

## Effect of the Artificial Intelligence Enhancement Program on Head Nurses' Managerial Competencies and Flourishing at Work

Hind Abdullah Mohamed<sup>(1)</sup>, Samia Gamal Awad<sup>(2)</sup>, Noura Elgharib Mohamed Mostafa Eldiasty<sup>(3)</sup>, Hanan ELsaid ELSabahy<sup>(4)</sup>

1 Assistant-Professor of Nursing Administration, Faculty of Nursing, Port Said University, Port Said, Egypt.

2 Lecturer of Psychiatric and Mental Health Nursing, Faculty of Nursing, Mansoura University, Egypt.

3 Lecturer of Nursing Administration, Faculty of Nursing, Port Said University, Port Said, Egypt

4 Assistant-Professor of Nursing Administration, Faculty of Nursing, Mansoura University, Egypt.

### Abstract

**Background:** With the emergence of artificial intelligence (AI), head nurses should use technology in their work to strengthen nursing management skills and practice, as well as to change nurses' jobs, in order to be successful and flourish. **Aim:** The present research aimed to investigate the effect of the artificial intelligence enhancement program on head nurses' managerial competencies and flourishing at work. **Subjects and methods:** This research used a quasi-experimental design (pre- and post-intervention) with all head nurses (92) from El Mansoura International Hospital. **Data collection tools:** The self-administered Artificial Intelligence Knowledge Questionnaire, the General Attitudes towards Artificial Intelligence Scale, the Head Nurses' Managerial Competencies Questionnaire, and the Flourishing at Work Scale were used. **Results:** Once compared to the pre-intervention phase, the post-intervention and follow-up phases had the highest mean scores, with a statistically significant difference for head nurses' knowledge level, attitudes towards artificial intelligence technologies, managerial competencies, and work flourishing. **Conclusion:** The partial  $\eta^2$  values found for head nurses' knowledge level, attitudes towards artificial intelligence technologies, managerial competencies, and work flourishing (0.856, 0.977, 0.968, and 0.892, respectively) indicated that the program's implementation had a substantial impact. **Recommendations:** Educational programs can assist nursing managers in developing an understanding of artificial intelligence as well as managerial skills. More studies in this area are also advised.

**Keywords:** artificial intelligence, head nurses, managerial competencies, and work flourishing.

### Introduction

The amount of technology in many health-care systems around the world has increased dramatically in recent decades, and as a result, the effect of technology on the nursing position has gained more attention in nursing research. Humans, technology, and the environment are inextricably linked, and nurse managers must better investigate these links in order to effectively use artificial intelligence health technologies (AIHTs) to improve patient experiences and health outcomes and provide a

new way to address health challenges in the twenty-first century (Buchanan et al., 2020).

By developing computer systems that can replicate intelligent human behavior and frequently carry out tasks that humans accomplish, artificial intelligence (AI) is generated (Ronquillo et al., 2021). AI refers to methods for teaching machines to imitate human cognitive processes like learning, reasoning, communicating, and making decisions. According to the definition of AI, it refers to "software (and possibly hardware)

systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge derived from this data, and deciding the best action(s) to take." (Von Gerich et al., 2021).

AI has numerous applications in healthcare, including assisting in disease assessment and diagnosis, solving various clinical problems, reducing missing data, improving nursing communication skills, improving inpatient care management, reducing nurse workload, improving patient safety, and improving the quality of handovers via electronic handover systems (Azzi et al., 2020; Seibert et al., 2021; Moreno-Fergusson et al., 2021; Zhou et al., 2022). AI can be utilized in education for analysis, prediction, guidance, assessment, and adaptive learning, according to Tang et al. (2021). Additionally, Liu et al. (2022) reported that nursing management can benefit from AI-based medical information processing.

In reality, head nurses employed in hospitals are required to do not only their clinical duties but also the administrative chores assigned to them as part of their management obligations. They must have the skills required to lead them down this path in order to successfully perform the work. Given that an individual's performance is evaluated in terms of particular behaviors or behavioral indicators, managerial skills are described as qualities associated with higher job performance (Chong, 2013). Theorists have divided managerial competencies into a number of categories, including influence, creativity, motivation, teamwork, achievement orientation, quality focus, customer focus, innovation, problem-solving and decision-making, and financial management. These categories include communication, leadership,

managing staff, analysis, and judgment (Fanelli et al., 2020).

The managerial skills of the head nurse refer to her competency to maintain a high level of efficiency in how her employees perform their daily tasks (Builder, 2017; Menem, Farouk, Eid, & El-Shahat, 2019). These competencies have the potential to significantly reduce organizational costs while also providing higher-quality services (Shafii et al., 2016). On the other hand, managers' lack of competencies and skills in hospitals resulted in inefficient resource allocation and poor quality and outcomes of health care services. The hospital manager's roles, competencies, and skills have a direct impact on the hospital's efficient management, which also helps to sustain services (Khadka, Gurung, & Chaulagain, 2014).

Kolbjornsrud, Amico, and Thomas (2016) estimate that 54% of a manager's time is spent on administrative coordination and control. They also spend approximately 30% of their time solving problems and collaborating with coworkers. Ten percent is spent on strategy and innovation, and the remaining ten percent is spent on employee development and engagement with company stakeholders. Nursing management practice is critical. Therefore, nursing administrators must take into account the usage of AI technologies to enhance healthcare quality and free up time by assuming this portion of their work and performing it more quickly, more effectively, and for less money (Ronquillo et al., 2021). As per McAfee, Goldbloom, Brynjolfsson, and Howard (2014), AI has an impact on top-management roles by strengthening their creative abilities and strategic thinking.

