- *Basic Research*

Improving Nurses' Knowledge, Attitude, Acceptance and Willingness toward Digital Health Literacy and Information System: An interventional Program

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Abstract

Background: Digital health literacy and information systems are essential healthcare delivery so that, nurses as frontline providers, require adequate knowledge and positive attitudes to effectively adopt these technologies. However, gaps in acceptance and willingness may limit optimal utilization of digital health tools, interventional programs can play a key role in improving patients' health outcomes. **Aim:** This study aimed to investigate the effect of an interventional program on improving nurses' knowledge, attitude, acceptance and willingness levels toward digital health literacy and information system. **Research design:** A Quasi-experimental design was utilized. **Setting:** the study was conducted at Health Insurance Hospitals in Cairo Governorate (Nasr City Insurance hospital, Sednawy hospital& Shobra hospital). **Sample size:** The calculation resulted in target sample size of 265 nurses from the three hospitals and stratified proportional random sample technique was adopted according to total number of nurses in each hospital **Data collection:** relied on four instruments: Nurses' Interview Questionnaire, Nurses' Attitude toward Digital health Literacy and Information System, Nurses' willingness toward Digital Health Literacy and Unified Theory of Acceptance and Use of Technology. **Result:** the study revealed that there was a significant improvement in nurses' knowledge regarding digital health literacy post-test compared with pre-test, also reflects increasing in the total positive attitude score level of the nursing regarding digital health literacy in addition., there was an increase in the total high score of nurses' willingness and acceptance to use digital health after intervention compared with pre-intervention. The study also highlighted a highly statistically significant positive correlation between nurses' total knowledge acceptance, willingness and attitude at post-test. **Conclusion:** The current study revealed that educational guidelines had positive effect in increasing nurses' knowledge, attitude, willingness and acceptance level toward digital health literacy post intervention pregame. **Recommendation:** the study recommends that integrate recent digital health technology into clinical health care settings, prioritize nursing education regarding digital health literacy and increase public awareness about the importance and benefits of digitalization in health care.

Keywords: Knowledge, Attitude, Acceptance, Willingness, Digital Health Literacy, Information System, interventional Program

Introduction

Digital technologies known as electronic tools, systems, devices and resources that generate, store, process, and/or transit data that range from equipment, such as computers and smart mobile phones to intangible materials such as software, web-based platforms, and algorithms, e.g., artificial intelligence (AI) **(El Hadi, M. 2022).** Digital Health Literacy (DHL) or e-Health Literacy refers to the degree to which individuals have the ability to find, understand and use electronic information in order to make health decisions and appropriate actions such as the ability to utilize the information system as well as the supporting infrastructure **(Kuek & Hakkennes., 2020).**

Digital health Advancement h has the potential to support equitable and universal access to health services, increase the efficiency and reliability of health systems, improve patient health and health providers safety, deal with staff shortages, reduce costs and, subsequently, improve people's health outcomes. New health technologies such as virtual care, remote monitoring, artificial intelligence, big data analysis, blockchain, smart wearable devices, platforms tools enabling data exchange and storage and have proven potential to improve health outcomes by improving medical diagnosis, data-based treatment decisions, digital therapy, clinical trials, self-management of care and patient-individualized care plan as well as creating more evidence-based knowledge, skills and competence for professionals to support health care **(WHO, 2021).**

Despite the suggested benefits of health digitalization , the use of digital solutions by health care providers is not yet fully satisfactory (**Von Wedel et al., 2022).** There are several barriers that affect nurses' attitude, willingness and acceptance of digital health literacy including organizational barriers such as poor technology infrastructure, little or no access to digital technology to facilitate the delivery of patient care, poor internet connectivity and workload. Also, there are certain individual barriers including lack of adequate training in digital health that often associated with negative attitudes towards health digitalization and lack of understanding how to use digital technology especially electronic health systems also, lack of competency framework for health professions to involve in a curriculum consequently those are the main factors for the low level of health digitalization **(Chevan et al., 2023, Bimerew, 2024).**

To eliminate the challenges of digital health technology and improve nurses' attitude and acceptance to utilize digital health and information system, governmental strategies are important to provide digital skills training for nurses and improve internet accessibility. Training programs should emphasize on illustration of perceived technology usefulness and illustrate the importance of digital health in decreasing administrative workloads, consuming time spent for looking for the lost or misplaced paper, and performing online consultation on minor cases that could minimize patient loads **(Bimerew, 2024)**. In addition, nurses are required to have digital health skills and competencies to take advantage of digital health technologies and great effort should be exerted to involve and apply digitalization in undergraduates nursing curriculum to master the digitalization skills **(Busse et al., 2022)**.

Enhancement of nurses' knowledge, attitude, willingness, and acceptance of health digitalization is a must for advancement of healthcare delivery in an increasingly technology-driven landscape. Enriching knowledge through extensive training programs, using electronic health records, telehealth, and data analytics equips nurses with the skills needed to navigate digital platforms confidently, thereby reducing fear of use and fostering a positive attitude toward digital tool utility **(Krick et al., 2019).** A positive attitude, reinforced by evidence of improved patient outcomes and decrease workload, fosters a stronger willingness to adopt

digitalization as nurses begin to perceive them as partners rather than burdens in health practice. This willingness promotes faster acceptance where digital health becomes a basic component of nursing proficiencies **(De Veer & Francke, 2010).**

Significance:
Internationally, registered nurses (RN) make a crucial contribution to universal health provision, emergency care and response, patient safety, and the delivery of integrated patient-centered care. However, by the year 2030, the world expected to face a nursing shortage estimated to be 5.7 million. Which might be due to increase number of elderly people aged 60 years and older, with multiple health problems and specialized complex healthcare needs, resulting in increasing demand for professional healthcare services **(WHO, 2022)**. digitalization of health care services emphasizes nurses' training and education about use of digital health and information system in care for patients which have been introduced as a necessary to address these challenges and ensure the delivery of high-quality, sustainable patient care **(Leonardsen et al., 2023)**.

Recently Egypt endorsed digital transformation for serving about 100 million people lives around the river Nile sides. Egypt plan to utilize a digital health technology to achieve efficient and suitable cost care service to patients. The last pandemic of COVID – 19 has accelerated the change towards digitalization in a new process called "digital transformation" **(Emara, & Nagy., 2021)**.

