Effectiveness of Educational Program on Nurses' Performance toward Sustainable Development and Green Practice in Intensive Care Unit

Hayam Ahmed Mohamed[1], Mona Shahat Mohamed[2] & Ayat Ali Hablass[3]
(1) Assistant professor of Medical Surgical Nursing, Faculty of Nursing, Benha University.
(2) Lecturer of Medical Surgical Nursing, Faculty of Nursing, Benha University.
(3) Lecturer of Medical Surgical Nursing, Faculty of Nursing, Benha University.

Abstract

Background: Green practices by nurses can directly protect the ICU environment and attain sustainability by conserving energy and resources. **Aim:** was to evaluate effectiveness of educational program on nurses' performance toward sustainable development and green practice in intensive care unit. **Design:** A quasi-experimental study design (pre/post-test) was used to fulfill the study aim. **Setting:** The study was carried out in intensive care unit, Benha University Hospital. **Sample**: A convenience sample of seventy nurses in the intensive care unit were recruited in the research. **Tools**: three tools were employed: Tool I. Self-administered Questionnaire, it includes two parts; 1): Nurses' personal data, 2) Nurses' knowledge assessment. Tool II: Nurses' sustainability and green practices observational check list. Tool III: Nurses' attitude assessment scale toward sustainability and green practice. **Results**: illustrated that 62.9%, 58.6% of the nurses under the study had satisfactory level of total knowledge about sustainable development and green practice respectively at immediate post-program implementation and post one-month in the intensive care unit in contrast 8.6% prior to the program at $p < 0.05$. Moreover 68.6%, 65.7% of the nurses had satisfactory level of total practice respectively at immediate post, and Post one-month of program implementation and there was a significant improvement in mean scores of their attitude post-program implementation compared to pre-program at ($p < 0.05$). **Conclusion:** the results demonstrated that the educational program effectively improved knowledge and practice of the nurses toward sustainable development and green practices respectively in the intensive care unit than before. Moreover, nurses' attitude toward sustainability and green practice was significantly and positively improved than before the educational program implementation. **Recommendations**: Encourage conducting research for environmental sustainability and green practice in the ICU, which aim to decrease the passive effects of the environment on ICU practices.

Key words: Educational program, nurses' performance, sustainability development & green practice.

Introduction

Sustainable development is a balance between the needs of today and tomorrow generations so the future generation can meet their needs in the long term. Sustainability performance became a major concern for many healthcare organizations globally, as it providing long-term opportunities for growth and development, competitive advantages and financial viability **(El sawah & Elkholy, 2024).** Sustainable development in nursing field is related to the long-term goal of conserving a safe environment for current and future generations. The healthcare sectors urgently need to become more responsible and sustainable about the environment based on the moral obligation to implement health in all strategies **(Mekawy, 2023).**

Sustainability behaviors in the nursing sector showing the goal to consciously decrease the harmful effect of the nurses' actions on the work environment through continuous improvement of nurses' practices **(Sorour & Elkholy, 2021)**. Effect of health initiatives about sustainable development depend on nurses' performance, there is

requirement for concept of green healthcare which involves concurrent reduction of negative impacts on the patients and the environment, besides elimination of the diseases, by recognizing the correlation between human well-being and environmental health **(Abd-Elhamid & Gaber, 2023).**

Green practice is a conscious management of environment that focuses on preventing or continuous reduction of pollutions and waste. Green practice is the process of implementing innovation across the entire organization to attain sustainability, waste reduction, social responsibility and a competitive edge through ongoing learning and development as well as adopting goals and strategies that are completely matched with the organization's goals and strategies. **Elshaer et al., 2023).**

Intensive care refers to a package of services that include all aspects of diagnosis and treatment in accordance with the disease state, and the patients' individual needs. (**Faltas et al., 2024).** Intensive care unit spend a lot of energy and produce significant vast quantities of wastes, depend largely on a single use equipment and devices, and the patients require increased quantities of medications used in the treatment (**Hunfeld et al., 2023)** and the effects on the environment of ICU are critical issue as ICU uses a lot of clinical supplies, water, and energy that create a proportionately high ecological footprint **(Prasad et al., 2022 & Gaetani et al., 2024**).

Hospitals produce the majority of their daily waste volume in ICU. So, the management of waste is a critical concern **(Dúnmez, et al., 2019).** Medical waste must be handled and disposed properly; health issues and environmental concerns arise from lacking of clear rules for handling medical waste, as well as from inadequate training and ignorance of their application. Today nurses must be environmentally attentive in evaluating the impact of their practices on the environment and how to provide options to reduce hazard because they are expected to perform expanded tasks under various conditions **(Mohammed et al., 2019)**

Waste management, recycling, using energy efficiency equipment, eco-friendly cleaning products, water-saving techniques, and education of nurses are the first steps for sustainability. The healthcare future may be more sustainable as a result of those activities **(Trus et al., 2019).** In addition, water conservation is important, Hospitals using huge quantities of water from standard medical care to specialized treatments, including activities as handwashing, sterilization and air-conditioning, in which motion sensor technology could be greatly reduce it. (**McGain et al., 2020** & **Hunfeld et al., 2023)**

Significance of the study:

Environmental sustainability is becoming more important to health care sectors worldwide. In fact, the Global Green and Healthy Hospitals Network are bringing together for assisting healthcare services worldwide in becoming more ecologically conscious. Since nurses act 60% of the global health care workforce, they play a crucial role in implementing green practices in intensive care units. **(Elsayed et al., 2020).**

In 2018, The average amount of medical waste delivered in healthcare services across all Egypt governorates was 100566 kg per day, and 77884 kg per day which processed, according to the Ministry of Health and Population in Egypt. **(World Bank document, 2018).** Green practices by nurses can directly lower expenses and protect the environment of ICU and achieve sustainability through energy and resource conservation. Therefore, evaluating nurses' performance toward sustainability development and green practice in intensive care unit is crucial.

Aim of the study:

The study aim was to evaluate effectiveness of educational program on nurses' performance toward sustainability development and green practices in intensive care unit.

Operational definitions

Nurses' performance refers to knowledge, practice and attitudes of nurses regarding sustainability development and green practice

Sustainability development refers to the nurses' sustainability practice to decrease the harmful effect of their actions on the ICU environment and achieving goals through continuous improvement of their practices

Green practices in the current study refer to the practices of nurses regarding waste disposal, energy efficiency, water conservation and using sustainable materials in the intensive care unit.

Research Hypotheses:

For achieving the study' aim, the following hypotheses formulated:
H1: Knowledge of nurses score about sustainability development and green practice will be significantly improved after implementing the educational program compared to pre-program.
H2- Nurses' sustainability development and green practices scores will be significantly improved after implementing the educational program compared to pre-program.
H3- Nurses' attitudes toward sustainability development and green practices will be significantly and positively improved after implementing the educational program compared to pre-program.