Thus, in order for head nurses to be successful and flourish, they must have managerial skills and use AI in their work. With a long history of use in digital

technologies and a current use to frame the AI debate, flourishing is a virtue ethics-related ethical notion (Stahl et al., 2021). A state of being known as "flourishing" is one in which you feel good (hedonic well-being) and perform well (eudemonic well-being) (Huppert & So, 2013). Diener et al. (2010) identified eight flourishing characteristics: purpose and meaning, healthy relationships, social contribution, involvement, self-respect, competence, social relationships, and optimism.

Nursing staff may be more productive when they are in a condition of flourishing, which is a positive frame of mind (Demerouti et al., 2015). The majority of recent research on flourishing connects it to meaningful employment, suggesting that it may be the best setting for the growth and use of human traits and skills, as well as the instillation of values like honor, pride, dignity, and self-respect (Ahlstedt, Eriksson Lindvall, Holmström, & Muntlin, 2020). People enjoy life more generally and perform better at work when they feel they have accomplished what they value in their careers and show that they are making progress towards their goals (Veltman, 2015).

Finally, Bono et al. (2011) found that people who succeed at work because of their personalities have a positive outlook on themselves, other people, and job-related situations. Additionally, they approach their work in a proactive, forward-thinking manner, especially in complex or unfamiliar circumstances. As a result of the experience, people may be more motivated to work harder at their jobs and feel these aspects of professional fulfillment. Another view is that meaningful work contributes to professional fulfillment and promotes human flourishing (Veltman, 2015).

### Significance of the study

Given the rapid advancements in technology, law, and patient expectations, healthcare institutions must implement artificial intelligence, which can aid in proactive patient treatment, reduce future risk, and streamline business operations. As a result of these challenges, healthcare institutions also must employ head nurses with strong managerial competencies, which are critical to the health care system's success and flourishing by reducing organizational costs and providing higher-quality services (Shafii et al., 2016; Ahlstedt et al., 2020).

Based on the data that some employees have a higher chance of success than others, it is assumed that the use of AI can enhance head nurses' competencies and result in job success. Even though individuals operate in the same environment, they use different behaviors, pursue different tactics, and interpret their experiences in different ways because of things like technology, personality traits, values, and goals. According to the hypothesis, people who achieve important goals and show favorable goal progress evaluations may display varying degrees of flourishing at work. People are more inclined to engage in meaningful work when they feel professionally fulfilled, which is another sign that the workplace is prospering. (Veltman, 2015; Stahl et al., 2021).

Since the emergence of AI, nursing managers must now take into account using AI technologies to enhance healthcare quality and put in place a training program to raise nursing staff's awareness of AI in order to succeed and thrive at work. Because nurse managers make up a sizable number of healthcare managers in the industry, and because their increased performance may result in hospital excellence, a logical approach for evaluating AI, managing abilities and workplace thriving would also be very helpful.

Furthermore, the effectiveness of head nurses is critical to the smooth operation of hospitals. It is critical to identify and rank the managerial skills that these supervisors must possess, as well as to evaluate their performance. Competent first line nurse managers can undoubtedly have a significant impact on an organization's success. According to the researchers, no attempt has been made to investigate how nurses at El-Mansoura International Hospital perceive and respond to artificial intelligence technology. As a result, the current study sought to investigate the impact of an artificial intelligence enhancement strategy on head nurses' managerial competencies and work flourishing.

### **The aim of the study**

This study aimed to investigate the effect of the artificial intelligence enhancement program on head nurses' managerial competencies and flourishing at work.

### **Through the following objectives:**

1. Assess the head nurses' knowledge levels about artificial intelligence.
2. Identify the head nurses' general attitude towards artificial intelligence technologies.
3. Determine the head nurses' managerial competencies.
4. Measure how well the head nurses' work is flourishing.
5. Develop an artificial intelligence-enhancement program for head nurses.
6. Evaluate the effect of implementing an artificial intelligence enhancement program on the head nurses' managerial competencies and flourishing.

### **Research hypotheses:**

H1: An applied artificial intelligence-enhancement program has an effect on head nurses' knowledge levels and attitudes towards artificial intelligence technologies.

H2: An applied artificial intelligence-enhancement program has an effect on head nurses' managerial competencies.

H3: An applied artificial intelligence-enhancement program has an effect on head nurses' flourishing at work.

### **Research design**

This research used a quasi-experimental research design (a pre- and post-intervention study) to evaluate the effect of specific interventions. "In quasi-experimental research, there is no control group, no select group, no randomization, and/or no energetic manipulation."(Iowa State University of Science and Technology, 2021).

### **Setting**

This research was carried out at El Mansoura International Hospital, which is affiliated with the ministry of health. It has seven floors and 400 beds for medical care for patients suffering from various diseases.

### **Participants**

All head nurses working at El Mansoura International Hospital at the time of data collection (92) who volunteered to participate were involved in the study.

### **Study tools**

The data was gathered using four study tools: a self-administered Artificial Intelligence

Knowledge Questionnaire, a General Attitudes toward Artificial Intelligence (AI) Scale, a Head Nurses' Managerial Competencies Questionnaire, and a Flourishing at Work Scale.

### **First Tool (I): Self-administered Artificial Intelligence Knowledge Questionnaire**

Researchers developed this questionnaire to assess head nurses' knowledge of artificial intelligence. It was split up into two sections as follows:

**Part I:** covered individual characteristics of head nurses like age, marital status, gender, educational level, unit, and years of professional experience.

