Assiut Scientific Nursing Journal
http://asnj.journals.ekb.eg http://www.arabimpactfactor.com
DOI: 10.21608/asnj.2023.205546.1567 http://olddrji.lbp.world/indexedJournals.aspx
https://vlibrary.emro.who.int/journals/assiut-scientific-nursing-journal

Evaluation of Nurse-led patients education Using Telehealth and artificial intelligence on Selected Outcomes among Orthopedic Patients with Restricted Mobility

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Abstract
Improved technology made Telemedicine easier. Patients can use Telemedicine online or through mobile apps. Moreover, Telemedicine enables video or phone appointments between patients and their healthcare practitioners to meet their mutual goals. Application of Telehealth and artificial intelligence in nurse-led patient education among Patients with Orthopedic Restricted Mobility could provide many advantages to patients and nursing practitioners. **Aim:** This study aims to examine the effect of an educational program using Telehealth and artificial intelligence on selected outcomes among orthopedic patients with restricted mobility **Design:** Quasi-experimental post-test-only design was employed in the present study **Setting:** The study was conducted in different orthopedic words at a governmental hospital afflicted with Cairo University Hospital, Cairo, Egypt. **Sample:** sixty adult male and female patients with different orthopedic problems/ surgeries divided into intervention and control groups (30 patients in each group). **Methods:** Researchers provided nursing instructions about the range of motion, coughing, and breathing exercises using selected mobile apps through artificial intelligence to facilitate patient training. **Results:** Neurovascular, respiratory and gastrointestinal status score of the patients who received the teaching program was higher than the neurovascular status score of patients who received routine care. **Conclusion:** The nurse-led education using Telehealth and artificial intelligence significantly improved patients' knowledge and selected physical functional outcomes one week and three weeks post-intervention. The total patients' knowledge score correlates positively with the total physical functional score. **Recommendation:** The application of nurse-led patient education using Telehealth and artificial intelligence should be included within nursing care. For patients with orthopedic disorders.

Keywords: Artificial intelligence, Orthopedic Patients, Patients education, Restricted Mobility & Telehealth

Introduction
Recent technological advances have challenged the ideology and the means traditional healthcare provides. For example, Telemedicine enables video or phone appointments between patients and their healthcare practitioners, benefiting both health and convenience. As a result, more healthcare providers are offering to assess patients through computers and/or smart phone. In addition, health organizations are providing virtual appointments and expanding their telehealth options, particularly during the COVID-19 pandemic **(Bashshur et al., 2020)**

Patients and healthcare personnel' fear of infection and movement constraints hindered the efficient operation of the healthcare system. In addition, it seems that social isolation and lockdown made getting medical help difficult and made people's lives unpleasant. Unfortunately, throughout the lockdown, people with various conditions, including hypertension, diabetes, joint and musculoskeletal problems, and neurological disorders, had restricted access to healthcare services. Also, prolonged lockdowns were, nonetheless, because asymptomatic carriers are the primary cause of most COVID-19 infections. As a result, using Telehealth to reduce in-person interactions with patients became indispensable **(Rajkumar et al., 2023).**

Improved technology has made Telemedicine easier; patients can use Telemedicine online or through mobile apps. In addition, the expansion and influence of machine learning and artificial intelligence raise the new ecosystem. Still, those two technologies are often described as a magic wand that could change the system. Mobile health **(shortly mHealth)** refers to public health and medicine delivery services through mobile devices. With digitalization gradually covering all segments, the healthcare industry registered significant growth in mobile apps **(DeSouza, 2002)**

Early in the COVID-19 pandemic, Telemedicine abruptly replaced ambulatory healthcare delivery to reduce the risk of viral transmission. The COVID-19 pandemic prompted a swift transition from ambulatory healthcare delivery to Telemedicine to improve access to care and lower the danger of viral transmission. Telehealth and artificial intelligence provide a suitable means to communicate with

patients and provide them with the suitable needed care **(Adams et al., 2023)**

Digital health services were extensively adopted in response to the 2019 coronavirus disease pandemic, including comprehensive monitoring technologies, Telehealth, and innovative diagnostic and therapeutic decision-making approaches. The World Health Organization suggested that artificial intelligence could be a useful tool for combating the epidemic. An essential technology of the fourth industrial revolution, artificial intelligence is a crucial nonmedical intervention. to overcome the present global health crisis, develop the next-generation pandemic preparation, and regain resilience **(El-Sherif et al., 2022)**

The application of Telemedicine has been described for its use in medical training and education, management of patients with stroke, urologic surgeries, pediatric laparoscopic surgeries, clinical outreach, and the field of orthopedics. However, the usefulness of a secure, mobile telehealth application and messaging platform has not been well described **(Daruwalla et al., 2014)**

Therefore applications of Telehealth and artificial intelligence in nurse-led patient education among patients with orthopedic restricted mobility.

