The Effect of Ergonomics Program on Nurses' Knowledge and Practice in Operating Room

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Abstract: *Operating room nurse has the highest prevalence rates of work-related musculoskeletal disorder (WMSD) among the nursing profession. Ergonomics is the process of creating a workspace which is safe, efficient, comfortable, and prevents WMSD. Ergonomic education programs are used increasingly as a strategy to decrease musculoskeletal disorders (MSDs) for nurses in the operating room. This study aims to evaluate the effect of ergonomics program on nurses' knowledge and practices in an operating room. Methods: A true-experimental research design was utilized in the current study. The study was conducted at the two cosmetics surgery operating rooms, affiliated to Ain Shams University Hospitals, Cairo, Egypt. Subjects: A random cluster sample of 40 nurses included (38 staff nurses and 2 head nurses, of both genders) over a period of six months. Tools for data collection: Four tools for data collection were used as follow, 1. Educational needs assessment questionnaire, 2. Self-administered questionnaire sheet, 3. Nurses' performance observational checklist; 4. and participants' opinionnaire sheet. Results: revealed that, there was a highly statistically significant improvement in total knowledge and practice of nurses' pre and post intervention (P>0.001). Conclusion: The current study concludes that the implementation of the training program had positive effects on improving nurses' knowledge and practice related to ergonomics. Recommendations: The study recommended that conducting periodic in-services training program for operating room nurses to improve knowledge and practices related to ergonomics principles.*
Key Words: *Ergonomics, Operating room nurses.*

I. Introduction:

Ergonomics is the process of creating a workspace that reduces employee exposure to the risks of workplace injuries. In addition, good workplace designs can help minimize fatigue and general discomfort from strain and stress on health care worker's bodies **[1].** Hospital ergonomics may help to prevent injury and promote health safety, efficiency, and comfort in health care units to optimize human performance and improve patient health. Ergonomists seek to understand the relationship between work demands and human capabilities to develop and apply knowledge and techniques to improve system performance in natural ways **[2] and [3].**

The nursing staff is one of the major categories of risk exposure to biological, chemical, physical, and psychological hazards in their working environment because it's a profession with one of the largest numbers of professionals in health services and to have direct contact in the care provided to patients **[4], [5], and [6].**

The nursing profession is known to have some of the highest prevalence rates of work-related musculoskeletal disorders (WMSD) among all healthcare profession groups due to many activities in positioning and manual handling (lifting, transferring, repositioning) of patients on a daily basis and prolonged tasks**.** Nurses are at significant risk of such injuries, including low back pain (LBP) (30–60%), neck pain (33–53%), and shoulder pain (30–48%) **[7].** A meta-analysis reported that the annual incidence of low back pain among patient handling nurses was between 40% and 50%. Studies of back-related workers' compensation claims to reveal that nursing personnel have the highest claim rates of any occupation and are among the highest at risk for musculoskeletal disorders that require medical treatment or that produce lost workdays **[8], and [9].**

A high prevalence of musculoskeletal injuries also contributes significantly to high patient care costs and to the shortage of nursing personnel, an inability to perform tasks appropriately, decreased productivity, and an increase in disability compensation claims **[10].**

Operating room (OR) is a complex environment with many people, technologies, and medical equipment. The primary goal for OR staff is to perform the surgical procedure on a patient with minimum risks possible in a timely and effective manner. The operating room is generally one of the major revenue procedures in any hospital [11].

Among hospital nurses, operating room nurses are considered a high risky group. Operating room nurses are exposed to a variety of risk factors that are responsible for MSD [4]. Operating room nurses undergo many high-risk tasks while performing their duties daily. Those high-risk tasks include: standing for long periods of time, adopting unnatural (non-neutral) postures to work effectively, leaning towards the patient for prolonged periods of time, lifting and holding patient's extremities, preparing a limb, holding retractors for long time periods, transferring patients between stretcher and operating table, reaching, lifting and pushing equipment, changing the position of the patient on the operating table, slippery shoe covers and floors, and finally tripping hazards that is caused by electrical wires and equipment in the way [12].