**Part II:** included an artificial intelligence knowledge that was developed by the research team after reviewing relevant literature (Ongena, Haan, Yakar, & Kwee, 2020; Lennartz et al., 2021; Shinnars, Aggar, Grace, & Smith, 2021; Shimon, Shafat, Dangoor, & Ben-Shitrit, 2021) to assess the artificial intelligence knowledge levels of head nurses beforehand and after a training session. The tool contained 35 questions of three different types: both true and false (15 questions), multiple-choice (10 questions), and try to match (10 questions). The questions were divided into seven categories: 1) definition, 2) importance and benefits, 3) core components and characteristics, 4) barriers, 5) role and strategies, 6) principles, and 7) applications.

### **Scoring system**

Each true or false, multiple-choice, and try to match question received a "one" if it was correct and a "zero" if it was incorrect. The head nurse was considered to have adequate artificial intelligence knowledge if the percent score was 60% or higher and inadequate

artificial intelligence knowledge if the percent score was less than 60% (Morsy, 2014).

### **Second Tool: General Attitudes toward Artificial Intelligence Scale**

The General Attitudes toward Artificial Intelligence (AI) Scale, developed by Schepman and Rodway (2020), uses 20 items to assess head nurses' general attitudes towards AI. Each item was scored on a 5-point Likert scale, with 1 indicating strongly disagree, 2 indicating agree, 3 indicating neutral, 4 indicating agree, and 5 indicating strongly agree. The item scores were totaled and divided by the number of items to yield a mean score. A low score  $\leq 60\%$  reveals a negative attitude towards AI, whereas a high score  $\geq 61\%$  reveals a positive attitude towards artificial intelligence (Elsayed and Sleem, 2021).

### **Third Tool: Head Nurses' Managerial Competencies Questionnaire**

The researchers adapted the managerial competencies of the head nurse questionnaire based on Khadka, Gurung, and Chaulagain (2014); Moghaddam et al. (2019); and Fanelli, Lanza, Enna, and Zangrandi (2020). The purpose of this questionnaire is to assess the managerial competencies of hospital department heads. The questionnaire has 51 items divided into nine domains: 1) planning (6 items), 2) organizing (9 items), 3) leadership (15 items), 4) controlling (4 items), 5) problem solving (4 items), 6) critical and systematic thinking (3 items), 7) information literacy (6 items), 8) evidence-based decision making (2 items), and 9) creativity and innovation (2 items).

### **Scoring system**

On a 5-point Likert scale, answers ranged from (1) strongly disagree to (5) strongly agree. The overall Managerial Competencies

Questionnaire score for head nurses was 255, with a range of 51 to 255. These scores were converted into a percent score, and the subscale item scores were totaled and divided by the number of items to yield a mean score for each part. Using the cut-off points, a high score of  $\geq 58\%$  indicates that head nurses have a high level of managerial competency, whereas a low score of  $< 58\%$  reveals a low level of managerial competency.

#### **The fourth tool is the Flourishing at Work Scale.**

Diener et al. (2010) created the Flourishing at Work scale, which uses eight items to assess head nurses' work flourishing. Items were graded on a 7-point Likert scale, with 1 representing "strongly disagree" and 7 representing "strongly agree." To calculate the mean score, the item scores were added together and divided by the number of items. The high rates of flourishing at work are demonstrated by the high scores that ranged from 31 to 56 on this scale. Meanwhile, the low rates of flourishing at work are demonstrated by the low scores that ranged from 1 to 31 on this scale based on the cutoff point.

#### **Tools validity**

All of the research tools were translated into Arabic and retranslated into English by the researchers and a language expert before being presented to a bilingual group of four nursing administration department experts and three psychiatric and mental health nursing department experts at the faculty of nursing in Port Said and Mansoura University for face and content validation. Minor changes were made in response to their feedback. From the standpoint of experts, the tools were deemed valid.

#### **Tools reliability**

The internal consistency of the tool was evaluated using the Cronbach's alpha coefficient reliability test. The self-administered Artificial Intelligence Knowledge Questionnaire scored 0.79, the General Attitudes towards Artificial Intelligence Scale scored 0.85, the Head Nurses' Managerial Competencies Questionnaire scored 0.92, and the Flourishing at Work Scale scored 0.90.

#### **Pilot study**

A pilot study was conducted on 10% of the study sample (9), to assess the tools' clarity, feasibility, and applicability, as well as the time required to complete them. The pilot study participants were included in the main study sample. The pilot study's data was analyzed. The questionnaire remained unchanged as a result of the positive feedback.

#### **Ethical considerations**

The study's implementation was officially approved by the Mansoura University Faculty of Nursing's Research Ethics Committee (Ref. No. P.0377), the assigned hospital administrators granted official permission to conduct the study. After being informed of the study's purpose and significance, all head nurses provided written informed consent. The participants' anonymity was guaranteed and maintained. There was no coercion or pressure applied to the participants, and no risk or burden was imposed on them in order for them to participate in the study. Participants were informed that they could refuse to participate or withdraw from the study at any time. The data gathered was declared confidential and would only be used for research purposes.

#### **Field work**

Between the beginning of May 2022 and the middle of November 2022, data was

gathered. The artificial intelligence training program's implementation was based on a training program model. The phases of assessment, intervention, and follow-up were all defined.

### **The assessment and planning phase**

An artificial intelligence knowledge questionnaire was used to conduct an assessment of the head nurses' artificial intelligence knowledge. The General Attitudes toward Artificial Intelligence (AI) Scale was used to assess the general attitudes of head nurses towards artificial intelligence. The head nurses' managerial competencies questionnaire was also used to assess head nurses' managerial competencies, and flourishing at work was evaluated. This was finished from May 2022 to the beginning of July 2022. Each head nurse spent approximately 35–40 minutes responding to the study tools. The preliminary evaluation of the knowledge of head nurses and their attitudes toward artificial intelligence was analyzed. The educational requirements were then identified. As a result, a training program and a training course schedule were created.