Research design:

Quasi experimental research design (pre/post- test) was used to achieve the aim of the study. This design utilized for investigating whether there is causal correlation between independent and dependent variables, whereas the independent variable manipulated, and participants were not randomly assigned because the independent variable is manipulated before the dependent variable is measured **(Maciejewski, 2020).**

Setting:

The study was conducted in intensive care unit, Benha University Hospital, Qalyubia Governorate, Egypt. The ICU locate in the medical building, second floor, consists of 4 sections divided into right and left, each one contains 4 beds and at the middle of the unit there are three isolation rooms for infected cases, each one has two beds, the total are 22 beds and station for nurses in the center of the unit. Another 4 small rooms; for nurses, supervisors, doctors and conferences, and 2 corridors, one for wastes and the other for a disposable equipment.

Subjects:

A convenient sample of seventy nurses, who are already working in intensive care unit were recruited in the study.

Preparation of the study tools:

It included reviewing the most recent and earlier related literatures on many facets of the research utilizing books, articles, periodicals, and the internet to develop tools of data collection and the educational program.

Tools of data collection:

Three data collection tools were utilized including the following:

Tool I: Self-administered questionnaire: designed by the researchers after a careful reviewing of current, relevant literatures **(Czerwinski, 2020; Dimitrova, 2021 & Algabar, et al., 2023)** to assess nurses' knowledge regarding sustainable development and green practices in ICU. It was in multiple-choices questions form and consisting of two parts as follows:

(I): Nurses' personal data; it included 8 questions related to nurses' age, the marital status, gender, level of education, nurses' years of experience working in Hospital, nurses' years of experience working in ICU, received training about sustainability

development and green practices in ICU and received training about disposal of medical waste.

(II): Nurses' knowledge assessment [pre/ post- test]: regarding sustainable development and green practices in the intensive care unit included 22 multiple choices questions divided into four domains as follows:

1) General knowledge about sustainabilit development and green practices which include 12 questions covered knowledge about meanin of sustainable development and green practices pillar of sustainability, purpose of the tripl bottom line concept in sustainability management of a sustainability green practice i intensive care unit, its relation to ICU, potentia benefits, role that nurses can play in promotin sustainability development and green practice barriers to implement sustainability and gree practices in intensive care unit, steps, how t integrate sustainability and green practice wit nursing practice, and essential concepts o sustainable development and green practice i ICU.

2) Nurses' knowledge regarding optimal waste disposal in the intensive care unit and included 6 questions covered general knowledge about types of wastes in ICU, purpose of waste disposal, conditions of storage, methods of storage, different strategies of disposal of medical waste and strategies to limit wastes in ICU.

3) Nurses' knowledge regarding energy efficiency and water conservation in the intensive care unit and included 3 questions covered general knowledge about practices for energy efficiency, green technology for energy efficiency and save water.

4) Nurses' knowledge regarding using sustainable materials in the intensive care unit, included 1 question covered general knowledge about types of sustainable materials in ICU.

Scoring system:

One score was given for every correct answer and zero score for every incorrect answer. Total knowledge scores were summed up "22 score'' converted into a percentage and categorized into: satisfactory if scores is ≥80% = (≥18) and unsatisfactory if scores is <80% = (<18)

Tool II: Nurses' sustainability and green practices observational check list [pre/ post-test]

It used to evaluate nurses' sustainability and green practices in ICU, it adapted from **(Sorour & Elkholy, 2021; Hassan, et al., 2024),** and modified by the researchers after review the related references and jury opinions. It composed of 13 steps related to 1- waste disposal which included (five steps), 2- energy efficiency, consisted of (four steps), 3- water conservation (two steps), 4- using sustainable materials in the intensive care unit (two steps).

Scoring system: The scores calculated as one mark for the step which correctly done and zero for the step which incorrectly done or not done. Total practice scores were summed up "0-13 score'', converted into a percentage and divided into two categories: satisfactory practice ≥ 80% (≥10) and unsatisfactory practice < 80% (<10)

Tool III: Nurses' attitude assessment scale toward sustainability and green practices (pre/post educational program implementation): It is three point- Likert like scale used to evaluate attitude of nurses towards sustainability and green practice in ICU. It adapted from (**Elshall, et al., 2022, Mahmoud, et al., 2022 & Yeboah, et al., 2024),** and modified by the researchers after jury opinions and related references. It composed of 15 statements measuring nurses' agreement

Scoring system: It consisted of three responses, nurses were given 3 scores if they agreed, 2 scores if they neutral, and 1 score if they were disagreed. Then calculate the total scores for each nurse by summing up the scores from their responses. Total scores were varied from 1 to 45 scores. After being

converted to percentages, scores were grouped as the following:

- Scores less than 60% indicated negative attitude towards sustainability and green practices.
- Scores from 60% and more indicated positive attitude towards sustainability and green practices

Procedures

The educational program: The researchers designed the program in Arabic. based on nurses' assessment in the pretest and after reviewing the most recent relevant literatures **(Geber S., 2022**, **Ahmed A., et al., 2023, Saleh N., et al., 2023, Yeboah, et al., 2024, Boakye D., et al., (2024)** to meet nurses' needs toward sustainable development and green practice.

Content validity and Reliability

The tools and the education program were revised through jury which consisted of five professors in medical surgical nursing department, Benha Faculty of Nursing. They expressed their opinions about the tools' accuracy, consistency, layout, format, substance, and relevance. The Cronbach's alpha test was used to statistically test the produced tool's reliability, a model of internal consistency with a normal range of 0 to 1 (value greater than 0.6 acceptable reliability). The tool-I Nurses' Knowledge Questionnaire had a reliability score of 0.770. tool II: Nurses' practice checklist was reliable at 0.734 and Attitude scale at 0.791

Administrative and ethical consideration:-

By submitting a legal letter from the dean of Benha University's Faculty of Nursing to the hospital directors and head managers of the intensive care unit at Benha University Hospital, for receiving granted official permissions for data gathering. Additionally, before starting the study, the Faculty of Nursing's ethical committee granted its approval of the study with code REC-MSN-P69. After explaining the study' aims and informing the nurses that the participation is voluntary and optional, then their verbal and written consent was obtained. The researcher assured that the information collected would remain anonymous and confidential and would only be utilized for achieving the study's goals.

Pilot study:

Seven nurses (10%) of the total nurses in ICU at Benha University Hospital participated in a pilot study to test applicability and clarity of the study tools, estimate the time needed to complete each one, and find any potential obstacles to data collection. As a result, the nurses participated in the pilot study were included in the main study as no changes were made.