Researches indicated that, the active application of ergonomics education program and principles of safer patient handling have increased awareness of methods to minimize the risks. Ergonomic interventions such as improved knowledge and technical performance of transfers and reduced frequency of manual lifting were recommended to be preferable to change general nurse's behaviors [13], and [14].

A common strategy for preventing and reducing WMSD among operating room nurses has been the use of educational programs in technique training [15]. Several review studies recommend, however, multifactorial interventions incorporating, for example, exercise training, the use of assistive devices and a broad-based ergonomics training. Results from these studies of nurses have shown smaller numbers of back injuries, less pain, fewer symptoms, and less absence from work due to musculoskeletal symptoms post-intervention [16], and [17].

II.   Significance Of The Study:

Researchers and organizations around the world have highlighted the nursing staff as a risk group in relation to musculoskeletal disorders. Nursing is one of the riskiest occupations for back injuries and it has the highest incidence of all types of nonfatal work-related injuries in the USA [18]. In addition to a high prevalence of WMSD, with lower back pain the most prevalent (84%) complaint, followed by ankle/foot (74%) and shoulder (74%) pain among nurses and technicians in the surgical environment (MSD) [19].

Musculoskeletal disorders (MSDs) are considered as a public health problem, in Egypt. A study on this problem in OR nurses is a very important issue because musculoskeletal disorders are considered a significant occupational problem among healthcare providers. In the study done at Cairo University Hospital, 97.8% of operating room nurses have musculoskeletal symptoms. Moreover, operating room nurses are overloaded at work with the overall nurse-to-patient ratio per shift which is considered high ranged 2-25 at Cairo University Hospital [20]. Also as Ain Shams University, the nurse-patient-ratio is high ranged 1-8 per shift [21]

The National Institute for Occupational Safety and Health (NIOSH) and CDC develop ergonomic guidelines for operating room nurses to maintain healthy and safe working conditions for men and women in working place, and recommend providing education, training, and information regarding ergonomics principles, safe patient lifting and handling [22].

Aim of the study:
This study aims to evaluate the effect of ergonomics program on nurses' knowledge and practices in operating room through the following:
(1) Assessment of ergonomic nurses' knowledge and practices in operating room
(2) Developing and implementing the ergonomic program.
(3) Evaluating the effect of ergonomics program on nurses' knowledge and practices in operating room.

Research hypothesis:
This study hypothesized that:
1. Implementation of ergonomic program will positively effect on the knowledge of nurses in the operating room.
2. Implementation of ergonomic program will positively effect on the practices of nurses in the operating room.

III. Materials And Methods:

Research design:
A true-experimental research design with one group pre-test and post-test was used to conduct this study.

Setting:
The study was conducted at the two cosmetics surgery operating rooms chosen by toss from twenty-one operating rooms with different specialties into three buildings of surgical hospitals namely (main building, burn building, and emergency building) which affiliated to Ain Shams University Hospitals, Cairo, Egypt.

Subjects:
A random cluster sample of 40 nurses included (38 staff nurses and 2 head nurses) who are working in the two-cosmetic surgery operating rooms, they are both genders with different educational levels, and agreed to participate in the study from a total of 300 staff nurses and 21 head nurses.

Tools for data collection:
Four tools for data collection were used as follows:

1)   Educational needs assessment questionnaire:
This questionnaire was developed by the researchers in an Arabic language based on the review of related literatures **[23]** to assess nurses' educational needs regarding ergonomics. It included two parts as follows:
-   Part 1 was used to assess nurses' personal and nursing characteristics such as age, gender, marital status, qualification, and years of experiences in operating room and attendance of previous training.

-   Part 2 included 10 questions to assess previous studying and training regarding ergonomics topics.

2)   Self-administered questionnaire sheet: to assess nurses' knowledge regarding ergonomics (pre/post test):
-   This questionnaire was developed by the researchers in an Arabic language based on the review of related literatures **[24], [25] and, [26]** to assess nurses' knowledge regarding ergonomics principles and hazards. It included 30 multiple choice questions grouped into five subgroups to assess nurses' knowledge regarding the following: (Concept and purpose of ergonomics (4 questions), Principles of ergonomics (7 questions), Lifting and moving objects (11 questions), Positioning and repositioning the patients (5 questions), Prolonged standing (3 questions).