The integration of digitalization in nursing curriculum and practice are progressively crucial to demonstrate strong digital skills applicable in daily life and the labor market. Moreover, their digital health literacy and positive attitude toward AI highlighted their overall preparedness in the digital sector. Substantially, positive correlations were observed between knowledge of digital transformation and attitude as participants exhibiting greater digital knowledge and a more positive attitude toward AI. These results emphasize the essential need to foster students with digital healthcare technologies to strengthen their digital competency, ensuring their preparedness for digitalization and using of technologies in their future occupations **(Abou Hashish, & Alnajjar,. 2024)**.

Aim of the study:
This study aimed to investigate the effect of an interventional program on improving nurses' knowledge, attitude, acceptance and willingness levels toward digital health literacy and information system.

Research hypothesis:

H1: An interventional program will improve nurses' knowledge level about digital health literacy and information system.
H2: An interventional program will improve nurses' attitude level about digital health literacy and information system.
H3: An interventional program will improve nurses' willingness level about digital health literacy and information system
H4: An interventional program will improve nurses' acceptance level about digital health literacy and information system.
H5: There will be a statistically significant positive correlation between nurses' knowledge, attitude, acceptance and willingness regarding digital health literacy.

Subject and methods:

Research Design: A Quasi-experimental design (pre-post interventional program) was utilized to conduct the study

Setting: This study was conducted at Health Insurance Hospitals in Cairo Governorate Naser city branch and Cairo branch including (Nasr City Insurance hospital, Sednawy hospital& Shobra hospital)

Sample size: The sample size was calculated by using EPI info7software based on the total population (853 nurse) enrolled in Nasr City Hospital (495 nurse), Sednawy Hospital (273 nurse) and Shobra Hospital (85 nurse). The estimation was expected with an acceptable error of 5% and confidence limit of 99%. The calculation resulted in target sample size of 265 nurses in the three hospitals.
Stratified proportional random sample technique was adopted according to total number of nurses in each hospital. So that., the target number of nurses in each hospital was:

Hospital	No. of nurses
Nasr Hospital	154
Sednawy Hospital	85
Shobra Hospital	26
Total nurses	265

Tools of data collection: Four tools were used in the present study as follows:
Tool I: Nurses' Interview Questionnaire

a) **Structured sociodemographic data**: to assess sociodemographic characteristics of studied nurses as age, sex, working environment, educational level, years of experience, attendance of training program about digital health and information system and nurses' self-evaluation of computer use.
b) **Nurses' knowledge about digital health literacy questionnaire:** it was developed by the researchers after reviewing of related literatures such as **(Abou Hashish & Alnajjar 2023)** translated into Arabic and included seven questions to assess nurses' knowledge regarding (definition of digital health, definition of digital health literacy, importance of digital health for patients, importance of digital health for health care provider, forms of digital health, barriers for digital health and overcoming barriers for digital health literacy).

Scoring system:
Responses to each question was scored as (1) for "correct answer" and (0) for "incorrect answer", the total score was calculated by the sum of correct answers and converted into a percent to be categorized into:

- Good total knowledge level if scores were ≥ 75% (≥5 marks).
- Average total knowledge level if scores were 51%-75% (4-5 marks).
- Poor total knowledge level if scores were ≤50% (≤4 marks).

Tool II: Nurses' Attitude toward Digital health Literacy and Information System:
It was adapted by the researchers after reviewing of related literatures such as **(Kuek, & Hakkennes, 2020 & Seemann et al., 2023)** for assessing nurses' attitude toward Digital health Literacy and Information System including ten items measured using five points Likert scale translated into Arabic language and divided into four main dimensions as follow: importance

of digital health (4items), nurses' confidence in digital health use (5 items), anxiety concerning digital health use (6 items) and safety and security of digital health use (3 items).

Scoring System:

Each statement was scored as (5) for strongly agree, (4) for agree, (3) for neutral, (2) for disagree and (1) for strongly disagree, the total score was calculated by the sum of each statement and converted into a percent to be categorized into:

- Positive total attitude if scores were ≥ 60% (≥54marks).
- Negative total attitude if scores were <60% (<54 marks).

Tool III: Nurses' willingness toward Digital Health Literacy:

It was adapted by researchers after reviewing related literature such as **(Liu et al., 2020)** to assess nurses' willingness toward Digital Health Literacy using five points Likert scale translated into Arabic language. It consisted of eleven items divided into three main dimensions as follows: using digital health (3items), deciding the reliability and relevance of digital health (3 items), and searching and navigation for digital health data (5 items).

Scoring System:

Each statement was scored as (5) for always, (4) for often, (3) for sometimes, (2) for rarely and (1) for never, the total score was calculated by the sum of each statement and converted into a percent to be categorized into:

- High willingness if scores were ≥ 70% (≥38 marks).
- Moderate willingness if scores were 51%<70% (27<38 marks).
- Low willingness if scores were ≤ 50.0% (≤27 marks).

Tool IV: Unified Theory of Acceptance and Use of Technology (UTAUT):

It was adapted by the researchers after reviewing of related literatures such as **(Kuek, & Hakkennes., 2020)** to investigate nurses' acceptance of use of technology using five points Likert scale translated into Arabic language including eighteen items and divided into three main dimensions as follow: Perceived benefits of digital health (6items), Perceived outcomes of digital health (8 items), and Perceived ease of using digital health data (4 items).

Scoring System:

Each statement was scored as (5) for strongly agree, (4) for agree, (3) for neutral, (2) for disagree and (1) for strongly disagree, the total score was calculated by the sum of each statement and converted into a percent to be categorized into:

- Acceptable level if scores were ≥ 60% (≥54 marks).
- Unacceptable level if scores were <60% (<54 marks).

Validity and Reliability:

The knowledge questionnaire, attitude, willingness and acceptance scales were revised by a group of five professors in medical surgical nursing and nursing administration to assess the validity of content. Also, reliability of tools was tested by Cronbach's Alpha test and proved the homogeneous of items and total score of knowledge, attitude, willingness and acceptance ranging from acceptable reliability as for knowledge questionnaire (.635) to excellent level of reliability as for attitude, willingness and acceptance equal (.931, .941 & .962) respectively.

