours per day throughout the three shifts. Each nurse was observed three times for each procedure. The same technique was applied in all stages of data collection.

Evaluation phase: The data collected from various sources during the preparatory phase was analyzed. It served as baseline or pretest data for later comparison with the post-intervention data to assess the effectiveness of the training. It also helped the researcher to identify the knowledge and skills gaps to be emphasized in the educational intervention. Thus, the training program was based on these identified needs, with the help of pertinent literature. These identified needs were translated into a general aim and specific objectives.

Pilot study:

A pilot study was carried out on 13 staff nurses representing 10% of the study sample. They were selected from other departments. The purpose was to test the tools feasibility and understandability, and to estimate the time needed for filling-in the forms. A brief explanation of the purpose of the study was provided to every participant in the pilot study, and then they were provided with a copy of the data collection forms. The time consumed in answering the questionnaire ranged between 20 and 30 minutes, and three hours for observation. The data collected from the pilot study was reviewed and any needed changes were applied. The nurses in the pilot were included in the main study sample to avoid any bias or contamination

Administrative and ethical considerations:

Permissions for data collection and implementation of the educational program were obtained through a letter issued from the Dean of the Faculty of Nursing to the Medical and Nursing Directors at Belbeis Central Hospital explaining the research aim and procedures. The researcher met with the nursing director of the hospital and explained the aim of the study and the tools to be used for data collection to obtain her agreement, support, and cooperation.

Ethical considerations: The study protocol was approved by the Research Ethics Committee at the Faculty of Nursing, Zagazig University. The researcher provided a full explanation of the nature, aim, and benefits of the study explained to each of the staff nurses as well as about their rights before inviting them to participate. They were informed about voluntary participation and the right to withdraw at any time and provided their informed consent to participate. All data obtained was considered confidential and not used outside this study purpose. No harmful maneuvers were performed or used.for the study.

Statistical analysis:

Data entry and statistical analysis were done using SPSS 20.0 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables and means and standard deviations and medians quantitative variables. Quantitative continuous data were compared using Student t-test in case of comparisons between two independent groups and paired t-test for dependent groups. Qualitative categorical variables were compared using chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables was less than 5, Fisher exact test was used instead. In larger than 2x2 cross-tables, no test could be applied whenever the expected value in 10% or more of the cells was less than 5. Spearman rank correlation was used for assessment of the inter-relationships among quantitative variables and ranked ones. In order to identify the independent predictors of the knowledge, practice, and QWL scores, multiple linear regression analysis was used. Statistical significance was considered at p-value <0.05 .

Results:

Table (1): The study involved 130 staff nurses whose ages ranged between 21 and 45 years, median of 30.0 years. The majority were females (83.1%), with a diploma degree (65.4%), and married (74.6%), the highest percentage of the staff nurses in the study sample were working in ICUs (22.3%)

Table (2) indicates that the daily working hours of the majority of staff nurses were <=8 and ranged between 7 and 12 hours. Their experience years ranged from one to 25 years, a median of 10.0 years.

Figure (1): illustrates that the staff nurses' satisfactory knowledge increased from 11.5% at the pre-intervention phase, to 87.7% at the post-intervention phase. The difference was statistically significant (p<0.001).

Table (3): As illustrated in Table 3, the use of PPE by the staff nurses in the study sample increased from 23.1% at the pre-intervention phase to 92.3% in the post-intervention phase (p<0.001). On the other hand, their reported exposures to ergonomic hazards and hazardous exposures significantly increased in the post-intervention phase (p<0.001).

Table (4): demonstrates that the staff nurses' knowledge was low in all areas at the pre-intervention phase, especially regarding psychological hazards (9.2%). At the post-intervention phase, there were statistically significant improvements in all areas (p<0.001), reaching 96.2% regarding biological hazards.

Table (5): indicates that staff nurses' practices were average at the pre-intervention phase. The highest was related to the practice of safe lifting (57.7%) while the lowest was for masking (38.5%). The post-intervention phase showed statistically significant improvements in all steps (p<0.001). The least improvement was related to masking (95.4%).