Scoring system
The assessment of nurses' knowledge consisted of 30 questions; the responses for the questions were by multiple choice. The correct answer was given (1 grade), the incorrect answer was given (zero), the total grade for the knowledge questionnaire was (30 grades), the total scores for every subgroup were calculated, and then the total score for the entire questionnaire was calculated for every nurse. Afterwards, the mean of the total score for all nurses was calculated (maximum scores 100 in nurses' knowledge).

3- Nurses' performance observational checklist: to assess nurses' practice related to ergonomics.
This checklist was used to assess nurses' ergonomics practices in two operating rooms before and after program implementation. It was developed by the researchers based on the review of related updated literatures **[24], and [25].** It included 30 practice steps which were distributed into 6 major parts as following:

-   Part 1 was used to assess nurses' practices regarding positioning and repositioning the patients. It included (4 steps).
-   Part 2 was used to assess nurses' practices regarding lifting and holding legs, arms, and head. It included (4 steps).
-   Part 3 was used to assess nurses' practices regarding prolonged standing. It included (6 steps).
-   Part 4 was used to assess nurses' practices regarding retraction. It included (6 steps).
-   Part 5 was used to assess nurses' practices regarding lifting and moving objects. It included (6 steps).
-   Part 6 was used to assess nurses' practices regarding pushing, pulling and moving objects on wheels (4 steps).

Scoring system:
The responses for the 30 practice steps were either done correctly or done incorrectly. One grade was given for each correct step and zero for each incorrect or not done step. The total scores for the observation checklist were (30 grades). The total scores for every subgroup were calculated, and then the total score of the entire checklist was calculated for every nurse. Afterwards, the mean of the total score for all nurses was calculated (maximum scores 100 in nurses' practice).

4- Participants' opinionnaire sheet: to assess nurses' satisfaction regarding ergonomics program:

This tool was adopted from **[27] and, [28]** and translated into an Arabic language and back translated by the researchers in order to assess the outcome of the program from nurses' participants' point of view. The evaluation form included 24 statements grouped into five subgroups as: evaluation of the trainer (9 items), evaluation of the teaching materials and methods (3 items), evaluation of training place (3 items), evaluation of lecture duration and content (3 items) and meeting trainee's expectations (6 items).

Scoring system:

The nurses were asked to rate their responses on a five-Likert scale ranged from 5=excellent to 1=bad. The total score for the whole evaluation scale was calculated for every nurse. Afterwards, the mean of the total score for all nurses was calculated.

Tools validity and reliability:

- These questionnaires were reviewed by a panel of 5 experts (1 medical occupational health in faculty of medicine, Ain Shams University, 2 professors in medical surgical nursing department, Ain Shams University and 2 professor nursing administration departments, Ain Shams University) to evaluate its face and content validity. The experts reviewed the tools for its content, clarity, simplicity, relevance, comprehensiveness, appropriateness, and applicability. Minor modifications were done and then the final forms of the tools were developed.

- Testing the reliability of the purposed data collecting tools was done by alpha Cronbach test which was 0.86 for the knowledge tool, 0.90 for the practice tool and 0.82 for Educational needs assessment.

Pilot study:

A pilot study was carried out on 10% of nurses to test the applicability of the study and to test clarity of the designed questionnaires, as well as to estimate the time needed for each tool, modifications were done for the used tools then the final form was developed. Nurses of the pilot study were included in the study's subjects.

Ethical considerations:

The research approval was obtained from the faculty of nursing research ethics committee before initiating the study. The researcher clarified the purpose and aim of the study to nurses included in the study. Oral consent was obtained from nurses to ensure willingness to engage in the study. The researcher-maintained anonymity and confidentiality of subjects' data. Nurses were informed that they could withdraw from the study at any time without penalty.

Procedure:

The procedure included three phases: preparatory phase, implementation phase, and evaluation phase.