Ethical considerations:

It was approved by the Research Ethics Committee at Research Ethics Committee - Faculty of Nursing - Modern University for Technology and Information (MTI), Cairo, Egypt, before the beginning of the actual work. Nurses were informed about the aim, significance and process of the study. Nurses also were informed about their right to refuse participation in the study and confidentiality was assured for all information provided. Then verbal approval was obtained from each nurse who agreed to participate before inclusion in the study as well as nurses were informed about the right to withdraw from the study at any moment.

Field Work: Data was collected through Six months from the beginning of June 2024 to the end of December 2024. According to the number of nurses in each hospital, the application of the educational program took (Three months for Nasr City hospital, two months for Sednawy hospital and one month for Shobra hospital). Nurses in each hospital are divided into small groups according to their total number.

Awareness sessions Construction: The awareness sessions aimed to improve nurses' knowledge, attitude, willingness and acceptance levels toward digital health literacy and information system. The awareness sessions were planned and designed in four phases as follows:

- **Preparatory phase:** A pilot study was carried out on 26 nurses in the three previously mentioned hospitals before starting the actual data collection to test the applicability and clarity of the items included in the adapted part of the data collection tool. Also, to estimate the time needed to complete the questionnaire, and to add or omit items. Accordingly, no modification was needed and the time to answer the sheet was estimated to be from 20-25 minutes.
- **Assessment phase:** Researchers conducted initial assessment through providing nurses with the pre-test (using both google form and handout) to assess sociodemographic characteristics, their experience in using digital health, and baseline nurses' level of knowledge, attitude, willingness and acceptance of digital health literacy and information system, using tool I, II, III & IV. A simple introduction about the aim and the significance of the interventional program also, the duration of the study was done. Based on the pre-test results, the awareness sessions were constructed. The awareness session's main objective was to improve their knowledge about digital health, their attitude toward digital health and how their knowledge and attitude affect their acceptance and willingness for digital health transformation. The sessions were planned to be conducted in the training hall in their hospitals using certain teaching methods such as interactive lectures, group discussion and certain scenarios for brainstorming then collecting their feedback about digital health. Also, different audiovisual aids were utilized such as booklet, sharing pictures, posters, videos and power point presentations were utilized.
- **Implementation phase:** Nurses divided into small groups, each group consisting of about twenty nurses according to work needs and nature in hospital working units. Each group was attending three sessions in the morning and afternoon shift. Each session lasted from 30-45 minutes in Arabic language. Continuous and different communication channels were used for additional questions and feedback. The content of the awareness sessions was covered into three sessions as follows:
  - **1st session** includes introduction about governmental initiatives to improve health care, meaning of digital health illiteracy, digital health transformation and importance of digital health literacy for both organization, patient and health care providers.
  - **2nd session:** Illustrate information about forms of digitalization and information technology in health care services such as using artificial intelligence in diagnosis and treatment, tele-health applications, robotic surgeries, blockchain in health care, health care using 5th generation technologies, using advanced connected ambulances, using mobile health applications (M-health) and electronic health records (HER).
  - **3rd session:** Handle all challenges for digital health applications such as organizational barriers, technical barriers, communication barriers and psychological barriers and illustrating how to overcome those challenges. In addition, explaining strategies to improve their attitude, willingness and acceptance of digital health such as participation in training about health digitalization and discussing their fear and challenges to be full prepared for future technology revolution.

- **Evaluation phase:** was done first through the pre-test before the interventional program conduction, then immediately after completing the interventional program in order to investigate the effect of educational intervention on improving nurses' knowledge, attitude, acceptance and willingness levels toward digital health literacy and information system**.**

Statistical Analysis:

SPSS version 27.0 was used in data entry and statistical analysis. Presenting of qualitative variables were in frequency & percentage. Quantitative variables were presented in mean & standard deviation. The normality of study variables was assessed by using Kolmogorov Smironov test. Chi- square test was used in testing the differences of parametric variables for nurse' knowledge, attitude, willingness and acceptance of digital health and for all related domains. Correlation among qualitative variables were tested by using One-way Anova and student t-test. The correlation between nurses' knowledge, attitude, willingness and acceptance was tested by using Pearson correlation and Cronbach's Alpha test was used for measuring reliability.

Results:

Table (1): displays the demographic and experience of the study participants. presents that the mean age of nurses was 33.17±8.04 with median age equal 29 years old and Min-Max age between 23-58 years old. The female nurses represent highest percentage (70.6%) of the sample moreover., 33.3% of nurses were working at medical departments. Concerning educational level., the current table shows that the highest percent of the sample (59.9%) had technical nursing institute in addition., the mean years of experience was 6.630±5.872 with median of 4 years and Min-Max 1-34 years. The current table also reveals that., most of the nurses studied (96.6%) didn't attend any training program about digital health and information technology beside that., (35.5%) of them evaluate their computer use as acceptable.

Table (2) detects that there was a significant improvement in nurses' knowledge regarding digital health literacy post-test compared with pre-test. As evidenced by 26.0%, 34.7%, 41.9, 27.5% and 43.0% of nurses had a correct answer regarding importance of digital health for patients, importance of digital health for healthcare providers, forms of digital health, barriers for digital health literacy and overcoming barriers of digital health literacy pre-test which increased to 77.0%, 77.4%,82.6%, 77.7% and 79.2% of nurses had correct knowledge post-test with statistically significant difference at p-value (<0.01*).

Figure (1) shows that there was an increase in the total good knowledge score level of nursing regarding digital health from 10.90 % in pre-test to 79.60% in post-test, with a statistically significant difference at p-value (<0.01*).

Table (3) clarifies that there was a significant improvement in nurses' attitude toward digital health literacy post-test compared with pre-program implementation. As evidenced by 44.9%, 35.1%, 21.5% and 27.5% of nurses had a positive attitude regarding importance of digital health, confidence in digital health, anxiety from digital health use and safety and security of digital health pre-test which increased to 91.7%, 90.2%, 83.4 % and 83.8% of nurses had positive attitude post-test with statistically significant difference at p-value (<0.01*).