Figure (2): demonstrates that the staff nurses' adequate practice increased from 49.2% at the pre-intervention phase, to 96.9% at the post-intervention phase. The difference was statistically significant (p<0.001).

Table (6): points to statistically significant relations between staff nurses' knowledge and practice at both pre-intervention and post-intervention phases (p=0.002). It is evident that more nurses with satisfactory knowledge had adequate practice. Meanwhile, no statistically significant relations could be shown between staff nurses' knowledge and QWL at any of the two phases.

Table (1): Frequency distribution of studied nurses according to their personal characteristics (n=130).

Demographic characteristics	No.	Percent
Age:		
<30	53	40.8
30+	77	59.2
Range	21-45	
Mean±SD	30.9±30.0	
Median	30.0	
Gender:		
Male	22	16.9
Female	108	83.1
Nursing qualification:		
Nursing school diploma	85	65.4
Bachelor	45	34.6
Marital status:		
Unmarried	33	25.4
Married	97	74.6

Table (2): Job characteristics of staff nurses in the study sample (n=130).

Job characteristics	No.	Percent
Daily work hours:		
<=8	**106**	**81.5**
>8	**24**	**18.5**
Range	**7-12**	
Mean±SD	**8.7±1.5**	
Median	**8.0**	
Experience years:		
<10	**63**	**48.5**
10+	**67**	**51.5**
Range	**1-25**	
Mean±SD	**9.4±4.9**	
Median	**10.0**	

Table (3) Pre-post-intervention changes in work exposures as reported by staff nurses(n=130).

Work exposures	Time				X^2 test	p-value
	Pre (n=130)		Post (n=130)			
	No.	%	No.	%		
Use of PPE:						
Some	100	76.9	10	7.7		
All	30	23.1	120	92.3	127.64	<0.001*
Exposed to ergonomic hazards:						
Some	99	76.2	32	24.6		
All	31	23.8	98	75.4	69.07	<0.001*
Hazardous exposures:						
Some	115	88.5	12	9.2		

All	15	11.5	118	90.8	163.30	<0.001*

(*) Statistically significant at p<0.05

Table (4) Pre-post-intervention changes in staff nurses' knowledge (n=130).

Knowledge	Time				X^2 test	p-value
	Pre (n=130)		Post (n=130)			
	No.	%	No.	%		
Ergonomic hazards:						
Satisfactory	32	24.6	89	68.5		
Unsatisfactory	98	75.4	41	31.5	50.23	<0.001*
Biological hazards:						
Satisfactory	50	38.5	125	96.2		
Unsatisfactory	80	61.5	5	3.8	98.32	<0.001*
Universal precautions:						
Satisfactory	26	20.0	105	80.5		
Unsatisfactory	104	80.0	25	19.2	96.02	<0.001*
Psychological hazards:						
Satisfactory	12	9.2	106	81.5		
Unsatisfactory	118	90.8	24	18.5	137.11	<0.001*