Field work:

Data collection and implementation of the educational program were between July 1st, 2024, to October end, 2024. The process of data collection achieved through three levels, Pre- program assessment to determine the baseline level of nurses' knowledge, practice and their attitude toward sustainability development and green practices, then immediately as post-test and one month later for follow up of nurses' knowledge, practice and attitude toward sustainability development and green practice following implementation of program.

The study was carried out in the following four phases:

Assessment phase pre- test:

It included assessment of nurses' knowledge using tool I, practice using tool II and attitude using tool III, regarding sustainability development and green practice, the assessment provided base line information on the current level of their knowledge, practices deficit and their attitude regarding sustainability development and green practice, in order to prepare the content needed to include in the program.

The assessment gave more

understanding about the current nurses' knowledge level and practices as well as their attitude, which helped in detecting the defects to prepare the educational program.

Planning phase:

The researchers gathered the needed data about the study setting for putting the plan for the study, and designed the educational program to meet nurses' needs, deficiency in their practices and achieve objectives of the program through preparing booklet as an educational material covering data included both theory and practice information.

The time of teaching sessions planned and arranged with the nurses after finishing their shift and some times before starting to be free from duties toward the patient, as ICU is consuming large time and effort from nurses during the shift, so we arranged together the time suitable for teaching sessions at the conference room in the unit

Implementation phase :

-The educational program was implemented through three sessions, about 30 minutes were allotted for each session, which included discussion times based on the nurses' input and progress. Seventy nurses were the total number of nurses under study, included fifteen groups, each one consisted of four to five nurses per session. Three times a week was the time in which the researcher visited ICU at morning and afternoon shifts throughout the data collecting period.

- Power Point presentations were used as a teaching method during the sessions, in addition to distribution of Arabic booklets to the participated nurses in the study, containing illustration pictures for reviewing and supporting the instruction and improving nurses' understanding of sustainability development and green practice in intensive care unit. To be sure that participated nurses received the anticipated benefit, each session began with an overview of the previous one and the goals of the current one and summary of the contents and input from the nurses**.**

Teaching sessions were conducted as the following:

The first session, An overview of the educational program's goals and contents was given and general information about sustainability development and green practices which included; meaning and examples of sustainable development and green practice in relation to the intensive care unit, barriers to implement sustainability and green practices in intensive care unit, benefits of green sustainable practices in the ICU, basic principles of sustainable development, the main objective of green practice, sustainable development goals and roles of nurses in promoting and integrating sustainability and green practice in the ICU.

The second session, nurses were provided information about energy efficiency, water conservation and sustainable materials in the intensive care unit included general information about energy efficiency in the ICU, best practices for energy efficiency, green technology for energy in the ICU, and water conservation in the ICU, importance of water conservation and green techniques for saving water in addition to general knowledge about types of sustainable materials in ICU.

The third session, nurses were provided information related to nurses' sustainability development and green practices covered knowledge about types of wastes in ICU, purpose of waste disposal, conditions of storage, methods of storage and dealing with it, different strategies of disposal of medical waste and strategies to limit wastes in ICU and using sustainable materials in the intensive care unit

After completing the sessions, the nurses informed that they will be evaluated one month post sessions

Evaluation phase:

Using the same pre-test tools; (tool I part 2) patients' knowledge assessment questionnaire, tool (II) Nurses' practice observational Checklist which evaluated at time of their shift and tool (III) Nurses' attitude toward sustainability development and green practice were used for nurses in ICU to evaluate their knowledge, practice and attitude immediately post the educational program and at follow up after one month.

Statistical analysis

The statistical package for social science (SPSS), version 25, was used to analyze the data. Mean and standard deviation to express the numerical data, while frequency and percentage to express the qualitative data. Chi-square test utilized to look for differences between the qualitative variables, and the paired t-tests were used to compare the mean scores between two different periods within the same group.

The Pearson product-moment correlation coefficient and spearman correlation for categorical variables were used to evaluate for correlation between various numerical variables. If p-value less than 0.05, it considered a significant, and if less than 0.001 considered highly significant.

Results:

Table (1) shows that 60.0% of the nurses under study were between 30 and 40 years old with mean age 29.60 ± 0.49. concerning to gender and marital status, 78.6% & 88.6% of the nurses are females & married respectively. As well, 65.7% of the nurses had Bachelor's degree in nursing, 58.6% of them had five to less than ten years of experience in the hospital, while 55.7% had one to less than five-years of experience in the ICU. Moreover 100.0% of the studied nurses had neither received training program for sustainable development and green practices in ICU nor received training program for waste disposal in ICU.

Table (2) represents that, 8.6% & 14.3% of the studied nurses had satisfactory knowledge regarding to general knowledge about sustainable development and green practice and optimal waste disposal in the intensive care unit respectively at before receiving the educational program, which improved to be 75.7% & 90.0% satisfactory level at immediate post program, while it declined post one month of program implementation to be 61.4% &68.6% respectively with statistically significant differences between the three stages.

Regarding to knowledge about energy efficiency, water conservation in the intensive care unit and using sustainable materials, the current results represent that 11.4% & 25.7% of the studied nurses respectively had satisfactory knowledge at pre the educational program which improved to be 68.6% & 75.7% (satisfactory level of knowledge) at immediate post, while it declined post one month of program implementation to be 67.1% & 67.1% respectively with statistically significant differences between the three stages.

Figure (1) demonstrates that, 8.6% of the nurses had satisfactory level of total knowledge regarding sustainable development and green practices in the ICU at pre- program implementation, while, immediately post implementation 62.9% of them had satisfactory level of total knowledge, and after one month there was a decrease in their total satisfactory level of knowledge 58.6% with statistically significant differences between the three phases.

Table (3) demonstrates that, there was a statistically significant difference between pre-program and immediately post implementation of the program, as well one month post program implementation among the studied nurses regarding all items of sustainability green practices in the intensive care unit as P-value ≤ 0.05 .

Additionally, there was an improvement in all items of sustainability development and green practices in the ICU immediately post and also post one month of program implementation among the nurses.

Figure (2) reveals statistically significant differences between the three phases of program implementation regarding nurses' sustainability green practices in the intensive care unit, where 88.6% of the studied nurses had unsatisfactory level of practice about sustainability green practices in the intensive care unit pre-program implementation and 11.4% had satisfactory level. While, 68.6% of them had satisfactory level of practice immediately post program implementation and 31.4% had unsatisfactory level. Post one-month there were slight decline in their practices observed as 65.7% were at satisfactory level and 34.3% were unsatisfactory.