Figure (2) reflects increasing in the total positive attitude score level of the nursing regarding digital health literacy from 24.50 % in pre-test to 87.20% in post-test, with a statistically significant difference at p-value (<0.01*).

Table (4) represents that there was a significant improvement in nurses' willingness for digital health use post-test compared with pre-test. As evidenced by 16.6%, 10.2%, 21.5% and 23.4% of nurses had a high willingness for using of digital health, deciding reliability and relevance

of digital health data and searching and navigation for digital health data pre-program implementation which increased to 91.7%, 90.2%, 83.4 % and 83.8% of nurses had positive willingness toward the same domains post-test with statistically significant difference at p-value (<0.01*).

Figure (3) reports increasing in the total high score of nurses' willingness to use digital health from 9.80 % in pre-test to 72.10 % in post-test, with statistically significant difference in p-value (<0.01*).

Table (5) shows that there was a significant improvement in nurses' acceptance for digital health use post-programs compared with pre-program implementation. As evidenced by 47.5%, 10.2%, 69.4% and 22.6% of nurses accepting benefits of digital health, outcomes of digital health and ease of using digital health data pre-program implementation which increased to 91.3%, 90.2% and 81.1 % of nurses accepting the same items post-program implementation with statistically significant difference at p-value (<0.01*)

Figure (4) reports that., there was an increase in the total nurses' acceptance score regarding use of digital health from 24.20 % in pre-test to 86.0 % in post-test, with a statistically significant difference at p-value (<0.01*).

Table (6) represents that there was a highly statistically significant relation between selected items of nurses' socio-demographic data and their total post knowledge about digital health literacy (p<0.01*) except for gender, there was no statistically significant relation (p>0.05). In addition, there was a highly statistically significant relation between selected items of nurses' socio-demographic data and their total post attitude toward digital health literacy (p<0.01*) except for their Nurses' self-evaluation of computer use, there was statistically significant relation (p<0.05*) and for gender, there was no significant relation (p>0.05*).

Table (7) represents that there was a highly statistically significant relation between selected items of nurses' socio-demographic data and their total post willingness for digital health use (p<0.01*) except for gender, there was no statistically significant relation (p>0.05*). In addition, there was a statistically significant relation between selected items of nurses' socio-demographic data and their total post acceptance for digital health use (p<0.01*) except for their age and years of experience, there was statistically significant relation (p<0.05*) and for gender, there was no significant relation (p>0.05*).

Table (8) represents that there was a statistically significant positive correlation between nurses' total knowledge and acceptance, willingness and attitude at post-test (r=.529**, r=1.000**, r=.388**). In addition, there was a highly statistically significant correlation between nurses' total attitude and acceptance and willingness at post-test (r=431**& r=.388**) moreover there was a highly statistically significant correlation between nurses' total willingness and total acceptance at post-test (r=.539**).

Table (1): Distribution of nurses regarding socio-demographic and their experience in use of digital health (n=265):

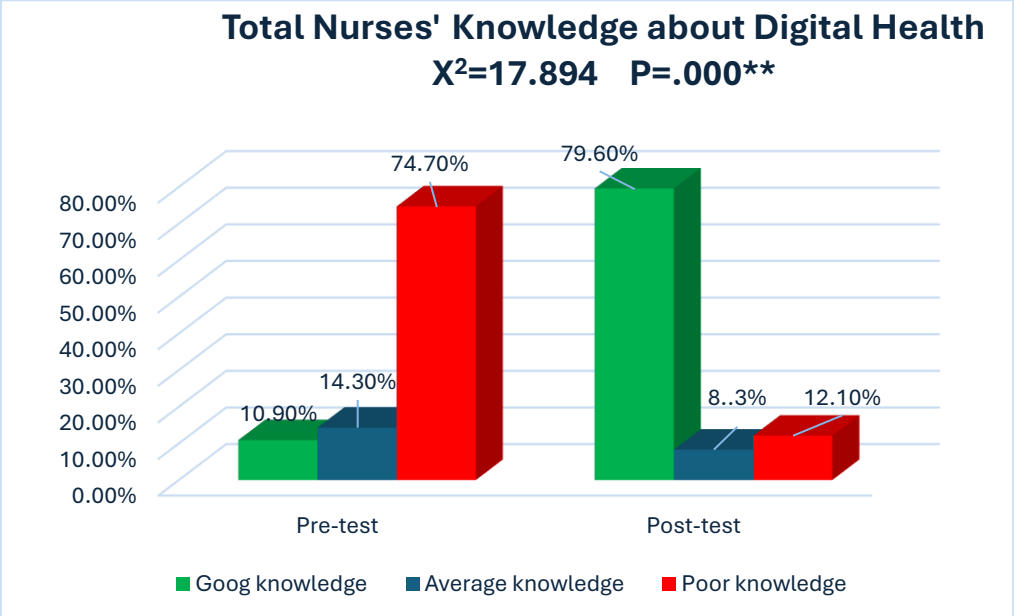
Socio-demographic data and nurses' experience	No.	%
Age (years): Mean±SD Median Min-Max	33.17±8.04 29.00 23-58	
Sex		
Male	78	29.4
Female	187	70.6
Working department		
Medical departments	90	33.3
Surgical departments	84	31.7
Operating rooms	43	16.2
ICU	30	14.0
Pediatric	18	6.8
Educational level		
Diploma/	52	19.6
technical nursing	156	58.9
BSc of nursing	43	16.2
MSc/ PHD of nursing -	14	5.3
Years of experience Mean±SD Median Min-Max	6.630±5.872 4.00 1-34	
Attendance of training program about digital health and information technology		
Yes	9	3.4
No	256	96.6
Nurses' self-evaluation of computer use		
Excellent	30	11.3
Good	49	18.5
Average	62	23.4
acceptable	94	35.5
Poor	30	11.3

Table (2): Pre-test and post-test comparison of nurses' knowledge regarding digital health literacy and information technology (n=265):

Knowledge Items	Pre-test		Post-test		X^2	P-value
	No.	%	No.	%		
Definition of digital health						
correct	113	42.6	206	77.7	36.225	.000**
incorrect	152	57.4	59	22.3		
Definition of digital health literacy						
Correct	128	51.7	208	78.8	15.695	.000**
Incorrect	137	48.3	56	21.2		
Importance of Digital health for patients						
correct	69	26.0	204	77.0	18.353	.000**
incorrect	196	74.0	61	23.0		
Importance of digital health for health care providers						
correct	92	34.7	205	77.4	30.221	.000**
incorrect	173	65.3	60	22.6		
Forms of digital health						
correct	111	41.9	219	82.6	22.000	.000**
incorrect	1154	68.1	46	14.4		
Barriers for digital health literacy						
correct	73	27.5	206	77.7	22.192	.000**
incorrect	192	72.5	59	22.3		
Overcoming barriers of digital health literacy						
correct	114	43.0	210	79.2	25.980	.000**
incorrect	151	57.0	55	20.8		

X^2= Chi square p<0.01* statistically significant difference.