Significance of the Study

Majid et al., 2015 emphasized that Patient education is an essential part of practice for all healthcare professionals. In the orthopedic setting, effective patient education contributes to positive patient outcomes. Patient education is critical to ensure patients receive appropriate information to assist in pre-admission, peri-operative treatment, and rehabilitation. Patient education is essentially one where the patient comes to understand their physical condition and self-care using the experience and guidance of the multidisciplinary team. Along with an effective and well-structured patient education program, the cost-benefit for the health care provider and patient includes a shortened stay and reduced cost of care.

Telehealth and artificial intelligence have evolved recently in all aspects of health care. Therefore the current research is significant in evaluating the use of these new technologies in health education and Patient outcomes.

Aim of the Study

This study aims to examine the effect of an educational program using Telehealth and artificial intelligence on selected outcomes among orthopedic patients with restricted mobility. The selected patient outcomes in this study were the neurovascular, respiratory, and gastrointestinal status assessments.

Research Hypothesis

To attain this research's aim, the following hypotheses are postulated to be tested:

H1: Neurovascular status scores of patients with orthopedic disorders who will receive a Telehealth teaching program will differ from those with restricted mobility who will use routine care.

H2: The respiratory status score of patients with orthopedic restricted mobility who will receive a Telehealth teaching program will differ from those with restricted mobility who will use routine care.

H3: The gastrointestinal status score of patients with orthopedic restricted mobility who receive a Telehealth teaching program will differ from that of patients with orthopedic restricted mobility who use routine care.

H4: The self-care knowledge score of patients with orthopedic restricted mobility who receive a Telehealth teaching program will differ from that of patients with orthopedic restricted mobility who use routine care.

Conceptual Framework

This study will conduct the self-care theory as a theoretical framework and nursing theory as a sub-theory (supportive educative). Dorothea Orem's Self-Care Deficit Theory focuses on each individual's ability to perform self-care, defined as the activities that individuals start and carry out on their behalf to maintain life, health, and well-being. It comprises three interrelated theories: the theory of self-care, the self-care deficit theory, and the theory of nursing systems, which are further classified into wholly compensatory, partially compensatory, and supportive-educative. It is discussed further below. This is also known as the supportive-developmental system; the person "can perform or can and should learn to perform the required measures of externally or internally oriented therapeutic self-care but cannot do so without assistance." **(Slemon et al., 2021)**

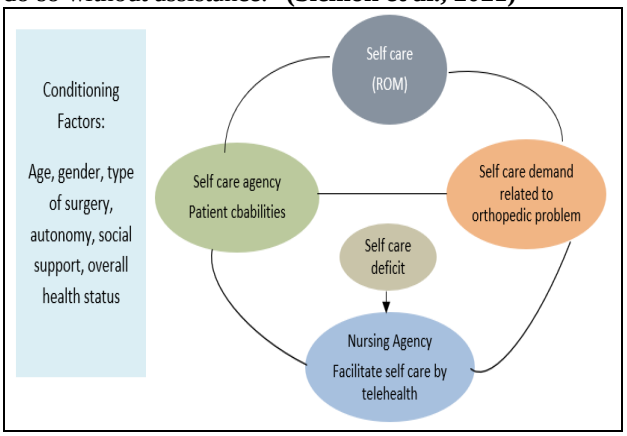

Figure (1): Allocation of research concepts into Orem's theory by the investigators (Yahia & Ali, 2023)

Operational Definitions:

Teaching Program Using Telehealth:

Researchers will provide nursing instructions about the range of motion exercises (ROM), coughing, and pursed lips breathing exercises using designed mobile apps to facilitate patients' training. The researchers will help the patients download the application on their mobile and use it with oral description to provide information and train patients and their relatives (if needed) how to use the application and do select exercises independently or with assistance. In addition, the researcher will select and inform each patient about the proper type of (ROM) for them and the frequency of application according to the patient's abilities.

Selected Outcomes: In the current study, selected outcomes include the neurovascular status of the patient, which include (pulse rate, presence of pain, skin color and temperature, presence of edema, and capillary refill time), respiratory status, which includes (respiratory characteristics, chest sound, presence of cough or secretion and presence of chest pain). At the same time, gastrointestinal status includes (eating pattern, frequency of meals, intestinal sound, presence of nausea, vomiting, abdominal distention or colic, and frequency of defecation).