Table (4) shows that, difference of sustainability and green practice attitude between the pre- and immediate post-program stages, there were statistically significant variations among the nurses under study and significant statistical differences between pre- and post-one month of program implementation in all items except one item (knowledge about sustainable green practice should be part of nurses' professional development) at P-value ≤ 0.0

Table (5) reveals a positive correlation between total nurses' knowledge, practice and attitude regarding sustainability and green practice during the program phases and a highly statistically significant positive correlation between nurses' knowledge and total practice post program implementation ($P < 0.001$).

Table (1):–Frequency and percentage distribution of studied nurses according to their personal data (n= 70).

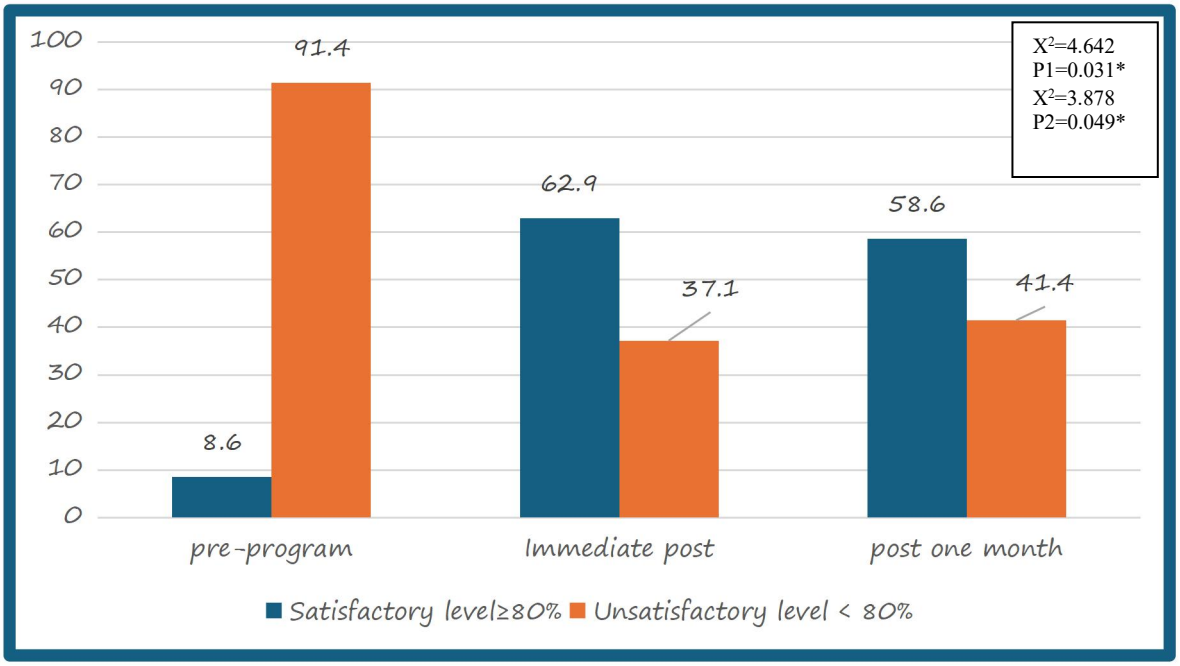
Nurses' personal data	No.=70	
	(No.)	%
Age		
20 - <30	28	40.0
30 – 40	42	**60.0**
Mean ± SD	29.60 ± 0.49	
Gender		
Male	15	21.4
Female	55	**78.6**
Marital status		
Single	8	11.4
Married	62	**88.6**
Level of education		
Nursing technical institute diploma	24	34.3
Bachelor of nursing	46	**65.7**
Years of Experience in the hospital		
1 < 5 years	22	31.4
5 ≤ 10 years	41	**58.6**
≥ 10 years	7	10.0
Years of Experience in ICU		
< 1 year	14	20.0
1 - < 5 years	39	**55.7**
5 - <10 years	17	24.3
Received training programs for sustainable development and green practices in ICU		
-Yes	0	0.0
-No	70	100.0
Received training programs for waste disposal in ICU		
-Yes	0	0.0
-No	70	100.0

Table 2. Comparison between nurses' knowledge dimensions regarding sustainable development and green practices in the intensive care unit during program phases (n=70).

Total nurses' knowledge dimensions	Pre- program		Immediately post Program		Post one month of program		χ^2 (p value) (1)	χ^2 (p value) (2)
	(No.)	%	(No.)	%	(No.)	%		
General knowledge about sustainable development and green practice	6	**8.6**	53	**75.7**	43	**61.4**	4.922	4.121
Satisfactory≥80%	64	91.4	17	24.3	27	38.6	0.027*	0.042*
Unsatisfactory <80%								
Optimal waste disposal in the intensive care unit					48		5.347	4.667
Satisfactory≥80%	10	**14.3**	63	**90.0**	22	68.6	0.021*	0.031*
Unsatisfactory <80%	60	85.7	7	10.0		31.4		
Energy efficiency and water conservation in the intensive care unit								
Satisfactory ≥80%	8	11.4	48	68.6	47	67.1	4.420	4.140
Unsatisfactory <80%	62	88.6	22	31.4	23	32.9	0.036*	0.042*
Using sustainable materials in the intensive care unit							11.858	4.623
Satisfactory ≥80%	18	25.7	53	75.7	47	67.1		
Unsatisfactory <80%	52	74.3	17	24.3	23	32.9	0.001**	0.032*

(1) Difference between pre and immediate post periods of program
(2) Difference between pre and post one month of program

Figure 1. Difference between the studied nurses' total knowledge levels regarding sustainable development and green practices in ICU during the program phases (n=70).



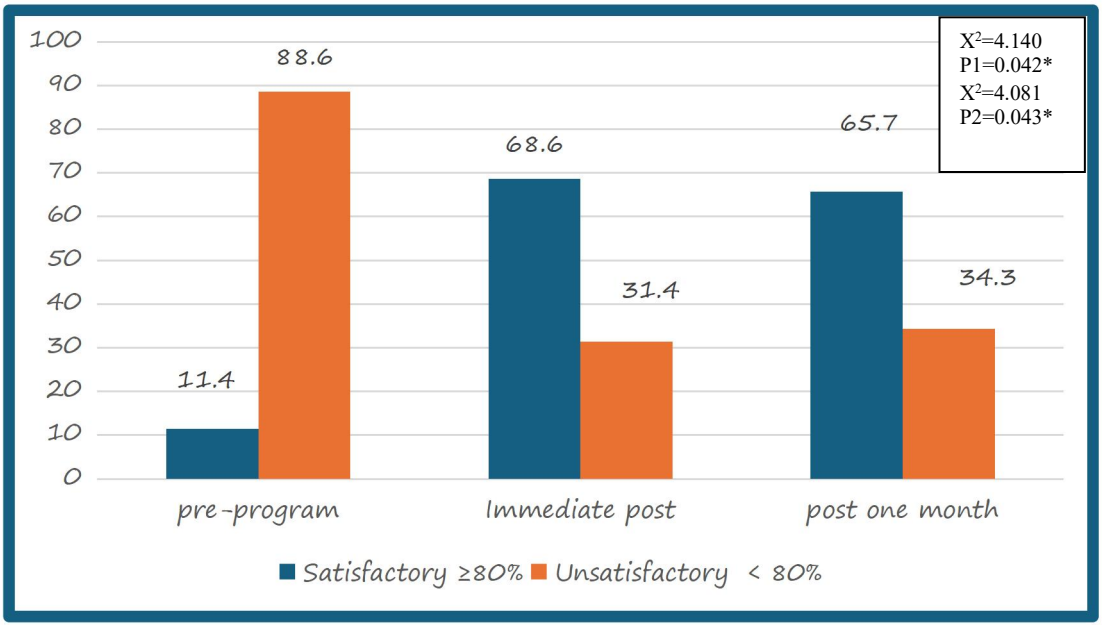
(1) Difference between pre and immediate post periods of program
(2) Difference between pre and post one month of program