Fig (1): Pre-post and post-test total knowledge score level of nurses regarding digital health literacy (n=265):



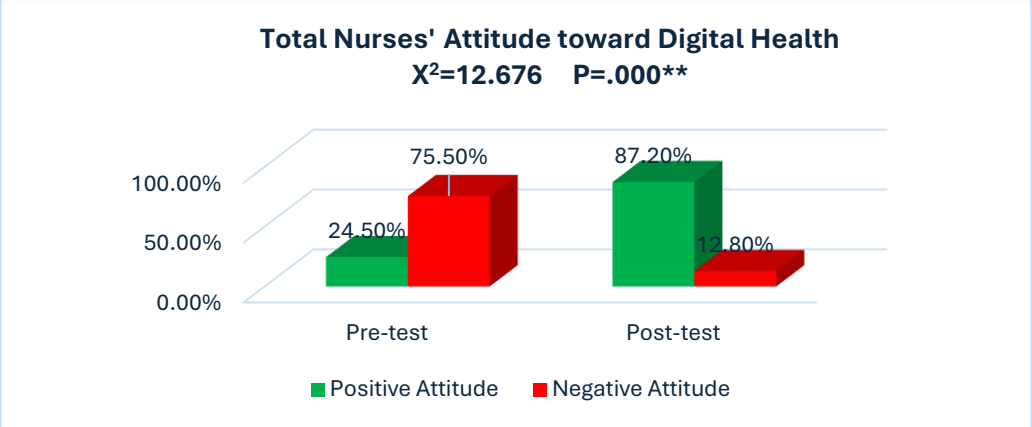
X^2= Chi square p<0.01* statistically significant difference.

Table (3): Pre and post-test comparison of nurses' attitude regarding digital health literacy and information technology (n=265).

Attitude domains	Pre-test		Post-test		X^2	P-value
	No.	%	No.	%		
Importance of digital health						
Positive	119	44.9	243	91.7	15.797	.000**
Negative	146	55.1	22	8.3		
Confidence in digital health use						
Positive	93	35.1	239	90.2	12.258	.000**
Negative	172	64.9	26	9.8		
Anxiety concerning digital health use						
Positive	57	21.5	221	83.4	14.458	.000**
Negative	208	78.5	44	16.6		
Safety and Security of digital health use						
Positive	73	27.5	222	83.8	19.516	.000**
Negative	192	72.5	43	16.2		

X^2= Chi square p<0.01* statistically significant difference.

Fig (2): Pre-post total attitude score level of nurses regarding digital health literacy (n=265):



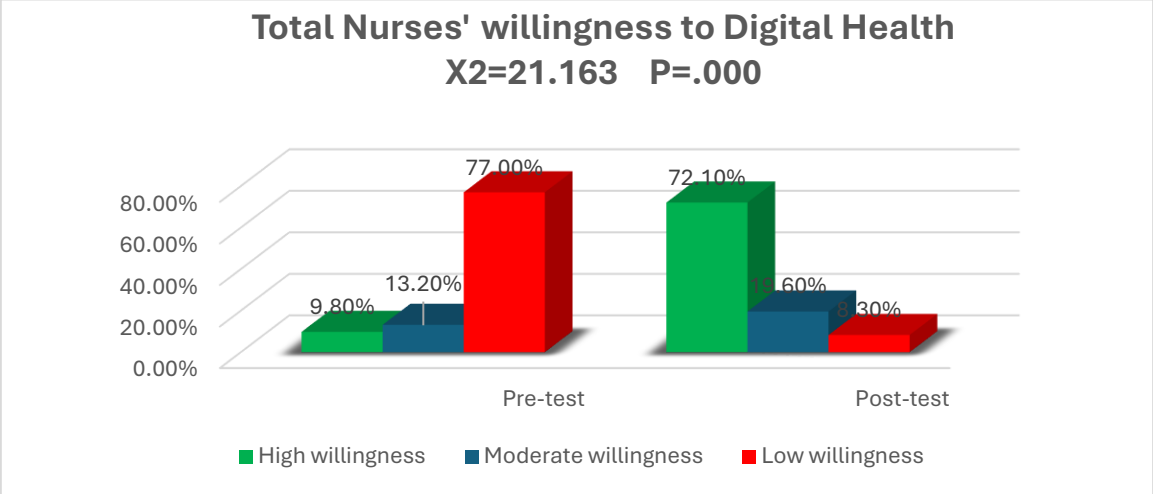
X^2= Chi square p<0.01* statistically significant difference.

Table (4): Pre-test and post-test comparison of nurses' willingness regarding digital health literacy and information technology (n=265):

Willingness to use digital health domains	Pre-test		Post-test		X^2	P
	No.	%	No.	%		
Using of digital health						
High willingness	44	16.6	210	79.2	18.461	.001**
Moderate willingness	28	10.6	39	14.7		
Low willingness	193	72.8	16	6.0		
Deciding the Reliability and relevance of digital health data						
High willingness	27	10.2	216	81.5	15.029	.005**
Moderate willingness	26	9.8	32	12.1		
Low willingness	212	80.0	17	6.4		
Searching and navigation for digital health data						
High willingness	62	23.4	194	73.2	47.801	.000**
Moderate willingness	85	32.1	52	19.6		
Low willingness	118	44.5	19	7.2		

X^2= Chi square p<0.01* statistically significant difference.