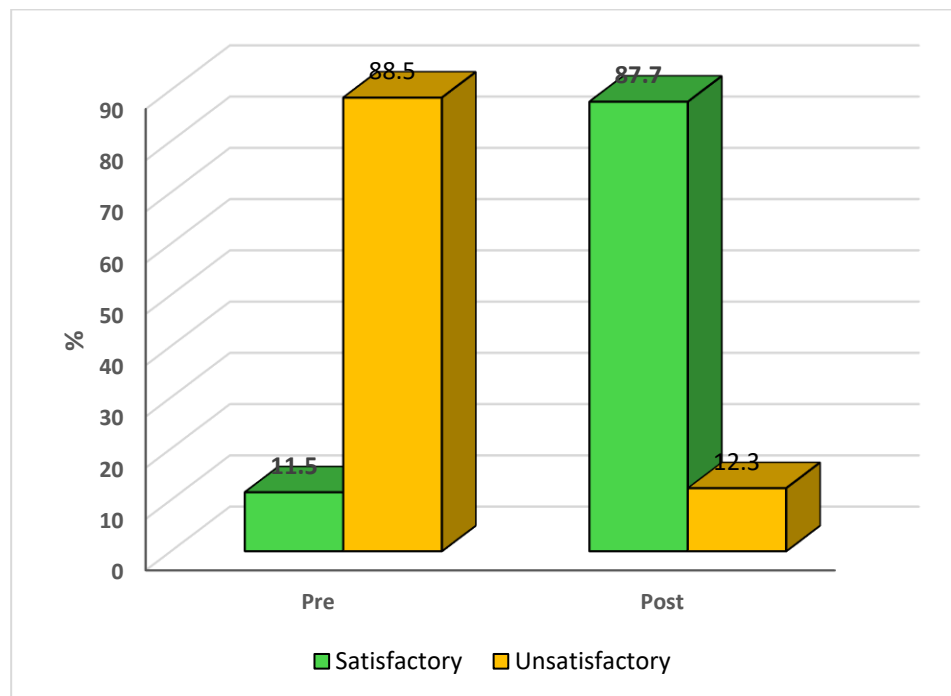*(*) Statistically significant at p<0.05*

Figure (1): Pre-post-intervention changes in staff nurses' knowledge (n=130).

Table (5) Pre-post-intervention changes in staff nurses' total practice (n=130)

Total practice	Time				X^2 test	p-value
	Pre (n=130)		Post (n=130)			
	No.	%	No.	%		

|						
Hand washing:						
Adequate	67	51.5	128	98.5		
Inadequate	63	48.5	2	1.5	76.33	<0.001*
Gloving:						
Adequate	69	53.1	127	97.7		
Inadequate	61	46.9	3	2.3	69.73	<0.001*
Eye protection:						
Adequate	56	43.1	5	96.2		
Inadequate	74	56.9	125	3.8	55.71	<0.001*
Masking:						
Adequate	50	38.5	124	95.4		
Inadequate	80	61.5	6	4.6	95.15	<0.001*
Personal hygiene:						
Adequate	67	51.5	127	97.7		
Inadequate	63	48.5	3	2.3	73.10	<0.001*
Cleaning instruments:						
Adequate	68	52.3	127	97.7		
Inadequate	62	47.7	3	2.3	71.40	<0.001*
Dealing with sharps:						
Adequate	68	52.3	128	98.5		
Inadequate	62	47.7	2	1.5	74.62	<0.001*
Safe lifting:						
Adequate	75	57.7	128	98.5		
Inadequate	55	42.3	2	1.5	63.12	<0.001*
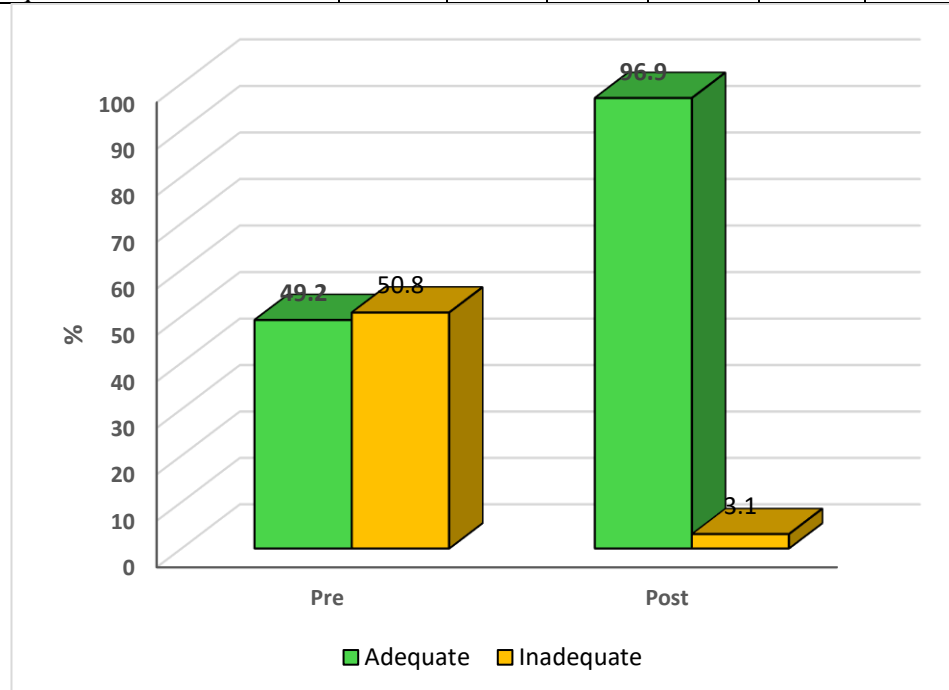
Figure (2): Pre-post-intervention changes in staff nurses' total practice (n=130).