### **The implementing phase of the AI enhancement program**

The program was run twice: the first time, the researchers divided the head nurses into two groups based on whether they worked in departments: all those who worked in quality, infection control, and safety in all departments; and the second time, supervisors of seven departments: one head nurse from each department working in all hospital departments. Each one had 40 to 50 head nurses, and the program lasted two weeks. Each group of head nurses has one working week with three sessions per week, lasting two

hours each. Session one discussed the concept and importance of artificial intelligence, the main characteristics of AI, and the areas in which AI has applications in clinical settings.

The role of AI in health care was discussed in session two. The principles and benefits of artificial intelligence, as well as artificial intelligence strategy, were also discussed. The implementation of artificial intelligence in health care, artificial intelligence barriers, and solutions to any problems were discussed in session three. Each session began with the definition of goals and objectives. Each session began with a discussion of the head nurses' questions, followed by the creation of objectives and an explanation of the new subject. The enhancement program was established between July 10 and the middle of August 2022.

The program was implemented at the hospital for the in-house conferences of the head nurses. Brainstorming, discussion, small group work, modified lectures, role-play, and audiovisual material were used as teaching methods.

### **Evaluation phase of the AI enhancement program**

An artificial intelligence knowledge questionnaire, the General Attitudes Toward Artificial Intelligence (AI) Scale, a head nurse's managerial competencies questionnaire, and the flourishing at work scale were distributed again immediately and after three months of the program to compare with the pre-test and to evaluate the program effect size on head nurses' managerial competencies and flourishing at work. The follow-up period was filled in November 2022.

### **Statistical analysis**

The statistical package SPSS v. 22 was used for data analysis. To determine data normality, a one-sample Kolmogorov-Smirnov test was used. To label qualitative data, numbers and percentages were used. Continuous variables' means and standard deviations are displayed. For parametric data, a one-way repeated measure ANOVA test and multiple comparison adjustment (the Bonferroni test) were used. The AI enhancement strategy's effect size was calculated using partial eta squared ( $\eta^2$ ). The level of significance was set at  $p < 0.05$ .

## Results

**Table 1** indicates that all head nurses were female, and about one-half of them (51.1%) were in the age range of 40 to less than 50 years old (mean:  $40.53 \pm 4.918$  years). Most of them had a bachelor's degree in nursing and were married (91.13% and 97.8%, respectively), and the majority of them (80.4%) had  $\geq 15$  years of experience. And a tiny percent 10.8 % of the head nurses had previous training in artificial intelligence.

**Table 2** depicts the head nurses' knowledge of artificial intelligence technology through the phases of pre-intervention, post-intervention, and follow-up. It explicates that there were significant differences in the mean difference scores of head nurses both before and after intervention ( $25.196^*$ ) and between pre-intervention and follow-up ( $25.033^*$ ). This indicates that the knowledge level of head nurses improved after the intervention in all domains. Non-statistically significant differences were found between the post- and follow-up phases, with the exception of definition, benefits, importance, and barriers, which all had significant differences. Furthermore, the mean scores of the seven artificial intelligence knowledge domains differ by a large margin. This demonstrated that the

post- and follow-up intervention phases had the highest mean scores compared to the pre-intervention phase ( $34.77 \pm 5.56$ ,  $34.61 \pm 8.11$ , and  $9.57 \pm 10.19$ , respectively), with a partial  $\eta^2$  value of .856, indicating that the program had a major effect on head nurses' artificial intelligence knowledge.

**Table 3** illustrates the head nurses' attitudes towards artificial intelligence technologies through the phases of pre-intervention, post-intervention, and follow-up. The mean score of the pre, post, and follow up phases shows a statistically significant difference ( $50.01 \pm 3.92$ ,  $83.58 \pm 2.12$ , and  $79.58 \pm 2.21$  at  $p = .000$ , respectively). There were also significant differences in head nurses' attitudes toward artificial intelligence technologies between pre- and post-intervention, pre- and follow-up, and post- and follow-up ( $p < .000$ ). Furthermore, the calculated partial  $\eta^2$  value was .977, indicating that the program had a significant impact on the attitudes of head nurses toward artificial intelligence technologies.

**Table 4** outlines the head nurse's managerial competencies through the pre-intervention, post-intervention, and follow-up phases. An examination of this table reveals a statistically significant difference ( $p < .000$ ) between all three program phases, with the highest mean ( $203.70 \pm 2.57$ ) for head nurses' managerial competencies at post-intervention, followed by a mean of  $159.61 \pm 7.21$  for head nurses' managerial competencies at follow-up. These significant differences in managerial competencies among head nurses were discovered at  $p < .000$  between pre- and post-intervention, pre- and follow-up, and post- and follow-up. The partial  $\eta^2$  values for planning, organizing, leadership, controlling, problem solving, critical and systematic thinking, information literacy, evidence-based decision making, and creativity and innovation of head nurses are



(.596,.862,.950,.849,.938,.871,.887,.656,.684) and (.968) for total managerial competencies, demonstrating the program's large effect on the managerial competencies.

**Table 5** highlights the head nurses' work flourishing via pre-intervention, post-intervention, and follow-up. According to this table, the post-intervention phase had a higher

mean score for work flourishing than the pre intervention and follow-up phases ( $30.81 \pm 2.561$ ,  $32.96 \pm 1.972$ , and  $44.33 \pm 2.594$ , respectively). With a significant difference between them pre and post, pre and follow-up, and post and follow-up ( $p = .000$ ), this demonstrates a substantial impact of the program on the flourishing of head nurses' work (Partial  $\eta^2$  value = .892).