Fig (3): Pre-post total willingness score level of nurses regarding use of digital health = (n=265):



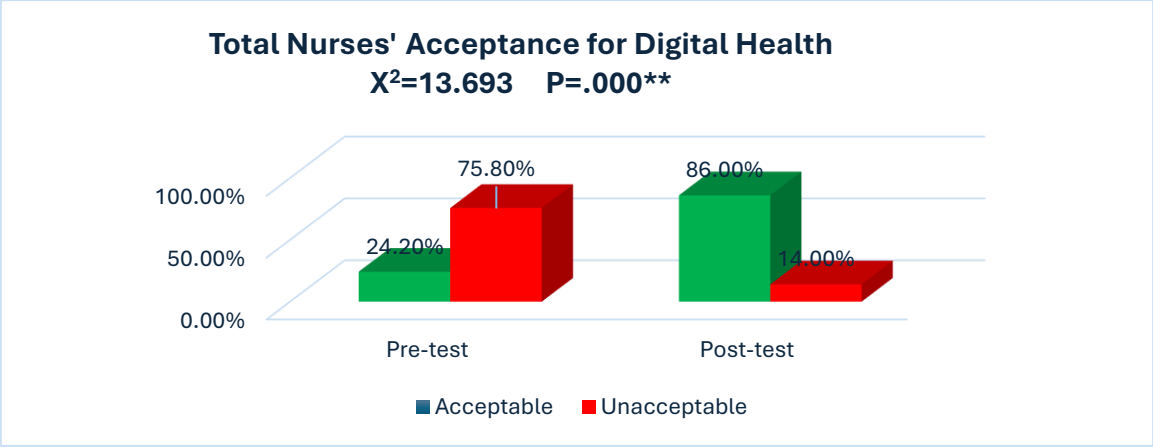
X^2= Chi square p<0.01* statistically significant difference.

Table (5): Pre-test and post-test comparison of nurses' acceptance of digital health literacy and information technology (n=265).

Acceptance domains	Pre-test		Post-test		X^2	P
	No.	%	No.	%		
Perceived Benefits of digital health						
Acceptable	126	47.5	242	91.3	18.846	.000**
Unacceptable	139	52.5	23	8.7		
Perceived Outcomes of digital health						
Acceptable	184	69.4	239	90.2	51.781	.001**
Unacceptable	81	30.6	26	9.8		
Perceived Ease of using digital health						
Acceptable	60	22.6	215	81.1	18.037	.005**
Unacceptable	205	77.4	50	18.9		

X^2= Chi square p<0.01* statistically significant difference.

Fig (4): Pre-post total acceptance score of nurses regarding use of digital health (n=265)



X^2= Chi square p<0.01* statistically significant difference

Table (6): Relation between selected items of nurses' socio-demographic data and their total post knowledge and total post attitude toward digital health (n=265).

Items	Total post Knowledge								Total Post Attitude					
	Good (n= 191)		Average (n=52)		Poor (n= 22)		Test of signific-ance	P-value	positive (n=231)		Negative (n=34)		Test of significa-nce	P- value
	No.	%	No.	%	No.	%			No.	%	No.	%		
Age/ years														
<30	99	51.8	31	59.6	20	90.9	F=5.061	.002**	121	52.4	29	85.3	F=4920	0.002**
30<40	40	20.9	17	32.7	1	4.5			57	24.7	1	2.9		
40<50	36	18.8	3	5.8	0	0.0			37	16.0	2	5.9		
≥50	16	8.4	1	1.9	1	4.5			16	6.9	2	5.9		
Gender														
Male	58	30.4	12	23.1	8	36.4	T=.055	.956	65	28.1	13	38.2	T=1.205	0.299
Female	133	69.6	40	76.9	14	63.6			166	71.9	21	61.8		
Educational level														
Diploma/ technical nursing	109	57.1	35	67.3	12	54.5	F=4.993	.002**	139	60.2	17	50.0	F=5.944	0.000**
BSc of nursing	39	20.4	3	5.8	1	4.5			41	17.7	2	5.9		
MSc/ PHD of nursing -	12	6.3	2	3.8	0	0.0			14	6.1	0	0.0		
Years of experience														
<5	94	49.2	26	50.0	20	90.9	F=6.241	.001**	111	48.1	29	85.3	F=9.226	0.000**
5<10	48	25.1	21	40.4	1	4.5			69	29.9	1	2.9		
≥10	49	25.7	5	9.6	1	4.5			51	22.1	4	11.8		
Nurses' self-evaluation of computer use														
Excellent	25	13.1	4	7.7	1	4.5	F=6.591	0.000**	22	9.5	8	23.5	F=2.461	0.041*
Good	43	22.5	6	11.5	0	0.0			79	34.2	15	44.1		
Average	48	25.1	10	19.2	4	18.2			56	24.2	6	17.6		
Acceptable	61	31.9	23	44.2	10	45.5			46	19.9	3	8.8		
Poor	14	7.3	9	17.3	7	31.8			28	12.1	2	5.9		

F=One-way Anova test T= Student T-test p <0.01* statistically significant difference p<0.05* statistically significant difference >0.05 no significant difference

Table (7): Relation between selected items of nurses' socio-demographic data and their total post willingness and total post acceptance toward digital health (n=265).