Methods

Research design:

Quasi-experimental post-test only nonequivalent groups design was utilized in the current study. In this design, participants in one group are exposed to a treatment, a nonequivalent group is not exposed to the treatment, and the two groups are compared (APA Dictionary of Psychology, 2022).

Setting: The current study was conducted in different orthopedic words at a governmental hospital afflicted with Cairo University Hospital, Cairo, Egypt. The hospital contains four orthopedic wards on the first and second floor, each word consisting of 2 sides, one for male and another for female patients. In addition, each word contains 20 beds to receive patients with different orthopedic problems or orthopedic surgeries.

Sample: Over six months, a convenient sample of at least 60 adult male and female patients with different orthopedic problems/ surgeries that interfere with their moving abilities were recruited for the study. 60 patients will be divided into intervention and control groups (30 patients in each group).

The sample size n was calculated using the following formula:

n = N*X / (X + N – 1), where, X = Zα/22 -*p*(1-p) / MOE2,

MOE is the margin of error, Z/2 is the critical value of normal distribution at /2 (a confidence level of 95%, 0.05, and a critical value is 1.96); p is the sample ratio; and N is the population size **(Daniel, 1999).**

Inclusion criteria

Age over 18 years, able to communicate, confirmed orthopedic problem (s) diagnosis, and unable to move from bed.

Exclusion criteria: Patients immediately post-operative have deep venous thrombosis in the affected part and patients with compartment syndrome.

Tools of Data Collection and Scoring System

Data pertinent to the current study was collected using three tools developed by researchers:

Personal and medical data form developed by the researchers, consisting of questions regarding gender, age, residence, marital status, level of education, occupation, medical diagnosis, type of surgery if present, time of surgery, and expected date of hospital discharge.

Patient's Knowledge regarding the orthopedic self-care strategies: It was aimed to assess the patients' information about orthopedic problems; it was concerned with physical activities practices, side effects, and complications after such exercises, the purpose of the exercise, instructions regarding exercises before the operation, signs of bleeding, chest pain, leg swelling, and tingling. It was composed of (15) MCQs, such as correct movement, body alignment, how to perform breathing exercises, and other self-care strategies. The correct answer score for each statement was (1 mark), and the incorrect answer was (0). The total score of the patients' knowledgeassessment was (15) marks.

Physical assessment tool consists of 3 parts; the first part is about neurovascular assessment, which includes assessment of patients' vascular and neurological status such as pulse, skin color, temperature, presence of edema, pain, and sensation. Part two contains questions to assess patients' respiratory status, including respiratory rate, depth, rhythm, cough, chest sound, and chest pain. The last part of the tool assessed patients' intestinal status and contained questions such as eating patterns, frequency of meals, presence of nausea, vomiting or abdominal destination, intestinal sound, and frequency of defecation.

Scoring System:

Each question in each part of the second tool will be scored using (0 or 1) as follow; if the item is within normal, the question is scored (1 mark), but if the item is abnormal, the question is scored (0).

Validity and Reliability

Face and content validity was established for all the study tools by a panel of five medical-surgical nursing experts from the nursing faculty at Cairo University. First, the experts will ask to examine the tools for content coverage, clarity, wording, length, format, and overall appearance. Then, the modifications will be done accordingly. Moreover,

hand, the reliability of the second study tool was established statistically using Cronbach's alpha to examine the internal consistency.

Ethical consideration:

Primary approval was obtained from the Faculty of Nursing Research Ethics Committee at Cairo University to conduct the study. In addition, official permission from orthopedic department administrators was obtained to conduct the study, and the purpose and nature of the study, as well as the importance of the study, was explained to each patient who meets the inclusion criteria. Also, anonymity and confidentiality were assured through coding the data. Patients were assured that participation in this study was voluntary and could be withdrawn without penalty.

Procedure

Upon receiving formal approval from the Research Ethical Committee at the Faculty of Nursing, Cairo University, to conduct the study, an official permission was obtained from hospital administrators for conducting the study. Four phases preceded the current study: assessment, planning, implementation, and evaluation.

Assessment phase: In this phase, the researchers reviewed the literature, the feasibility of the study, accessibility of the sample, and facilities of the environment was assessed, and a proper mobile application was selected. In addition, the content validity of the study tools was established. The necessary modification was done; also reliability of tools was tested statistically using Cronbach's alpha.