Table 6: Relations between staff nurses' knowledge and their practice and QWL Pre and post program intervention (n=130).

Practice and QWL	Knowledge				X^2 test	p-value
	Satisfactory		Unsatisfactory			
	No.	%	No.	%		
PRE						
Total practice:						
Adequate	13	20.3	51	79.7		
Inadequate	2	3.0	64	97.0	9.51	0.002*
QWL:						
Adequate	11	16.9	54	83.1		
Inadequate	4	6.2	61	93.8	3.69	0.06
POST						
Total practice:						
Adequate	113	89.7	13	10.3		
Inadequate	1	25.0	3	75.0	9.63	0.002*
QWL:						
Adequate	114	88.4	15	11.6		
Inadequate	0	0.0	1	100.0	1.33	0.249

(*) Statistically significant at p<0.05

Discussion:

Nurses are exposed to a gamut of occupational exposures during their work in hospitals and healthcare settings. Such exposures may impacts on the nurses practice. Thus, certain exposures at work were associated with reproductive problems and pregnancy outcomes, as well as infectious diseases. Moreover, such exposures may jeopardize the safety and wellbeing of the patients under their care *(Sani et al., 2024)*.

The aim of this study was to assess the effect of occupational health hazards training program on nurses' practice. It hypothesized that there will be an improvement in nurses' knowledge and practice regarding occupational health hazards, after implementing training program. The results revealed significant improvements in staff nurses' post-intervention knowledge and practice regarding occupational health hazards. This leads to acceptance of the set research hypothesis.

The present study sample included staff nurses in early and mid-career, in the third to fifth age decades, with a median of 10 years of experience. Like most staff nurses in Egypt, the majority were females with a diploma degree in nursing and were married. Thus, the sample could be considered a representative sample of Egyptian staff nurses According to the current study results, most of the staff nurses reported being exposed to ergonomic hazards at work. Bending was the most frequent of the ergonomic exposures, while twisting was the least. Similarly high prevalence rates of bending and twisting were reported among nurses in China *(Zhang et al., 2024)*.

Such high exposure to ergonomic hazards as identified in the current study could lead to several musculoskeletal problems that may affect their work as well as personal life and wellbeing. In fact, a great majority of the nurses in the present study reported suffering from low back pain, and this was experienced after joining the work in the hospitals. In agreement with this, a study of ergonomic exposures among staff nurses in Oman reported a significant association between such exposures and various musculoskeletal disorders *(Attia et al., 2023)*. On the same line, a

study in Japan found that low back pain was one of the most common occupational hazards facing nurses *(Kikuchi et al., 2024)*.

Concerning hospital work exposures as reported by the staff nurses in the current study sample, the long work and shift hours were the most frequent as mentioned by a majority of them. This is in agreement with a study on Chinese nurses where long working hours were reported by a significant percentage of them, and was associated with musculoskeletal disorders *(Liu et al., 2023)*. Such exposure could have a negative impact on staff as they can decrease their work efficiency, stress, and fatigue, along with low morale and decreased productivity. These in turn lead to more lost time and increased costs.