**Table 1:** Frequency distribution of head nurses' individual characteristics (n = 92)

Personal characteristics	N	%
<b>Age groups</b>		
< 30 years	1	1.1
30 : < 40 years	43	46.7
40 : < 50 years	47	51.1
$\geq 50$ years	1	1.1
<b>Mean age <math>\pm</math> SD</b>	40.53 $\pm$ 4.918	
<b>Range</b>	27	
<b>Gender</b>		
<b>Female</b>	92	100.0
<b>Educational levels</b>		
Bachelor	84	91.3
Post graduate	8	8.7
<b>Years of experience</b>		
< 5 years	6	6.5
5 : < 10 years	1	1.1
10: < 15 years	11	12.0
$\geq 15$ years	74	80.4
<b>Mean age <math>\pm</math> SD</b>	17.54 $\pm$ 5.638	
<b>Marital status</b>		
Single	2	2.2
Married	90	97.8
<b>Training</b>		
No	82	89.2
Yes	10	10.8

**Table 2:** The head nurses' artificial intelligence technologies knowledge through phases of pre-intervention, post-intervention, and follow-up (n = 92)

Artificial intelligence knowledge domains	Pairwise Comparisons			Pre	Post	Follow-up	F	Sig.	Partial $\eta^2$	Effect size
	Pre and Post	Pre and Follow-up	Post and Follow-up							
	Mean Difference	Mean Difference	Mean Difference	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD				
	Sig. <sup>a</sup> (P)	Sig. <sup>a</sup> (P)	Sig. <sup>a</sup> (P)							
<b>Definition</b>	2.293* (.000)	2.217* (.000)	.076* (.022)	.706 $\pm$ .896	3.00 $\pm$ .000	2.93 $\pm$ .266	535.50	.000	.850	Large
<b>Benefits and importance</b>	9.750* (.000)	9.522* (.000)	.228* (.000)	3.24 $\pm$ 3.97	12.99 $\pm$ 1.104	12.76 $\pm$ .477	520.81	.000	.851	Large
<b>Core component-s and characteristics</b>	3.467* (.000)	3.500* (.000)	.033 (.543)	1.49 $\pm$ 1.86	4.95 $\pm$ .205	4.98 $\pm$ .104	317.14	.000	.777	Large
<b>Barriers</b>	2.239* (.000)	2.315* (.000)	.076* (.022)	.685 $\pm$ 1.09	2.92 $\pm$ .266	3.00 $\pm$ .000	376.08	.000	.805	Large
<b>Role and strategies</b>	1.272* (.000)	1.315* (.000)	.043 (.475)	.663 $\pm$ .929	1.94 $\pm$ .248	1.98 $\pm$ .146	161.24	.000	.639	Large
<b>Principles</b>	3.435* (.000)	3.391* (.000)	.043 (.135)	1.56 $\pm$ 2.18	5.00 $\pm$ .000	4.96 $\pm$ .205	220.08	.000	.707	Large
<b>Applications</b>	1.989* (.000)	2.011* (.000)	.022 (.475)	.989 $\pm$ 1.38	2.97 $\pm$ .146	3.00 $\pm$ .000	188.18	.000	.674	Large
<b>Total knowledge</b>	25.196* (.000)	25.033* (.000)	.163 (.312)	9.57 $\pm$ 10.19	34.77 $\pm$ .556	34.61 $\pm$ .811	546.93	.000	.857	Large

a. Adjustment for multiple comparisons: Bonferroni.

(P): p value for comparing the groups studied\*: At the.05 level, the mean difference is significant.

F = Repeated Measure ANOVA

Partial  $\eta^2$  = Partial Eta Squared

**Table 3:** The head nurses' attitudes towards artificial intelligence technologies through the phases of pre-intervention, post-intervention, and follow-up (n = 92)

Program phases	Pairwise Comparisons			Pre	Post	Follow-up	F	Sig.	Partial $\eta^2$	Effect size
	Pre and Post	Pre and Follow-up	Post and Follow-up							
	Mean Difference	Mean Difference	Mean Difference	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD				
	Sig.a (P)	Sig.a (P)	Sig.a (P)							
Attitudes towards artificial intelligence technologies	33.576* (.000)	29.576* (.000)	4.000* (.000)	50.01 $\pm$ 3.92	83.58 $\pm$ 2.12	79.58 $\pm$ 2.21	380.8	.000	.977	Large

a. Adjustment for multiple comparisons: Bonferroni.

(P): p value for comparing the groups studied\*: At the.05 level, the mean difference is significant.

F = Repeated Measure ANOVA

Partial  $\eta^2$  = Partial Eta Squared

**Table 4:** The head nurses' managerial competencies through the phases of pre-intervention, post-intervention, and follow-up (n = 92)