Preparatory phase:

This phase involved extensive reviewing of the recent related literatures to develop tools for data collection and prepare some posters related to ergonomics principles and hazards. The aim and purpose of the study was explained by the researchers to the study subjects prior to data collection, as well as their approval to participate in the study was obtained. The previous questionnaires were distributed to the nurses to complete it by themselves in the presence of the researchers in order to assess nurses' knowledge regarding ergonomics to identify the nurses' learning needs. It took 30-45 minutes to fill this questionnaire. Then the observation checklists were used to observe every nurse three times by the researcher before implementation of the program. It took 45 minutes during morning and afternoon shifts to fill in these checklists. The researchers developed the program about ergonomics which were revised for content validity by a group of five experts (1 medical occupational health in faculty of medicine, Ain Shams University, 2 professors in medical surgical nursing department, Ain Shams University and 2 professor nursing administration department, Ain Shams University) and the final modifications were done based on the opinions of the experts.

Implementation phase:

The teaching sessions were conducted for nurses at the surgical hospital. The program's contents were explained over 7 sessions with 30 minutes for every session for using the prepared posters. All nurses were divided into 4 groups and each group received the seven sessions separately to minimize interruption of nurses' work. The first, second, and third teaching sessions included: pre-test of knowledge and the theoretical part related to (the concepts, importance and principles, and challenges of ergonomics in the operating room). While, the fourth, fifth, and sixth sessions included: practical parts about ergonomics hazards and how-to

prevention regarding (musculoskeletal disorders, working postures and movements, handling the heavy patients and objects, transport the surgical carts, and making retraction during surgery and standing for long periods of time) the last session (seventh) included: posttest of knowledge and program evaluation. Lecture and small group discussions were used for giving the theoretical part, while demonstration and re-demonstration was used for the practical part. Data collection and teaching sessions were conducted over a period of six months starting from April 2017 till the end of September 2017 in the morning shifts.

Evaluation phase:

Post implementation of the program training sessions, all tools were filled in again immediately. Evaluations of the effect of the training was done by comparing the results of nurses' knowledge and practice pre and post the implementation of program training sessions by using the same data collection tools, and the training program evaluated to assess the outcome of the training program from nurses' participants' point of view. The evaluation form included: evaluation of the trainer, the teaching materials and methods, training place, lecture duration, content, and meeting trainees' expectations.

IV.   Data Analysis:

The collected data was analyzed using the statistical package for social science (SPSS) version 18. Quantitative data were presented as a mean and standard deviation (SD), t-test was used to determine the differences. The significance of the observed difference was obtained at $P \leq 0.05$.

V.   Results:

Table 1: Personal and nursing characteristics of the studied nurses (n=40):

Items	Frequency	Percent
Age: <30 30+	24 16	60.0 40.0
Mean:29.8 ± SD 6.81 Range:22-45		
Gender: Male Female	3 37	7.5 92.5
Marital status: Unmarried	9	22.5
Married	31	77.5
Nurses qualifications: Diploma	38	95.0
Bachelor degree	2	5.0
Job position: Head nurses	2	95.0
Staff nurses	38	5.0
Experience years: <10 10+	24 16	60.0 40.0
Attended previous training: No Yes	9 31	22.5 77.5
Attended training about ergonomics: No Yes	32 8	80.0 20.0

Table (1) shows that, the studied nurses consisted of 40 nurses, the demographic characteristics of the present study, as regards to age revealed that nearly two thirds (60 %) of nurses their age was less than 30 years. Concerning gender, most of them (92.5%) of nurses were females, and (77.5%) were married. In relation to job position the majority (95%) of nurses were staff nurses. About nursing qualification, most (95%) of nurses were diploma. Concerning experience around two thirds (60%) of nurses have experience less than 10 years. With respect to attending previous training, the majority (77.5%) of nurses attended previous training. Concerning attended training in ergonomics, the majority (80%) of nurses haven't attended training regarding ergonomics.
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Table 2: Studied nurses' knowledge scores before and after the intervention:

Knowledge of ergonomics:	Knowledge score (max=100)				Mean Difference	Paired t-test	p-value
	Pre (n=40)		Post (n=40)				
	Mean ±SD	Median	Mean ±SD	Median			
Concept and purpose	63.1±25.9	75.00	91.9±13.1	100.00	28.750	7.667	<0.001*
Principles of body mechanics	25.0±17.3	28.60	67.8±16.1	71.40	42.857	15.834	<0.001*
Positioning and repositioning patients	37.5±17.1	40.00	79.0±17.5	80.00	41.500	12.248	<0.001*
Lifting and moving objects	45.9±15.0	45.50	76.8±12.7	81.80	30.909	11.532	<0.001*
Prolonged standing	42.5±30.2	33.30	76.7±25.3	66.70	34.167	7.050	<0.001*
Total knowledge	41.6±10.7	43.30	76.8±8.4	76.70	35.250	21.839	<0.001*