Planning phase: Based on the outcome of the previous the researchers will start randomly selecting study participants from different orthopedic words affiliated with Kasr Aini Hospital to ensure homogeneity. The selected participants were assessed for the inclusion and exclusion criteria to decide their involvement in this study. Selected participants will be allocated randomly to two groups (intervention and control groups).

Implementation phase:

The researchers met each participant individually to explain the purpose, nature of the study, benefits of adherence to the intervention, and all the previously mentioned ethical considerations. First, each participant was asked to sign the consent form; then, the researcher conducted a structural interview to fill up the two research tools to conduct the initial research assessment. Regarding the study group, the researchers helped them download the mobile application and explain how to use it individually. Then, each participant was interviewed individually (face to face) for 45 minutes to give them instructions about how to use mobile apps to conduct pursed lips breathing exercises and range of motion exercises and let the participants perform the exercises under the supervision of the researchers to ensure that the participants could do the exercises correctly. Then, the searchers interacted online with the participants via video call or Zoom meetings 3 times per week for 3 weeks to follow them while conducting the previously mentioned exercises and to ensure that the participants correctly used the selected mobile application to answer any questions. During this phase, the researchers observed the control group to ensure they only received routine care.

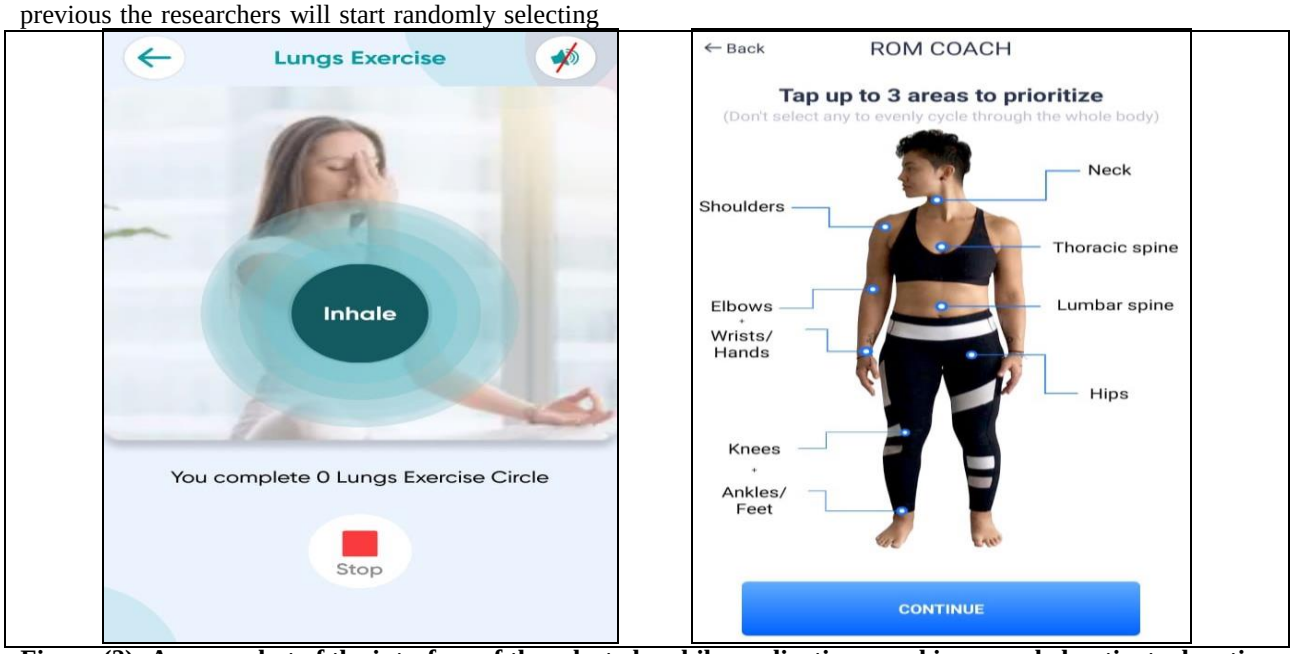

Figure (2): A screenshot of the interface of the selected mobile applications used in nurse-led patient education using telehealth and artificial intelligence

Evaluation phase:
Post-test was collected from the two groups twice immediately and at the end of 3 weeks using a physical assessment questionnaire (tool two) to assess the effect of telehealth nursing instructions on participants' neurological, respiratory, and gastrointestinal status. The final overall effect was determined and compared between the two groups.