Managerial competency domains of head nurses	Pairwise Comparisons			Pre	Post	Follo w-up	F	Sig.	Partial $\eta^2$	Effect size
	Pre and Post	Pre and Follow-up	Post and Follow-up							
	Mean Difference	Mean Difference	Mean Difference	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD				
	Sig. <sup>a</sup> (P)	Sig. <sup>a</sup> (P)	Sig. <sup>a</sup> (P)							
<b>Planning</b>	3.272* (.000)	3.272* (.000)	(.000)	16.23 $\pm$ 2.16	19.50 $\pm$ 1.74	19.50 $\pm$ 1.74	134.12	.000	.596	Large
<b>Organizing</b>	9.293* (.000)	3.196* (.000)	6.098* (.000)	25.64 $\pm$ 2.41	34.94 $\pm$ 1.16	28.84 $\pm$ 1.76	567.41	.000	.862	Large
<b>Leadership</b>	18.359* (.000)	3.304* (.000)	15.054* (.000)	42.18 $\pm$ 3.16	60.54 $\pm$ 1.13	45.49 $\pm$ 2.68	172.53	.000	.950	Large
<b>Controlling</b>	4.815* (.000)	.717* (.001)	4.098* (.000)	11.39 $\pm$ 1.74	16.21 $\pm$ .545	12.11 $\pm$ .602	510.07	.000	.849	Large
<b>Problem solving</b>	4.652* (.000)	.533* (.000)	4.120 (.000)	11.55 $\pm$ .941	16.21 $\pm$ .545	12.08 $\pm$ .506	138.33	.000	.938	Large
<b>Critical and systematic thinking</b>	3.239* (.000)	.152 .475)(	3.087* (.000)	8.88 $\pm$ 1.07	12.12 $\pm$ .551	9.033 $\pm$ .313	612.65	.000	.871	Large
<b>Information literacy</b>	6.011* (.000)	.641* (.001)	5.370* (.000)	17.85 $\pm$ 1.68	23.87 $\pm$ .997	18.50 $\pm$ .989	711.17	.000	.887	Large
<b>Evidence-based decision making</b>	1.946* (.000)	.989* (.000)	.957* (.000)	5.95 $\pm$ .609	7.902 $\pm$ .555	6.95 $\pm$ .998	173.81	.000	.656	Large
<b>Creativity and innovation</b>	1.946* (.000)	1.022* (.000)	.924* (.000)	6.087 $\pm$ .623	8.032 $\pm$ .431	7.108 $\pm$ .942	197.29	.000	.684	Large
<b>Total competency</b>	57.913* (.000)	13.826* (.000)	44.087* (.000)	145.7 $\pm$ 8.57	203.7 $\pm$ 2.57	159.6 $\pm$ 7.21	271.93	.000	.968	Large

a. Adjustment for multiple comparisons: Bonferroni.

(P): p value for comparing the groups studied\*: At the .05 level, the mean difference is significant.

F = Repeated Measure ANOVA

Partial  $\eta^2$  = Partial Eta Squared

**Table 5:** The head nurses' work flourishing through phases of pre-intervention, post-

Program phases	Pairwise Comparisons			Pre	Post	Follow-up	F	Sig.	Partial $\eta^2$	Effect size
	Pre and Post	Pre and Follow-up	Post and Follow-up							
	Mean Difference	Mean Difference	Mean Difference	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD				
	Sig.a (P)	Sig.a (P)	Sig.a (P)							
Work flourishing	13.522* (.000)	2.152* (.000)	11.370* (.000)	30.81 $\pm$ 2.561	44.33 $\pm$ 2.594	32.96 $\pm$ 1.972	754.988	.000	.892	Large

intervention, and follow-up (n = 92)

a. Adjustment for multiple comparisons: Bonferroni.

(P): p value for comparing the groups studied\*: At the .05 level, the mean difference is significant.

F = Repeated Measure ANOVA

Partial  $\eta^2$  = Partial Eta Squared

## Discussion

It is absolutely essential for head nurses to use AI and grasp its benefits in healthcare. These potential benefits can help with immediate patient care, decision-making assistance, and long-term planning and management. Furthermore, by assuming this portion of their responsibilities and achieving it faster, better, and at a lower cost, such technologies can improve head nurses' competencies and thus flourish at work (Ronquillo et al., 2021). To combat and anticipate the emergence of many challenges, healthcare settings need to be supported by cutting-edge technologies like artificial intelligence and run training programs to improve the AI literacy of nursing staff (Vaishya, Javaid, Khan, and Haleem, 2020).

In this context, the current research revealed that only a tiny percentage of head nurses had adequate knowledge of artificial intelligence prior to program implementation. This finding could be explained by the fact that the majority of head nurses had not previously attended any artificial intelligence training courses and stated that the nursing curriculum did not include the fundamentals of AI. Because only a small percentage of them claimed to have learned AI through postgraduate courses, they had no prior knowledge of artificial intelligence. Furthermore, the absence of such a training session is due to a lack of concern on the part of responsible hospital authorities. This finding supports Abuzaid, Elshami, and Fadden (2022) assessment of the UAE's knowledge, attitude, willingness, and organizational readiness to integrate AI into nursing practice.

The study findings are consistent with those of Zawacki-Richter, Marn, Bond, and Gouverneur (2019), who investigated the uses of artificial intelligence in higher education and discovered a lack of thought on the challenges and risks of AI in education, a lack of connection to theoretical perspectives, and a need for more research and ethical approaches to the use of AI in higher education. This is also consistent with Seibert et al.'s (2021) claim that the use of AI systems is required in various nursing care settings. Given the lack of data on the effectiveness and deployment of AI systems in real-world situations, it was suggested that further studies should focus on objectives, outcomes, and benefits in nursing care. Swan (2021) also investigated nursing staff knowledge and attitudes towards artificial intelligence in health care settings in the United States and discovered that the majority of nurses were unaware of or did not understand AI in clinical practice. While these findings contradict those of Sheela (2022), who found that, more than half of participants had prior knowledge of AI.