(*) Statistically significant at p<0.05

Table (2) displays that there were highly statistically significant differences between pre and post test mean scores of nurses' knowledge regarding concept and purpose, principles of body mechanics, positioning and repositioning patients, lifting and moving patient, prolonged standing, and total knowledge (t- test = 7.66, 15.83, 12.24, 11.53, 7.05, & 21.83, respectively at p<0.001).

Table 3: Studied Nurses' practice scores before and after the intervention:

Practice:	Practice score (max=100)				Mean Difference	Paired t-test	p-value
	Pre (n=40)		Post (n=40)				
	Mean ±SD	Median	Mean ±SD	Median			
Positioning and repositioning patients	78.1±11.6	75.00	79.4±12.5	75.00	1.250	1.433	0.160
Lifting and holding legs, arms, head	76.3±13.8	75.00	78.1±14.1	75.00	1.875	1.778	0.083
Prolonged standing	72.5±11.0	66.70	77.9±13.2	83.30	5.417	3.340	0.002*
Retraction	72.1±14.8	66.70	75.4±16.4	66.70	3.333	1.842	0.073
Lifting and moving objects	55.4±21.5	50.00	62.5±17.2	66.70	7.083	3.076	0.004*
Pushing, puling, moving objects on wheels	54.4±25.2	50.00	65.6±22.4	62.50	11.250	4.767	<0.001**
Total practice	68.1±8.9	66.70	72.8±8.4	73.30	4.667	5.099	<0.001**

(*) Statistically significant at p<0.05
(**) Statistically highly significant at p<0.001

Table (3) reveals that there were no statistically significant differences between mean scores of nurses' performance in both groups regarding positioning and repositioning of patient and lifting and holding legs, arms, and head, retraction (t-test 1.44,1.77,1.84 respectively at p<0.05).However, there were statistically significant differences between mean scores of nurses' performance in both groups regarding prolonged standing, lifting and moving object(t-test 3.34, 3.07 respectively at p<0.05). Also, there were highly statistically significant differences between mean scores of nurses' performance in both groups regarding pushing, pulling, moving object on wheels, and total knowledge (t-test 4.76, 5.09 respectively at p<0.001)

Table (4): Mean score of participants' opinions regarding satisfaction of the program:

Dimensions of program evaluation	Mean	SD
Evaluation of the trainer	90.3	11.5
Evaluation of the teaching materials and methods	71.4	18.4
Evaluation of training place	73.2	23.2
Evaluation of lecture duration and content	82.2	14.1
Meeting trainee's expectations	84.1	16.7
Total evaluation mean score	95.2	13.46

Table (4) discloses, most studied nurses were satisfied of the ergonomics program, all mean scores in all items of the program above 70%. The studied nurses were very satisfied regarding the trainer, and the total evaluation of the program (90.3, 95.2 mean scores respectively).

Table 5: Correlation between post pre-improvements of nurses' knowledge and practice scores and their characteristics and satisfaction with the intervention.

	Spearman's rank correlation coefficient		
	Scores (post pre-difference)		Satisfaction score
	Knowledge	Practice	
Knowledge		-.280	
Practice			-.093
Age	.123	.197	-.044
Qualification	-.004*	.085	-.075
Experience years	-.088	.106	.020

(*) Statistically significant at p<0.05
Table (5) displays that there is statistically significant correlation between studied nurses' qualifications and their knowledge (p<0.05). Furthermore, there is statistically significant correlation between studied nurses' experience years and their satisfaction of the program.
There is no statistically significant correlation between nurses' practice and satisfaction scores.