Items	Total post willingness								Total Post Acceptance					
	High (n= 191)		Moderate (n=52)		Low (n= 22)		Test of significance	P- value	Acceptable (n=228)		Unacceptable (n=37)		Test of significance	P- value
	No.	%	No.	%	No.	%			No.	%	No.	%		
Age/ years														
<30	99	51.8	31	59.6	20	90.9	F=5.061	0.002**	124	54.4	26	70.3	F=2.763	0.046*
30<40	40	20.9	17	32.7	1	4.5			49	21.5	9	24.3		
40<50	36	18.8	3	5.8	0	0.0			39	17.1	0	0.0		
≥50	16	8.4	1	1.9	1	4.5			16	7.0	2	5.4		
Gender														
Male	58	30.4	12	23.1	8	36.4	T=.055	.966	65	28.5	13	35.1	T=.818	.414
Female	1333	69.6	40	76.9	14	63.6			163	71.5	24	64.9		
Educational level														
Diploma/	31	16.2	12	23.1	9	40.9			36	15.8	16	43.2		
technical nursing	109	57.1	35	67.3	12	54.5			140	61.4	16	43.2		
BSc of nursing	39	20.4	3	5.8	1	4.5	F=4.993	0.002**	38	16.7	5	13.5	F=5.768	0.000**
MSc/ PHD of nursing	12	6.3	2	3.8	0	0.0			14	6.1	0	0.0		
Years of experience														
<5	94	49.2	26	50.0	20	90.9			116	50.9	24	64.9		
5<10	48	25.1	21	40.4	1	4.5	F=6.241	0.001**	59	25.9	11	29.7	F=3.159	0.044*
≥10	49	25.7	5	9.6	1	4.5			53	23.2	2	5.4		
Nurses' self-evaluation of computer use														
Excellent	25	13.1	4	7.7	1	4.5			20	8.8	10	27.0		
Good	43	22.5	6	11.5	0	0.0			80	35.1	14	37.8	F=3.444	0.009**
Average	48	25.1	10	19.2	4	18.2	F=6.591	0.000**	54	23.7	8	21.6		
Acceptable	61	31.9	23	44.2	10	45.5			46	20.2	3	8.1		
Poor	14	7.3	9	17.3	7	31.8			28	12.3	2	5.4		

F=one-way Anova test T= Student T-test p <0.01* statistically significant difference p >0.05 no significant difference

Table (8) Post-test Correlation Matrix between nurses' total knowledge, attitude, willingness and acceptance to use digital health.

Scale		Post-test nurses' knowledge	Post-test nurses' attitude	Post-test nurses' willingness
Post-test nurses' acceptance	r	.529**	.431**	.539**
	p	0.000**	0.000**	0.000*
Post-test nurses' willingness	r	1.000**	.388**	
	p	0.000	0.000	
Post-test nurses' attitude	r	.388**		
	p	0.000		

r= Pearson correlation p<0.001** highly statistically significant correlation

Discussion

Digital health literacy offers many valuable features covering broad connectivity, speed, low cost, and ease of use **(Moshood, et al., 2020).** Digital health has been rapidly integrated into the healthcare system including nursing and heath care providers and has the ability to reduce errors, cut cost, and enhance patient care **(Adams, 2015).**

Over the last three decades, digitalization gained increasing attention as a mean to enhance efficiency and safety of healthcare. Digital literacy is essential for nurses to actively participate in the digital healthcare systems. Consequently, it is important to assess nurses' skill levels to identify strengths and areas for improvement **(Guillari et al., 2024).**

Due to innovations in digital health, nurses are expected to make frequent use of health digitalization. Accordingly, it is important to improve nurses' level of knowledge, skills and attitude toward these technologies. Regarding nurses' knowledge about digital health, the findings of this study revealed that most nursing staff had increased total good knowledge score level regarding digital health after training, with a highly statistically significant difference. The pretest and the posttest result of this study revealed that there is improvement in the level of nurses' knowledge regarding digital health after training in agreement with **Carson, (2021).** who conducted an interventional Quasi experimental Pre-post study aimed to measure the effectiveness of digital health training for nurse leaders and showed that the nurse leader EHR training improved the knowledge of system use for nurse leaders and there was an increase from the pre-to post education mean for all questions. Which supports the researchers' point of view that educational session increased nurses' awareness and improved the level of nurses' knowledge.

The nurse's attitude affects their ability to successfully implement digital health. Regarding nurses attitude toward digital health, the findings of this study revealed that majority of nursing staff had increased total positive attitude regarding digital health after training, in acceptance with **Adams, (2015)** who conduct an interventional study on Nurses aimed to evaluate the effectiveness of simulated training with a generic EHR to improve the IT related knowledge, skill, and attitude of nurses and report that the nurses had limited awareness about computer technology in healthcare before the simulated training and found positive attitude after training.

Pertaining to nurses' willingness to use digital health, the findings of this study revealed that majority of nursing staff become willing to use digital health after training and these findings in the same line with **Lacambra, (2021)** who conduct an interventional study on Nurses aimed to design, develop, implement, and evaluate a training program to prepare inpatient nurses for the successful implementation of new Health Information Technology and report that the nurses' willingness and agreement to use technology were increased after educational training.

Nurses' acceptance of digital health is very important and should not be underestimated. It can be the reason for success or failure of implementation. Regarding the nurses' acceptance score regarding use of digital health was improved after training to include most of nurses to be in accordance with **Abell, Bragg-Underwood, Alexander, Abell, & Burd, (2015)** who conducted a study titled Nurses' knowledge and attitudes toward implementation of electronic medical records and found that most nurses are accepting of, and positive about usage of EHRs. In addition, proper training and support increased the level of acceptance.

Concerning the relation with sociodemographic data, our study revealed that there was a highly statistically significant relation between nurses' age and their level of knowledge and attitude post educational training, and this finding in agreement with **Kuek, & Hakkennes, (2020)** who conducted a survey study titled with healthcare staff digital literacy levels and their attitudes towards information systems and found the Users >50 years of age were identified to be less

frequent users of various hardware devices and software systems, with this user group also expressing lower confidence levels using these devices. In the researchers point view this result may be due to the difficulty the older staff found when dealing with new technologies.

Level of education is one of the important factors that affect nurses' knowledge and attitudes with high statistically significant relation, and this finding supported with **Ngcobo, (2019)** who studied knowledge, attitudes and practice of healthcare workers on the use of Health Information Technology and showed significant education effects for the digital data management factor. And the same line with **Salameh, Eddy, Batran, Hijaz, & Jaser, (2019)** in a Cross-sectional study titled Nurses' attitudes toward the use of an electronic health information system in Palestine and found that nurses with higher degrees had more positive attitudes toward EHRs. This is understandable, as bachelor's programs in universities may be more likely to encourage more computer-based learning modalities than certificate programs. However, this finding contradicts that of the **Yontz, Zinn, & Schumacher, (2015)** study which showed no significant relationship between educational degrees level and attitudes toward EMR implementation.

The willingness and acceptance of digital health are highly statistically significant with age of nurses in our study, which reveals that younger nurses were more accepting of digitalization than older nurses, possibly due to their familiarity with technology and computers. in contrast with **Salameh, et al., (2019)** who found no correlation between age and acceptance of computerization.