This foregoing present study's finding is expected given the shortage of staff nurses in various healthcare settings in Egypt. In this respect, a study in Switzerland revealed a significant association between nurses' high workload related to high patient-to-nurse ratios and their work-life balance *(Zraychikova et al., 2023)*. Moreover, *Schwartz et al. (2024)* in a study in the United States mentioned that hospitals are faced with a crisis of shortage of nurses crisis, which is anticipated to increase over the coming decade, with a heightened workload burden on nurses.

The conflict with supervisors was also an important ergonomic hazard as reported by more than three-fourths of the staff nurses in the present study. This could also have a negative influence on nurses' job satisfaction and burnout. In congruence with this, a study in the United States demonstrated that among the important factors underlying burnout and the intention to leave among nurses was the lack of efficient leadership, and the absence of responsive supervisors, with associated conflicts *(Aboutaleb et al., 2024)*.

A paradoxical finding of the current study was that the nurses reported significantly more exposures to ergonomic hazards and occupational hazardous exposures after the implementation of the study intervention program. This could be explained by their increased awareness of such exposures after attending the educational intervention.

According to the present study results, the exposure to physical hazards was the highest, being reported by more than three-fourths of the nurses. On the other hand, the exposure to biological hazards was the least reported. The finding could be explained by the greater emphasis given to infection control precautions in comparison with the measures of protection from physical and ergonomic hazards. Thus, the absence of strict infection control measures has been associated with a very high exposure to biological hazards such as needle stick injury as reported in a study of nurses in Yemen *(Abdo Almoliky et al., 2024)*.

As regards the use of personal protective equipment (PPE), the present study results demonstrated that only less than one-fourth of the nurses reported using them. Obviously, the personal protective equipment most used were gloves and masks which are essential in their daily work. In line with this, a study of nurses' use of PPE in Singapore found that only 20% of them were complying with their use *(Chia et al., 2024)*. The reasons underlying low compliance with the use of PPE, as identified in a study in Australia, include fatigue, and their adverse effects on skin and respiration *(McKenna et al., 2024)*.

Meanwhile, the implementation of the present study educational intervention led to a significant improvement in nurses' use of PPE, reaching more than ninety percent. The finding indicates the effectiveness of the intervention, which could be attributed to its being based on nurses' identified needs and gaps of knowledge. In agreement with this, a study in India demonstrated the effectiveness of an educational intervention on nurses' compliance and correct use of PPE *(Lazar et al., 2024)*.

The present study has also addressed nurses' knowledge of the various occupational hazards and

exposures. The results revealed low levels of knowledge. Thus, less than one-tenth of them had satisfactory knowledge of the psychological hazards, while less than two-fifths had satisfactory knowledge of the biological hazards before the implementation of the pre-intervention. Overall, approximately one-tenth of the nurses had total satisfactory knowledge. Such deficient knowledge of occupational hazardous exposure explains their high exposure to all hazards.

In contradiction with this foregoing present study results, a study assessing the knowledge, attitude, and practice of nursing staff at teaching Hospitals in Kerbala City, South-Central Iraq regarding occupational health hazards found that 84% of subjects had satisfactory knowledge *(Kumar et al., 2022)*. Meanwhile, a cross-sectional study assessing the knowledge and practice of nurses regarding needle stick injury in allied hospital Faisalabad revealed that 54% of nurses have insufficient knowledge *(Baishya and Baruah, 2023)*. The differences might be explained by differences in the settings.

Concerning the factors influencing nurses' knowledge, the bivariate analyses better knowledge among diploma nurses, those more exposed to hazards, those who use all PPE, and those exposed to all hazardous exposures. However, in the multivariate analysis, only the level of education and the hours of work had a significant association with the nurses' knowledge. In line with this, a study assessing health workers knowledge towards Occupational Health and Safety Program in Primary Health Care Centers, Iraq found that the level education have a great effect on occupational health and safety program *(Rai et al., 2021)*.