Table 6: Best fitting multiple linear regression model for the knowledge score

	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
Pre	36.45	2.42		15.082	<0.001**	31.64	41.26
Intervention	35.25	2.07	0.88	17.016	<0.001**	31.13	39.37
Previous training	6.62	2.48	0.14	2.671	0.009*	1.69	11.56

 (*) Statistically significant at p<0.05
(**) Statistically highly significant at p<0.05
r-square=0.79
Model ANOVA: F=148.34, p<0.001
Variables entered and excluded: rank, age, gender, qualification, experience

Table (6) discloses that there was highly statistically significant correlation between total scores of nurses' knowledge pre and post intervention (p> 0.001). However, there was a statistically significant correlation between total scores of nurses' knowledge and previous training (p<0.001).

Table 7: Best fitting multiple linear regression model for the practice score

	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error				Lower	Upper
Pre	78.41	2.96		26.506	<0.001**	72.52	84.31
Intervention	4.67	1.75	0.26	2.659	0.010*	1.17	8.16
Qualification	-10.47	3.50	-0.31	-2.990	0.004*	-17.45	-3.49
Experience years	-2.41	0.97	-0.25	-2.492	0.015*	-4.34	-0.48
Previous training	-5.63	2.21	-0.27	-2.553	0.013*	-10.03	-1.24

r-square=0.22
Model ANOVA: F=6.63, p<0.001
Variables entered and excluded: rank, age, gender
Table (7) clarifies that there was highly statistically significant correlation between total scores of nurses' practice pre-intervention (p> 0.001). However, there was a statistically significant correlation between total scores of nurses' performance, qualifications, experience years, and previous training (p<0.005).

VI.   Discussion:
Operating room nurses are dealing with very exhausting, busy, and overloading work environment which requires more effort, organization and training. Ergonomic training and physical conditioning programs have been effective, for instance; lifting teams were helpful in reducing injuries among nurses **(Bulter, et al. 2012) [29].** The present study aimed to evaluate the effect of ergonomics program on nurses' knowledge and practices in the operating room. Discussion of the findings in the current study will cover the main areas; personal and job characteristics of the studied nurses, nurses' knowledge, nurses practice, nurses' satisfaction, and correlation between nurses' knowledge, practice, and satisfaction.

Regarding personal and job characteristics of the studied nurses, the study subject of one group of operating room nurses'; it was obvious that the highest percent of the total subject were less than thirty years of age**,** while the minority of the total subject were more than thirty years of age. From the researcher's point of view, the interpretation of the previous findings clarifies that the nurses age is young, and this age is a productive age, this indicates they highly need training to continue the productivity of their work and avoid MSD symptoms.

The present study stated that, most nurses participating in the study were, female and married, this finding was supported with **El Ata, et al. (2016) [20]** in her study of occupational risk factors for musculoskeletal disorders among operation room nurses at Cairo University Hospitals, she founded that most of operating room nurses were females, also more than half of them were thirty years of age.

The previous finding was supported by, **Bernal, et al. (2015), [30]** in his study of work-related psychosocial risk factors and musculoskeletal disorder in hospital nurse and nursing aides, he mentioned that, most of participants in his study were woman, also MSD is very common in woman than men.

In relation to the job of studied nurses', results revealed that, most nurses were staff nurses. Also, most nurses who took part in the current study have a diploma nursing qualification and very few of them have bachelor's degree in nursing qualification. The pervious finding with in agreement with (**Abou El Soud, et al, 2014) [18].** She mentioned in her study of prevalence of low back pain in working nurses in Zagazig University Hospitals: an epidemiological study, many nurses who participated in her study were diploma nursing qualification. Moreover, the majority of working nurses in Egypt were diploma nursing qualification.

With regards to years of nurses' experience in operating room, the current study revealed that, more than half of nurses have experience years less than 10 years. Regards to attend previous training, this study showed that, the majority of studied nurses have had previous training, while the minority of studied nurses had training regarding ergonomics. From the researchers' point of view, the operating room nurses were highly in need of ergonomic program, because they have lack of knowledge and training to protect themselves and the patient from musculoskeletal disorder.

As regards to nurses' scores of knowledge, the finding of the present study showed that, there is a highly statistically significant difference between the nurse scores of knowledge pre and post intervention regarding concept and purpose, principles of body mechanics', positioning and repositioning patients, lifting and moving objects, prolonged standing and total knowledge.