Table 3. Comparison between total nurses' sustainability green practices in the intensive care unit during the program phases (n=70).

Total nurses' Sustainability green practices	Pre program		Immediately post Program		one month post program		χ^2 (p value) (1)	χ^2 (p value) (2)
	(No.)	%	(No.)	%	(No.)	%		
Waste disposal in the intensive care unit							7.112	3.848
Satisfactory ≥80%	19	27.1	61	87.1	55	78.6	0.008*	0.050*
unsatisfactory <80%	51	72.9	9	12.9	15	21.4		
Energy efficiency in the intensive care unit							5.657	3.950
satisfactory ≥80%	15	21.4	58	82.9	54	77.1	0.017*	0.047*
unsatisfactory <80%	55	78.6	12	17.1	16	22.9		
Water conservation in the intensive care unit								
satisfactory ≥80%	22	31.4	59	84.3	57	81.4	7.317	5.982
unsatisfactory <80%	48	68.6	11	15.7	13	18.6	0.007*	0.014*
Using sustainable materials in the intensive care unit								
satisfactory ≥80%	13	18.6	55	78.6	47	67.1	4.583	4.354
unsatisfactory <80%	57	81.4	15	21.4	23	32.9	0.032*	0.037*

(1) Difference between pre and immediate post periods of program
(2) Difference between pre and post one month of program

Figure 2. Comparison between total practices scores pre/post implementation of the program (n=70).



(1) Difference between pre and immediate post periods of program
(2) Difference between pre and post one month of program

Table (4): the studied nurses' attitude regarding sustainability and green practice during the program phases (n=70).

Nurses' attitude	Pre-program	Immediately post Program	Post one month of program	t- test P value (1)	t- test P value (2)
	Mean ± SD	Mean ± SD	Mean ± SD		
Knowledge about sustainable green practice should be part of nurses' professional development	3.00 ± 0.00	3.00 ± 0.00	3.00 ± 0.00	N.A	N.A
believe that green sustainability training is effectively delivered by hospital	1.50 ± 0.50	2.09± 0.79	2.01± 0.75	- 5.816 (<0.001**)	- 5.420 (<0.001**)
Feel that they have sufficient resources to implement sustainability and green practices in the ICU	1.59 ± 0.49	2.19 ± 0.72	2.19 ± 0.72	-5.633 (<0.001**)	-5.633 (<0.001**)
Feel confident in implementing sustainability and green practices in daily work	2.69 ± 0.46	3.00± 0.00	2.96 ± 0.20	- 5.624 (<0.001**)	- 4.235 (<0.001**)
Think sustainability is important in the ICU	2.79 ± 0.53	3.00 ± 0.00	2.96 ± 0.20	-3.348 0.001**	- 2.984 (0.004*)
Willing to participate in new green sustainability initiatives in the intensive care unit	2.80 ± 0.40	3.00 ± 0.00	2.97 ± 0.16	-4.153 <0.001**	- 3.778 (<0.001**)
Believe that healthcare facilities have a huge impact on the environment	2.83 ± 0.38	3.00 ± 0.00	2.96 ± 0.20	-3.778 <0.001**	- 3.191 (0.002*)
Implementing sustainable practices in the ICU is essential for the well-being of future generations	2.77 ± 0.42	2.96 ± 0.20	2.94 ± 0.23	-3.967 <0.001**	- 3.778 (<0.001**)
feel personally responsible for reducing my environmental footprint while working	2.64 ± 0.70	2.96 ± 0.20	2.94 ± 0.23	- 3.688 (<0.001**)	- 3.268 (0.002*)
Proper waste separation and disposal are critical elements of my job	2.76 ± 0.43	3.00 ± 0.00	2.94 ± 0.23	- 4.704 (<0.001**)	- 3.638 (0.001**)
Energy Conservation: It is important to conserve energy in the ICU	2.89 ± 0.32	3.00 ± 0.00	2.93 ± 0.25	- 3.391 (0.001**)	- 2.115 (0.038*)
The hospital should prioritize the purchase of environmentally friendly products	2.77 ± 0.51	3.00 ± 0.00	2.94 ± 0.23	- 2.984 (0.004*)	- 2.435 (0.017*)
Water Conservation: Reducing ICU water use is important to achieve sustainable green practice	2.73 ± 0.58	3.00 ± 0.00	2.94 ± 0.23	- 3.709 (<0.001**)	- 2.134 (0.036*)
open to continuous learning about green sustainability practices and eco-friendly products.	2.84 ± 0.47	3.00 ± 0.00	2.99 ± 0.12	- 2.795 (0.007*)	- 2.439 (0.017*)
Sustainable green practices can enhance the quality of care provided to patients	2.81 ± 0.46	3.00 ± 0.00	2.94 ± 0.23	- 3.380 (0.001**)	- 2.006 (0.049*)
Total	39.31 ± 3.02	42.51 ± 1.83	40.15 ± 1.11	- 8.125 (<0.001**)	- 2.020 (0.047*)

(1) Difference between pre and immediate post periods of program

(2) Difference between pre and post 1 month periods of program

Table 5. Correlation coefficient between nurses' total knowledge, practice and attitude regarding sustainability and green practice during the program phases (n=70).