The current study discovered statistically significant differences in the mean difference scores of head nurses' knowledge of artificial intelligence before and after the intervention, as well as between the intervention and the follow-up. This indicates that the overall knowledge level of head nurses improved immediately after the training program was implemented. This might be explained by head nurses discovering the value of artificial intelligence in nursing from the AI instructional program. Also, "head nurses identified and learned in the education program how and why building AI systems is similar to building human intelligence in that they can observe their environment, recognize objects, assist in decision-making, resolve conflicts, plan actions, learn new things, solve complex problems, make use of prior knowledge, and

mimic patterns." This increases the awareness levels of head nurses.

This result aligns with the findings of Abuzaid et al. (2022), who explored an inadequate understanding and knowledge of AI principles and technical potential in the nursing profession and concluded that higher education institutions and healthcare organizations must design and implement appropriate AI educational and training programs for nursing staff to improve their competency in promoting the safe integration and application of AI into nursing practice. Furthermore, the majority of nursing staff confirmed that basic AI knowledge should be addressed in nursing education and training courses. Furthermore, Zhang (2022) investigates the use of artificial intelligence in clinical nursing in the information age among Chinese nursing staff and concludes that the study yielded excellent results and contributed to the use of artificial intelligence technology in clinical nursing, as well as recommending the development of effective application measures in tandem with the actual work content.

Furthermore, with a calculated partial  $\eta^2$  value of .977, the current study found a significant difference in head nurses' attitudes toward artificial intelligence technologies among pre- and post-intervention, pre- and follow-up, and post-and-follow-up, denoting that the program had a substantial impact on head nurses' attitudes toward artificial intelligence technologies. This could be explained by research findings that confirmed significant differences in overall mean scores for the head nurse's artificial intelligence across program phases, with the largest mean scores gained directly after post-intervention. Otherwise, during the follow-up period, these mean scores decreased slightly.

This result was in line with research by Kwak, Ahn, and Seo (2022) on the impact of

AI ethics awareness, attitude, anxiety, and self-efficacy on the behavioral intentions of Korean nursing students, which identified the necessity of fostering favorable attitudes towards AI through educational initiatives on AI technology in healthcare settings. Therefore, it is essential to broaden the AI educational experience. It is crucial to create and implement numerous educational programs focused on ethical awareness, pertinent knowledge, and the usage of AI technology in healthcare settings before nurses start clinical practice. Under this manner, Mehdipour (2019) observed that, while nurse managers' attitudes towards the use of AI systems were largely positive, it was clear that managers required additional incentives and knowledge about the technology's benefits.

Nurses' behaviors towards AI play a significant role in the acceptance of AI in practice. In this context, Kim and Lee (2020) stated that attitudes towards information technology influenced learners' thoughts, feelings, behaviors, and ideas about IT, reinforcing the significance of having a positive attitude towards IT. Besides that, studies have shown that more experience with IT, such as AI, can result in less fear and anxiety for nurses as well as a better understanding of AI. As a result, nurses who had attended training courses and were acquainted with AI were more cheerful and enthusiastic about AI-related work than their colleagues (Sassis, Karli, MSassi, and Zervides, 2021).

The effectiveness of head nurses is essential to the smooth operation of hospitals. It is critical to list and rate the managerial competencies that these head nurses must possess, as well as to use standards to evaluate their performance. Following the implementation of the training program, the head nurses' managerial competencies were altered and improved, according to the research

findings. There was a statistically significant difference between the three program phases, with post-intervention having the highest mean for head nurses' managerial competencies, followed by follow-up. The partial  $\eta^2$  values for all competency domains demonstrate the program's strong influence on managerial competencies.

This could be explained by study findings that showed head nurses' positive attitudes towards AI after training, as well as the fact that using AI-based technology to integrate data and improve information utilization will help achieve a higher standard of provided services while also strengthening head nurses' competencies. This point of view was supported by Kwak, Ahn, and Seo (2022), who stated that positive attitudes towards AI initially expected its usage and application. Also, Mehdipour (2019) claimed that nursing managers who use AI effectively will be able to provide better, faster, and safer services.

Furthermore, with the evolutionary development of AI-based technology and the demand for AI nursing education, we must develop and advance nurses' job competencies and roles to enable them to acquire pertinent knowledge and increase their awareness of large amounts of data and how to use it (Ji and Lee, 2020). According to Ronquillo et al. (2021) and Tiase & Cato (2021), AI can help head nurses understand complex situations by simulating thinking processes and human reasoning approaches and successfully responding to them; learning and the ability to acquire knowledge and critical thinking and problem-solving abilities; decision-making assistance; and bringing more evidence-based information, long-term planning, and management.

In addition, Lee and Yoon (2021) evaluated the use of artificial intelligence-based technologies in the healthcare industry in the

United States, claiming that the findings indicated that AI systems were improving the efficiency of nursing and managerial activities in hospitals. Swan (2021) also believes that artificial intelligence will transform nursing and healthcare by enhancing health promotion and illness prevention, assisting in the development of personalized treatment plans, automating work, and fostering professional collaboration. AI has already been used in nursing for the analysis of electronic nursing records, clinical decision support through the analysis of pressure ulcers and safety risks, nursing robots, and scheduling (Topol, 2019).

More than a half of a manager's time is spent on coordination and control processes. AI will save them a significant amount of time by completing this portion of their tasks faster, better, and at a lower cost. The most effective and successful managers must be skilled in delegating administrative duties to artificial intelligence, placing emphasis on decision-making and judgement work, treating software and intelligent machines as coworkers, empowering design thinking and embracing creativity, and building social skills and networks (Kolbjornsrud, Amico, and Thomas, 2016). Also, McAfee, Goldbloom, Brynjolfsson, and Howard (2014) stated that AI impacts top-management roles by strengthening their creative abilities and their strategic thinking by presenting answers to the right questions. Furthermore, Eriksson, Eriksson, and Djoweini (2020) concluded that implementing AI will improve the speed and accuracy of decisions if the training data is of high quality.