According to the researchers point of view, the previous findings, showing improvement in nurses' knowledge could be attributed to the effect of the program implemented only, since the baseline knowledge preprogram implementation was the same (the same group). The program gave them the basic knowledge regarding ergonomics.

The previous finding was in the same line with Choi and Brings (2016) [1], they mentioned that there is a significant improvement in understanding the principles of ergonomics and patient handling techniques in the education program to nurses handling obese patients.

Further, the previous finding is in coherence with Garg, et al, (2012) [31] in her study of efficacy of an ergonomics program that includes patient-handling devices on reducing musculoskeletal injuries to nursing personnel, she mentioned that, there is a highly statistically significance difference between the nurses scores of knowledge pre and post intervention regarding patient handling, lifting, and moving object (P<0.001).

As regards to nurses' practice, the finding of the current study supported that, there is a highly statistically significant difference between the nurse total practice pre and post intervention. The previous finding agreed with **Garg, et al, (2012) [31],** she supported that, the ergonomic program for nurses applying handling technique is very effective in improving nurses' practice and decrease in patient-handling injuries 59.8%.

Concerning studied nurses' satisfaction regarding ergonomic program, the finding in current study mentioned that, the total mean scores of studied nurses were more than 70. The rationale of the pervious finding may be because the nurses were interested with the topic. Moreover, attractive teaching materials, fulfill trainee expectation. On the other hand, the mean score of studied nurses' satisfaction were more than 95 regarding trainer, and total program evaluation. This may be because the efficient teaching skills of the trainer and year experience in teaching.

As regards to, correlation between nurses' knowledge, practice and satisfaction

In relation to correlation between post pre-improvement of nurses' knowledge and practice scores and their characteristics and satisfaction with the intervention. The finding of current study revealed that there is statistically significant correlation between nurses' qualifications and their knowledge (p<0.05). The rationale of

the previous finding may because the bachelor's degree of nursing is taught the updated and advanced level of knowledge compared to the diploma of nursing qualification. The previous finding with in agreement with **Bulter, et al. (2012) [28]**in her study of applying sciences and strategy to operating room management, she explained that, ergonomics program with a training focus showed success among hospital workers. She added that there is an improvement in nurses' knowledge and practice in OR nurses as relation to their qualification. On the other hand, the finding of this study showed that there is statistically significant correlation between studied nurses' experience years and their satisfaction (p<0.05). The rationale of pervious finding may be because the studied nurses' may have a MSD and they were interested to avoid reoccurrences of these symptoms. Moreover, the studied nurses, worked many years, there is a lack of training program of them.

Concerning the correlation regression model for the nurses' score of knowledge, the current study showed that there is a highly statistically significant correlation between total scores of nurses' knowledge pre and post intervention (p> 0.001). The rationale of the previous finding may be because the effect of the program to gain new knowledge and practice regarding the ergonomics. However, there was a statistically significant correlation between total scores of nurses' knowledge and previous training (p<0.05). The rationale of the previous findings may because some of the nurses attended the previous training regarding ergonomics. They have baseline knowledge; the program adds as a refreshing course and adds many practical skills.

Regarding regression model for the nurses' practice score, the finding of the current study clarifies that there was highly statistically significant correlation between total scores of nurses' practice pre-intervention (p> 0.001). However, there was a statistically significant correlation between total scores of nurses' performance, qualifications, experience years, and previous training (p<0.005).

VII. Conclusion:
The results of this study concluded that the implementation of the training program had positive effect on improving nurses' knowledge related to (concept, importance, principles and challenges of ergonomics in operating room), nurses' practice related to ergonomics hazards and how-to prevention regarding (musculoskeletal disorders, working postures and movements, handling the heavy patients and objects, transport the surgical carts, and making retraction during surgery and long standing).

Recommendations
- Conducting periodic in-services training program for operating room nurses to improve knowledge and practices related to ergonomics principles of work place and reduce the harmful effects of its hazards among nurses is considered of great importance.
- It is recommended to continuously monitor nurses who are working at operating room by administrative staff to ensure human wellbeing and overall performance to prevent injury.
- Developing the discipline of ergonomics to promote a holistic approach to occupational safety and satisfaction among operating room nurse.

Acknowledgment:

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