	Study periods	total practice	Total attitude
		r (P value)	r (P value)
Nurses' knowledge	Pre program	0.875 <0.001**	0.481 <0.001**
	Immediate post program	0.938 <0.001**	0.271 0.023*
	One month post program	0.921 <0.001**	0.723 0.043*

** Highly statistically significant p ≤ 0.001

Discussion

Intensive care unit consume large amounts of energy, generate significant vast quantities of wastes, using large volumes of clinical supplies, water and nurses are requested to perform expanded roles under different conditions, so they must be sensitive in assessing the influence of their practices on the ICU and how to make available ways to diminish hazard through applying green practice in their performance in ICU as it is crucial in sustainable development, **(Mohammed et al., 2019)** so educational program needed for nurses about sustainability development and green practices to improve their performance in intensive care unit.

Related to personal data of the studied nurses. The findings showed that three fifths of the nurses under study were between 30 and 40 years old, and the mean age was 29.60 ± 0.49 years, this result may attributable to the majority of nurses providing direct care for critically ill patients in intensive care unit are at young age, while the older age nurses have managerial roles. This finding is matched with **Faltas, et al., (2022),** study about green practice guideline related to waste management and nurses' knowledge and practice in intensive care units, which reveal that half of the sample of their study was at ages ranged from 35 to less than 40 years old.

Findings of the present study reveals that more than three quarters of the nurses were females. It might be because the long-held belief about nursing profession in Egypt that it is a career for females only. Study by **Hassan, et al., (2024)**, about barriers to green practices regarding waste management between operating room nurses, mentioned that majority of the nurses were females, which is consistent with the current finding, also, **Musa et al. (2020)** studied nurses' practice and barriers to medical wastes management and showed that majority were female. Also, the current study shows that majority of the nurses were married. It may be referred to they were female and the Egyptian culture support the early marriage for females. This result was in the same line with **Geber, (2022) and Bein, (2023)** studies which revealed that, the majority of the studied nurses were married.

Concerning to the level of education, the current study finds that roughly two thirds of the nurses graduated from nursing faculty. This finding is because intensive care units in Benha university hospital depend on nurses who have Bachelor's degree. This outcome is congruent with **Kwakye, (2020)** research about green practices for surgical units who reported that more than half of studied nurses got Bachelor degree in nursing.

In respect to nurses' experience in nursing field, the present study demonstrated that more than half of the nurses reported having five to less than ten years of experience in nursing field. This finding is because the majority of nurses were recently graduated. This outcome was consistent with **Dimitrova, (2021)** study regarding sustainable development and competence of nurses in intensive care, who showed that more than half of the sample has from six to ten years' experience. Also, the present study reveals that more than half of the nurses reported having one to less than five years of experience in intensive care unit. This result was in the same line with **Bhonagiri et al., (2023)** in the study of environmental sustainability in the ICU who reported, about half of the sample has one to five experience years in ICU.

Related to received training courses for sustainable development and green practices in ICU and for waste disposal in ICU, all of studied nurses had neither received any training courses for sustainable development and green practices nor received training courses for waste disposal in ICU. This may be due to lack of staff, excessive work load and deficiency of training program for waste management in the intensive care unit. This result was congruent with **Saleh et al., (2023)** study which reported that most of nurses had no training courses about green practices.

Related to nurses' knowledge about sustainable development and green practices in the intensive care unit pre and post program implementation. Findings represent that majority of the studied nurses had unsatisfactory knowledge regarding general information about sustainable green practice and optimal waste disposal in the intensive care unit before receiving the educational program, this unsatisfactory level of nurses' knowledge because; lack of training and educational program to raise their awareness towards sustainable development and green practices in ICU. While their knowledge improved significantly with increasing in the percentage to a satisfactory level at immediate post program implementation then it declined post one month of program implementation. So, they need continuous periodic educational program and follow up.

This result was consistent with **Iira et al., (2021)** who conducted research about perceptions of nurses about the climate change impact and the preparation to these impacts, revealed that about three quarters of nursing managers had unsatisfactory knowledge about green management before intervention, and improved to majority of them had satisfactory knowledge and at follow-up after intervention. The present study results also similar to the result of study carried out by **Hassan, et al., (2024)**, revealed that majority of studied nurses had poor knowledge level related to green practice and management of wastes in the operating room before implementation of the program, while about three quarter had good level of knowledge at immediately post implementation.

The majority of the nurses in the present study results had unsatisfactory knowledge regarding energy efficiency and water conservation in the intensive care unit, at pre the educational program, this because the nurses have not known standard to follow related to energy efficiency and water conservation in ICU. While the nurses' knowledge improved to more than two thirds were at satisfactory level at immediate post and slightly declined post one month of program implementation, which reflect the positive effect of the program and the need for continuous follow up to prevent any decline in their knowledge. This result is in the same line with **Saleh et al., (2023)** study, mentioned that the mean score for energy conservation knowledge that significantly improved post intervention and at follow-up. Related to knowledge about using sustainable materials nearly three quarters of nurses had unsatisfactory knowledge at pre the educational program which significantly improved to more than three quarters were at

a satisfactory level at immediate post and declined to more than two thirds post one month of program implementation. The satisfactory knowledge level of nurses post program implementation reflect the positive effect of the educational program

Regarding to nurses' total knowledge level about sustainable development and green practices in the intensive care unit pre and post periods of program. The result demonstrated that the most of studied nurses had unsatisfactory level of total knowledge regarding sustainable development and green practices in the intensive care unit at pre- program implementation, while, it significantly increased at immediate post implementation to be about two third of them had satisfactory level of total knowledge and after one month there was a decrease to be more than half at satisfactory level of knowledge. These results support the first hypothesis. The findings were in consistent with **Mahmoud et al., (2022),** who revealed that most of studied nurses had poor total knowledge before implementation of the program, while about three quarters of them had good level of knowledge immediately post implementation.

As regards to sustainability green practices of nurses in the ICU pre and post program implementation, findings indicated that there was a significant improvement in all items of sustainability green practices in the intensive care unit at immediate post and post one month of program implementation among the studied nurses. It explained as following; Nearly three quarter of nurse had un satisfactory practice in proper waste disposal in the intensive care unit, while the majority of them their practices improved to be satisfactory at immediate post of the educational program then it declined post one month to be more than three quarter were satisfactory in their practice. the improvement reflects the positive effect of the educational program toward proper waste disposal in ICU.

The explanation of this unsatisfactory nurses' practices at pre- program may be because no specific protocol to follow for the disposal of hazardous wastes in the ICU. Other research by **Kumar. (2020)** studied knowledge and practice among staff nurses about biomedical waste management in the hospital and showed inadequate in their Practice of biomedical waste management. And study by **Saleh et al. (2023)** showed a significant improvement of nursing mangers' knowledge and the green management practices at post and follow up of green management training program, also study by **Hassan et al. (2024),** in their study regarding to barriers of green practice related to waste management for operating room nurses and demonstrated that 100% of studied nurses had unsatisfactory green practice related to waste management in operating room.