The study result is similar to that of Shawkey Abdallah, Mohammed Eid, and Ghoneimy Hasanin (2022), whose head nurses were found to be extremely competent in the immediate aftermath of programs and in the follow-up phase, preprogrammed by computers. And they came to the conclusion

that the training program was effective and that it improved the head nurses' knowledge, attitude, and performance as compared to the pre-program phase. Additionally, a statistically significant difference was found between the head nurses' skills during the pre, immediate post, and follow-up phases and their knowledge, attitude, and performance. Also, Goktepe et al. (2018) stated that there were significant differences between nurses' pre- and post-test scores in managerial competency levels, concluding that the program significantly improved nurses' professional skills and managerial competencies.

The study result was also consistent with the findings of Seada, Etway, and El-Shafay (2022), who claimed that there was a statistically significant difference between the total mean scores of the managerial competencies. Furthermore, total scores increased significantly from pre- to post-program. In the three months following program implementation, the immediate post-program implementation period was also found to have a statistically significant beneficial relationship with overall knowledge.

As AI becomes an increasingly essential component of healthcare and nursing, studies confirm the necessity for AI-related skills, knowledge, competencies, and flourishing. The term "flourishing" refers to a situation in which individuals, teams, or organizations are performing at their best. It includes indicators such as "thriving," "engagement," "health," "growth," and "innovation." According to the research findings, in the post-intervention phase, head nurses had a higher mean score for work flourishing than in the pre-intervention and follow-up phases, with a statistically significant difference between them. That revealed that the artificial intelligence program significantly impacted overall professional success.



This could be attributed to previously reported study findings, which revealed an improvement in head nurses' managerial competencies following program intervention, resulting in their becoming more skilled and effective in their workplace. Chang, Jen, and Su (2022) reported that AI has the potential to strengthen nursing management, nursing performance, safety practices, and group communication while encouraging future international collaboration. As a result of all of this, work flourishes.

In this line, Haenlein and Kaplan (2019) reported that AI focuses on external data analysis, learning from this kind of data, and data use to achieve unique goals more efficiently. Thus, the advancement of artificial intelligence (AI) is frequently framed in terms of human progress. Furthermore, Stahl et al. (2021) confirmed that recent machine learning advances have led to expectations of increased efficiency as well as new and improved services for customers and citizens, supported by increasing amounts of readily available data and expanding computing capabilities.

Johansson & Björkman, (2018) investigated what expectations managers in the technology field have about the impact of AI on their roles as managers in their master's thesis at Lunds University. They discovered that leaders are expected to grow by being adaptable and open to change, as well as by performing at a higher level of transformative leadership. According to the study, as AI performs technical tasks, future leaders will be more focused on motivating employees and fostering teamwork and creativity in the workplace.

According to the findings of Oliviera-Silva and Porto (2021), higher levels of professional competency and fulfilment are a predictor of higher levels of subjective well-being and flourishing at work. People are

happier and perform better at work when they believe they have achieved what they value in their jobs and are making positive, objective progress. One of the goals of using AI, according to Stahl et al. (2021), is to promote workplace flourishing. Flourishing is a virtue-ethics-based ethical principle that has a long history of application to digital technologies and has recently been used to frame the AI debate.

Finally, the present study found a significant statistical difference between all three phases of the program, with vast partial  $\eta^2$  values for the head nurses' artificial intelligence knowledge, attitude, managerial competencies, and work flourishing, indicating a considerable program effect size. This outcome can be linked to the head nurses' application of artificial intelligence concepts, which had a positive effect on how they dealt with their personal and professional lives and assisted them in organizing and planning their work. While some of them see AI as improving human intellect and decision-making, others worry that it poses a threat to the delivery of healthcare.

In conclusion, new technological advancements bring with them new opportunities as well as new challenges. The question now is how health care organizations can best capitalize on emerging opportunities while addressing challenges. As with AI, major advances in data analysis will be made, and these will need to be leveraged and combined with head nurse management skills such as innovative thinking and creativity to maximize the potential value that head nurses can generate. Head nurses who want to stay efficient in their organizations as AI enters the labor market must be educated on how to best exercise their managerial skills and integrate AI into their administrative processes in order to fully exploit its potential.

## Conclusion

In this study, the mean difference scores of head nurses between pre-intervention and post-intervention, post-intervention and follow-up, and pre-intervention and follow-up program phases were discovered to be statistically significant. Furthermore, the ( $\eta^2$ ) values for head nurses' knowledge of artificial intelligence technology, attitudes towards artificial intelligence, managerial competencies, and work flourishing indicate that the program has a large magnitude effect. Additionally, all study hypotheses were proved.

## Recommendations

- Nursing staff needs to receive AI training at various levels to increase their competency in order to face the challenges posed by AI.
- To close the gap between theory and practice in nurse management, nursing services and nursing education should work together.
- Formally develop and communicate a managerial competency model to employers, staff representatives, personnel managers, and others involved in the selection of nursing managers.
- In future nursing manager selections at all three levels, use a competency-based assessment format. A broader and more structured approach may be needed.
- Establish systems, protocols, rules, and strategies to raise the competency level of nursing managers in managing financial planning and hiring initiatives.
- Provide nursing managers with training programs to help them improve their skills.

- Utilize the study's findings as a guide to create a better working environment that would encourage the nurse managers' competency and creativity.

## Research limitations

This study used a limited sample of 92 head nurses from El-Mansoura International Hospital. Furthermore, the findings are only applicable to similar hospitals. More large-sample studies from various geographic areas should be conducted to validate these findings.

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