After the implementation of the present study intervention, the nurses' knowledge significantly improved. Thus, almost ninety percent of them had satisfactory knowledge. This improvement is undoubtedly attributed to the effect of the educational intervention as confirmed by the results of the multivariate analysis, which identified it as the main positive predictor of the knowledge score. The significant positive effect of the intervention on nurses' knowledge could be because its knowledge core content gave a major emphasis on applied information. A similar improvement in nurses' knowledge following attendance of a training program in a study in Denmark *(Nielsen et al., 2024)*.

A second objective of the present study was related to nurses' performance regarding occupational health hazards. This was measured by assessing their reported practice. Overall, staff nurses' practices were average in the pre-intervention phase, with less than one-half of them having total adequate practice. Their practice was highest regarding safe lifting and lowest regarding masking. Such low practice might explain their reported high prevalence of pain related to work, especially low back pain. It could jeopardize nurses' health and wellbeing exposing them to many serious sequels as reported in a study of nurses' preventive practices in China *(Feng et al., 2024)*.

In congruence with this, according to the World Health Organization (WHO), nurses' compliance rates in implementing infection control are still low, with the hand hygiene compliance rate is 22-60% *(Haac et al., 2017)*. As many as 41% of nurses never wear masks when there is a risk of infectious diseases through the air, and 44% say they never wear gloves when taking action with patients *(Öztürk et al., 2020)*. Lack of compliance rates in the use of personal protective equipment (PPE) resulted in the incidence of injury to sharps (such as syringes) 21.5%, injuries and scratches 17.0%, direct contact with contaminated specimens 10.5%, air infections 9.0 % *(Ndejjo et al., 2015)*.

The implementation of the present study educational intervention led to significant improvement in nurses' practice. Thus, the percentage of those with adequate practice was double that in the pre-intervention phase, reaching nearly a hundred percent. This demonstrates the effectiveness of the intervention program, which was also confirmed by the results of the multivariate analysis

that identified it as a main positive predictor of the practice score. In agreement with this, a study of a training program on nurses' compliance with universal precautions and hand hygiene showed significant post-intervention practices *(Ghorbanmovahhed et al., 2023)*.

The effectiveness of the present study intervention program could be attributed to its content and process. It was administered to nurses with an adult learning approach, and in addition, it emphasized the practical and applied aspects, with hands-on training. Moreover, its knowledge content was focused on applied information, and thus, the knowledge score was identified as another positive predictor of the practice score, i.e., the training program had both a direct and an indirect effect on nurses' practice. Furthermore, significant positive correlations were revealed between the knowledge and practice scores.

Coclusion:

The study results lead to the conclusion that the staff nurses are highly exposed to various occupational hazards, with low use of PPEs. Their related knowledge and practice are low, and they are positively inter-correlated. The implementation of the training intervention shows effectiveness in improving their knowledge and practice. The intervention has a direct positive impact on their scores, as well as direct impacts through improving their knowledge and practice.

Recommendation:

Given the study findings, the following is recommended.

- The developed training program could be applied to similar settings given its proven effectiveness, along with its related manual.
- The staff nurses need continuing education and training through workshops and seminars to boost their knowledge and skills related to occupational safety and health.
- Special emphasis should be given to the areas identified as deficient in their knowledge and skills.
- The training should also include training in ergonomic principles and safe ways for handling and lifting to avoid related hazards.
- A comprehensive program for personal protective equipment (PPE) should be developed and applied, with the provision of high-quality and efficient PPE.
- Staff nurses should be trained in the
- Proper use of PPE, and they should be monitored for their use, with a system of reward and retribution.
- The infection control committee in the hospital should have an active role in protecting healthcare workers from hospital-acquired infections and biological hazards.
- The hospital administration should use the study findings related to the work environment to correct any deficiencies that could pose occupational hazards to nurses and employees.
- Safety policies must be available in each department in the hospital, with the orientation of nurses about these policies and their related procedures, especially for the newly appointed staff.

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