Regarding energy efficiency practice in the intensive care unit including turning off lights and medical instruments when not in use and adjusts heating and cooling systems appropriately to avoid energy wastage, the findings revealed, more than three quarters were unsatisfactory in their practice at pre - program, while it significantly improved to be the majority were satisfactory at immediate post then declined post one month to be more than three quarter were satisfactory in their practice. The reason for unsatisfactory in nurses' practice at pre - program may be because they not follow a specific standard for energy conservation in ICU and show that the program was efficient to improve their green practice.

Regarding water conservation practice in the intensive care unit, more than two thirds of them were unsatisfactory at pre- program while it significantly improved to majority were satisfactory at immediate post and slightly declined in their practice post one month. And related to using sustainable materials by nurses in the intensive care unit, the finding shows, the majority were unsatisfactory pre the program

implementation which improved to more than three quarter were satisfactory at immediate post and more than two thirds post one month, this positive change in practice shows that presence of guidelines or programs for nurses' green practice in ICU is very important.

Result was in the same line with **Masud et al., (2024)** study, who revealed that, more than two third of nurses were unsatisfactory in sustainability green practices in the intensive care unit pre-program implementation, and majority of them were satisfactory in sustainability green practices immediate post program implementation then declined post one month of program implementation. Also, the findings were consistent with research conducted by **Leppänen et al., (2022),** who revealed that more than half of nurses were incompetent in sustainability practices in the operating room pre- implementation of the program, while most of them were competent in sustainability practices at immediate post-implementation of the program.

concerning nurses' sustainability and green practices in ICU pre and post program implementation, this result shows that the majority of studied nurses had unsatisfactory level of practice about sustainability and green practices in the intensive care unit pre-program implementation, however, immediately post program implementation it significantly improved to more than two third of them had satisfactory practice, while post one-month slight decline in their practices was observed, this decline may relate to the heavy work in ICU with more emergent cases and procedures that hinder their adherence to green practice. These finding support the second hypothesis and the outcome is congruent with research done by **Mahmoud et al., (2022),** which revealed that majority of the nurses had incompetent practice pre-program, and most of them had competent practice immediately post program implementation. In addition to, **Dimitrova, (2021)** demonstrated that most of nurses were incompetent in practice level about sustainability development in intensive care structures before program, and the majority were competent in practice immediately post program implementation.

Related to attitude of the studied nurses toward sustainability and green practice pre and post periods of program implementation**,** the present findings showed that there were highly significant statistical differences between pre- and immediate post and significant statistical differences between pre- and post-one month of program implementation in all items except item of (Knowledge about sustainable green practice should be part of nurses' professional development) at P-value ≤ 0.05. Related to their total mean score of nurses' attitudes, it was 39.31 ± 3.02 pre the program which significantly improved to 42.51 ± 1.83 at immediate post and were 40.15 ± 1.11 post one month with slightly decrease, these results support the third hypotheses. This improvement of nurses' attitude showed the effectiveness of the educational program and their readiness to practice sustainability and green practices in ICU.

The results were consistent with **Yeboaha, et al., (2023)** study which studied nurses' attitudes, perceptions, and their perspectives regarding climate changes and sustainability health care practices and revealed a highly significant statistical differences between pre- and immediate post implementation of the program in all knowledge items about sustainable development in area of improvement in their attitude. And **Elshall1 et al., (2022)**, found increased total mean score of attitudes among studied nursing students' group post the intervention related to Sustainability development.

Regarding correlation coefficient between nurses' total knowledge, practice and attitude regarding sustainability and green practice post program implementation. It is noted a significant positive correlation present between total nurses' knowledge,

practice and attitude regarding sustainability and green practice post one month of program implementation with a highly statistically significant correlation (P <0.001) these results explained importance of raising knowledge level for nurses as it affect their awareness to best practice and change their attitudes. other study by **Algabar, et al., (2023),** about nurse mangers' role in sustainability management behavior for building sustainability consciousness among nurses, mentioned positive correlation between total nurses' knowledge, attitude and practice regarding sustainability and green practice pre and post program.

Additionally, the current study's findings aligned with **Almukhtar et al. (2024)** study about barriers and facilitators for sustainability in operating room, utilizing the theoretical frame work and reported a highly statistically correlation between nurses' knowledge, attitude and practice after the program.

Conclusion

The research findings demonstrated that the educational program effectively improved the studied nurses' knowledge and practice toward sustainable development and green practices respectively in the intensive care unit than before the program. Moreover, nurses' attitude toward sustainability and green practice, significantly and positively improved post implementing the educational program than before. And noted a positive correlation between total nurses' knowledge, practice and attitude regarding sustainability and green practice post one month of program implementation with a highly statistical significant positive correlation.

Recommendation:

- Nurses should integrate sustainable green practices in their routine care for critical patients in the ICU.
- Encourage conducting researches for environmental sustainability and green practice in the ICU, and that aimed to decrease the environmental impact on ICU procedures.
- Design sustainability green practice guidelines for the nurses in the ICU

References:

Abd-Elhamid, E, & Gaber, S., (2023): Effect of Green Management Educational Program on Nurses' Sustainability Management Knowledge in A Selected Hospital, Nurses' Demographics Correlate. Egyptian Journal of Health Care, December. EJHC Vol. 14(4), p. 1050-1059.

Ahmed, A., Hassan, A., Gabra, F., (2023): Effect of educational program on knowledge, attitude and practice of nursing students toward sustainable development goals. Egyptian journal of health care, 14(3), 919-932.

Algabar, A., Ghadery, S., Mohamed, L., & Shaheen, R., (2023): Role of nurse mangers sustainable management behavior in building sustainability consciousness among nurses,Tanta scientific nursing journal,30(3) ,Pp 246-261.

Almukhtar, A., Batcup, C., Bowman, M., Winter-Beatty, J., Leff D., Demirel, P. & Judah G., (2024): Barriers and facilitators to sustainable operating theatres: a systematic review using the Theoretical Domains Framework. International journal of surgery, 110(1), Pp554-568.

Bein, T., (2023): The CO 2 footprint of intensive care medicine-let's go green. National library of medicine, critical care,118(5), P1094.

Bhonagiri, D., Pinder, M., & Huckson, S., (2023): Environmental sustainability in the intensive care unit: A toolkit to counter futility. *Critical Care and Resuscitation*, *25*(2), P 61.

Boakye, D., Kwashie, A., Adjorlolo, S. & Korsah, K., (2024): Nursing education for sustainable development: A concept analysis. Nursing open ,11(10), e70058

Czerwinski, M. A., (2020): A Dissertation on Sustainability Competence: Directions for Nursing (Doctoral dissertation, University of Michigan).

Dimitrova, (2021): Sustainable Development in the Training and Professional Competence of Nurses in Intensive Care Structures, International health science, 8(6), P654.