While our finding is in agreement with **Salameh, et al., (2019)** findings related to the level of experience which reveal that nurses with more experience were more positive about the electronic health information system. The researchers' point of view that it makes sense that nurses with more working years had experienced many difficulties associated with a paper-based documentation system, which may have encouraged them to use a computerized system. Different than **Kipturgo, Kivuti-Bitok, Karani, & Muiva, (2014)** and **Yontz et al. (2015)** studies, which found no significant relationship between work experience and attitudes toward computers.

Finally about correlation between the study variables, this study revealed that there are highly statistically positive correlation between nurses knowledge, acceptance, attitude and willingness toward digital health literacy after educational intervention in agreement with **Abou Hashish & Alnajjar (2024)** who conduct a study aimed to assess the perceived knowledge, attitudes, and skills of nurses regarding digital transformation and report that the findings indicated significant positive correlations between knowledge of digital transformation services and all the digital variables measured ($p = < 0.05$). in the researcher point of view these finding indicate the importance of training and education to increase nurses' knowledge, acceptance, attitude and willingness toward digital health literacy and improve patient outcomes.

Conclusion:

The current study revealed that educational program has positive effect in increasing nurses' knowledge toward digital health literacy. Also, there is a significant increase in nurses' positive attitude regarding digital health literacy after receiving the educational program, and there is improvement in nurses' willingness and acceptance of digital health literacy and information technology after receiving the educational program. Also, there are highly statistically significant positive correlations between nurses' total knowledge and acceptance, willingness and attitude. The current study and educational program used can be used as best practices and

evidence based on improving nurse's adherence to technology and increasing benefits in patient outcomes.

Recommendation:
Based on the findings of this study, the following recommendations are proposed:

For Clinical Practice:

- **Integrate recent digital health technology** into clinical health care settings to improve patient outcomes and reduce costs.
- **Prioritize nursing education** regarding digital health literacy to provide effective care and to be involved in world digitalization
- **Increase public awareness** about the importance and benefits of digitalization in health care.

For Education:

- **Incorporate into Nursing Curricula:** Nursing education programs should integrate digital health education, informatics, computer skills and advanced internet search

For Future Research:

- **More research focuses** on nurses' digital health literacy to be included in the changing world

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الملخص العربي

تحسين معرفة الممرضات وسلوكهم وقبولهم واستعدادهم لمحو الأمية الصحية الرقمية ونظام المعلومات: برنامج تدخلي

الخلفية: تعتبر محو الصحية الرقمية وأنظمة المعلومات ضرورية لتقديم الرعاية الصحية و يتطلب ذلك من مقدمي الرعاية الصحية وهيئة التمريض أن يمتلكوا المعرفة الكافية وان يكون لديهم اتجاه ايجابي لتبني هذه التقنيات بشكل فعال وبالرغم من ذلك يوجد فجوات في قبول الممرضات واستعدادهم للاستخدام الأمثل للصحة الرقمية، حيث يمكن أن تلعب البرامج التدخلية دورًا رئيسيًا في تحسين نتائج صحة المرضى. **الهدف:** هدفت هذه الدراسة إلى معرفة أثر البرنامج التعليمي على تحسين مستوى معرفة الممرضين واتجاهاتهم وقبولهم واستعدادهم نحو محو الأمية الصحية الرقمية ونظم المعلومات. **تصميم البحث:** تم استخدام تصميم شبه تجريبي لإجراء الدراسة وتم اعتماد تقنية العينة العشوائية النسبية الطبقية وفقا للعدد الإجمالي للممرضات المتاحات. **المكان:** أجريت الدراسة في مستشفيات التأمين الصحي بمحافظة القاهرة (مستشفى مدينة نصر للتأمين، مستشفى صيدناوي، مستشفى شبرا). **حجم العينة:** حجم عينة المستهدفة يبلغ 265 ممرضة من المستشفيات الثلاثة وتم اعتماد تقنية العينة العشوائية النسبية الطبقية وفقا لإجمالي عدد الممرضين في كل مستشفى. **جمع البيانات:** اعتمد على أربعة أدوات: 1-استبانة مقابلة الممرضات، 2- واستبانة موقف الممرضات من محو الأمية الصحية الرقمية ونظام المعلومات،3-واستبانة رغبة الممرضات تجاه محو الأمية الصحية الرقمية، والنظرية الموحدة لقبول التكنولوجيا واستخدامها. **النتيجة:** كشفت الدراسة عن وجود تحسن معنوي في معرفة الممرضات فيما يتعلق بالاختبار اللاحق لمحو الأمية الصحية الرقمية مقارنة بالاختبار التمهيدي ، كما يعكس زيادة في إجمالي مستوى درجات الموقف الإيجابي للتمريض فيما يتعلق بمحو الأمية الصحية الرقمية ، وهناك زيادة في إجمالي الدرجة العالية لرغبة الممرضات في استخدام الصحة الرقمية بعد التدخل ، وهناك زيادة في إجمالي درجة قبول الممرضات فيما يتعلق باستخدام الصحة الرقمية في بعد الاختبار ، كان هناك ارتباط إيجابي معتد به إحصائيا للغاية بين إجمالي معرفة الممرضات وقبولهم واستعدادهم وموقفهم في مرحلة ما بعد الاختبار. **الخلاصة:** كشفت الدراسة الحالية أن استخدام برنامج الارشادات التعليمية لها تأثير إيجابي في زيادة معرفة الممرضات ومواقفهم ومستوى استعدادهم وقبولهم تجاه محو الأمية الصحية الرقمية. **التوصية:** توصي الدراسة بدمج تكنولوجيا الصحة الرقمية الحديثة في أماكن الرعاية الصحية ، وإعطاء الأولوية لتعليم التمريض فيما يتعلق بمحو الأمية الصحية الرقمية، وزيادة الوعي العام بأهمية وفوائد الرقمية في الرعاية الصحية وإدراجها في مناهج التمريض.

الكلمات المفتاحية :المعرفة، الإتجاهات، القبول، الإستعداد، محو الأمية الصحية الرقمية ، نظم المعلومات، برنامج التدخلي