DÖnmez, Y., Aslan, A., & Giersbergen, M., (2019): Environment-Friendly Practices in Operating Rooms in Turkey. The Journal of Nursing Research.27(2),1-7.

El sawah, E., & Elkholy, S., (2024): Prosocial leadership and Organizational sustainability: moderating role of nurses' green behavior. International Egyptian Journal of Nursing Sciences and Research, 4(2), 70-86.

Elsayed, A., Ibrahem, M. & Diab, G., (2020): Assessing Knowledge and Performance of Healthcare Providers Regarding Hospital Waste Management in Menoufia Governorate Hospitals. Menoufia nursing journal,5(1), 27 -38.

Elshaer, I., Azazz, A. & Fayyad, S., (2023): Green Management and Sustainable Performance of Small and Medium-Sized Hospitality Businesses: Moderating the Role of an Employee's Pro-Environmental Behaviour. Int. J. Environ. Res. Public Health 2023, 20, 2244. https:// doi.org/10.3390/ijerph20032244

Elshall, S., Darwish, S., & Shokry, W., (2022): The Effectiveness of Educational Interventions about Sustainability Development among Nursing Students. Egyptian Journal of Health Care, 13(1), 294-310.

Faltas, S., Soliman, S. Ahmed, A. & Mahmmoud, S., (2022): Green practice guideline program regrading waste management on nurses' knowledge and practice in intensive care units, International journal of nursing science,8(6), P1019.

Gaetani, M., Uleryk, E., Halgren, C., & Maratta, C., (2024): The carbon footprint of critical care: a systematic review. Intensive Care Med. https://doi.org/10. 1007/s00134- 023- 07307-1.

Geber S., (2022): Nursing managers' knowledge regarding green management in a selected hospital, Egyptian journal of health care,14(4), Pp1050-1052.

Hassan, E., Mahdy, N., & Ahmed, N. (2024): Barriers to Green Practice regarding Waste Management among Operating Room Nurses. Egyptian Journal of Health Care, 15(2), 265-284.

Hunfeld, N., Diehl, JC., Timmermann, M., van Exter, P., Bouwens, J., Browne Wilkinson, S., de Planque, N., & Gommers, D., (2023): Circular material flow in the intensive care unit-environmental effects and identification of hotspots. Intensive Care Med 49:65–74. https://doi.org/10.1007/ s00134- 022-06940-6.

Kumar, B., Sameer, S., murthy, V. & Prasad, G., (2020): Knowledge and Practice of Biomedical Waste Management and Awareness of 3 'R's Concept Among Staff Nurses in the Hospital—A Cross-sectional Study. In: Ghosh, S. (eds) Urban Mining and Sustainable Waste Management. Springer, Singapore. https://doi.org/10.1007/978-981-15 0532-4_3

Kwakye G., (2020): green practices for surgical units, Yale Medicine Thesis Digital Library, national library of medicine, 146(2), P131.

Leppänen, T., Kvist, T., McDermott-Levy, R. & Kankkunen, P., (2022): Nurses´ and nurse managers´ perceptions of sustainable development in perioperative work: A qualitative study, Journal of clinical nursing, 31(7-8),1061-1072.

Iira, T., Ruth, M., Hannele, T., Jouni, J., &Lauri, K., (2021): Finnish nurses' perceptions of the health impacts of climate change and their preparation to address those impacts, national library of medicine, 56(2), Pp365-371

Maciejewski, M., (2020): Quasi-experimental design. Biostatistics & Epidemiology, 4(1): 38-47. https://doi.org/10. 1080/24709360. 2018.1477468

Mahmoud, M., Farag, E., & Khalil, B., (2022): The effect of training program on improving awareness regarding climate change-related disasters among hospitalized patients undergoing surgical procedure. International Journal of Health Sciences, 6(S8), pp 7151–7174. https://doi.org/10.53730/ijhs.v6nS8.14848

Masud, F., Sasangohar, F., Ratnani I., Fatima, S., Hernandez, M. Riley, T., Fischer, J., Dhala, A., Gooch, M., Johnson, K., Moon, J. & Vincent, J., (2024): Past, present, and future of sustainable intensive care: narrative review and a large hospital system experience, national library of medicine, critical care, 28(1),P154. https://doi.org/10.1186/s13054-024-04937-9

McGain, F, Muret, J, Lawson, C, Sherman, JD., (2020): Environmental sustain- ability in anaesthesia and critical care. Br J Anaesth 125:680–692. https:// doi.org/10.1016/j.bja.2020.06.055

Mekawy, S., (2023): Climate Change and its Relation to Environmental Sustainability Practice as Perceived by Staff Nurses, journal of nursing science,1(4), P392.

Mohammed, H., El-Kader. R., & Ibrahim, A., (2019): Knowledge, Attitude and Practice of Health Care Personnel about Medical Waste Management in Selected Family Health Centers in Mansoura, Egypt. International Journal of Innovative Research in Medical Science, 4(6).

Musa, F., Mohamed, A., & Selim, N., (2020): Assessment of Nurses' Practice and Potential Barriers Regarding the Medical Waste Management at Hamad Medical Corporation in Cross-Sectional Qatar: Study. A Cureus journal,12(5),1-12. DOI: 10.7759/cureus.8281

Prasad, PA., Joshi, D., Lighter, J., Agins, J., Allen, R., Collins, M., Pena, F., Velletri, J., Thiel, C., (2022): Environmental footprint of regular and intensive inpatient care in a large US hospital. Int J Life Cycle Assess 27:38–49. https://doi. org/10.1007/s11367- 021-01998-8.

Saleh, N., Eldeep N., & Soliman, S., (2023): Effect of Green Management Training Program on Nursing Managers' Perception of Occupational Safety and Green Management Practices, Egyptian Journal of Health Care, 14(3), P381.

Sorour, M., & Elkholy, S., (2021): Relationship between servant leadership and its' role on staff nurses' creativity and sustainable development behavior. Assiut Scientific Nursing Journal, 9(24.0), 87-101.

Trus, M., Galdikiene, N., Balciunas, S., Green, P., Helminen, M., & Suominen, T., (2019): Connection between organizational culture and climate and empowerment: The perspective of nurse managers. Nursing & health sciences, 21(1), 54-62.

World Bank Document (2018): Environmental and Social Management Framework (ESMF), Transforming Egypt's Healthcare System Project available

at:http://documents1.worldbank.org/curated/en/594471524601888530/pdf/ESMF.pdf

Yeboah, E., Adegboye, A. & Kneafsey, R., (2024): Nurses' perceptions, attitudes, and perspectives in relation to climate change and sustainable health care practices: A systematic review who, journal of climate change and health, (16)1, p1029.