Results:

Table (1): Distribution of socio-demographic characteristics among the study and control groups (n = 60).

Socio-demographic characteristic	Study group N=30		Control group N=30	
	No	%	No	%
Age groups				
18-<25	5	16.6%	4	14.5 %
25-<50	22	73.3%	20	68.9 %
50-<60	3	10.1 %	5	16.6%
Mean ±SD	**34.6 ± 4.25**		**35. 3 ± 4.38**	
Gender				
Male	17	56.7%	19	63.3%
Female	13	43.3%	11	36.7%
Education				
Illiterate	7	23.5%	12	40.1%
school education	16	56.5%	13	43.3%
University and above	6	20%	5	16.6%
Residence				
Urban	30	100.0%	30	100.0%
Rural	0	0.0%	0	0.0%

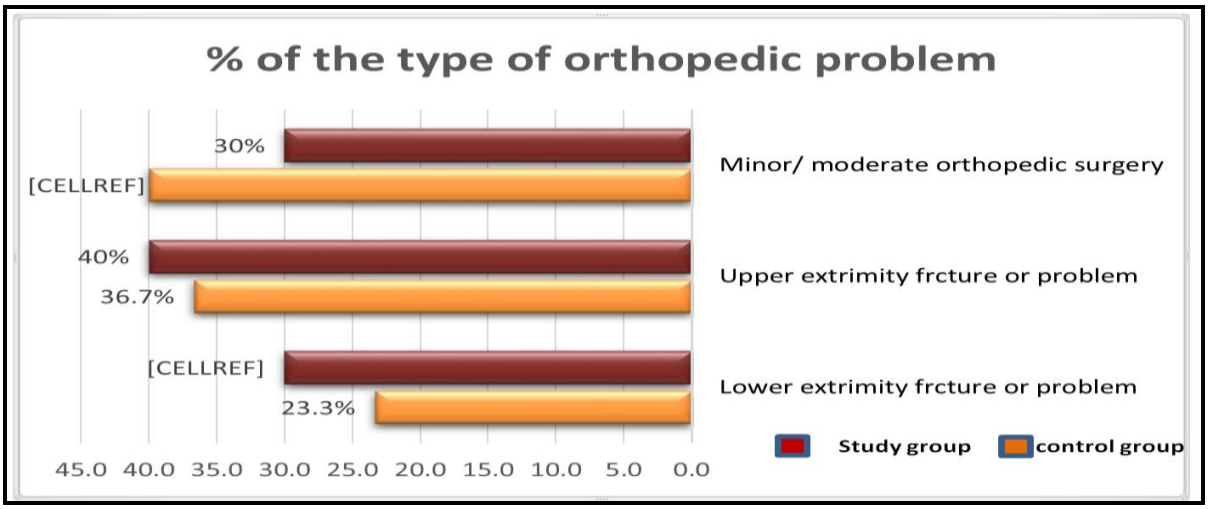

Figure (2): Illustrates the percentage of orthopedic problem types.

Table (2): Functional physical score of the study (N=30) & control (N=30) groups after 1 week and 3 weeks of nurse-led patient education Using Telehealth and artificial intelligence (for the study group only).

Functional physical score	Study group				control group			
	After 1 week		After 3 weeks		After 1 week		After 3 weeks	
	No	%	No	%	No	%	No	%
Vascular and neurological score	1	3.3%	28	93.3 %	6	20.0%	18	60.0%
Respiratory status score.	3	10.0 %	30	100.0%	8	26.7%	21	70%
Gastrointestinal status score	2	6.7 %	29	96.7%	6	20.0%	16	53.3%

Table (3): Shows a statistically significant distinction between the study and control groups. After 1 week and 3 weeks of nurse-led patient education application using Telehealth and artificial intelligence among the study with (P<0.001).

	After 1 week		After 3 weeks		t. test 1	t. test 2
the total score of knowledge	15.56±1.92	4.62±1.18	19.56±1.83	5.21±1.41	1.886 P0.137	11.137 P<o.oo1*
total functional physical score	10.0±2.42	4.35±2.42	16.94±2.90	7.35±2.33	0.443 P0.659	23.832 P<o.oo1*

**Statistically Significant Differences at P<o.oo1*

Table (4): The total score of knowledge about orthopedic self-care

Item	Immediately post		After one month	
Toral functional physical score	r 0.754	P-value <0.001*	r 0. 876	P-value <0.001*

r: Pearson correlation & Indicates a statistically significant difference at P< 0.05*

Table (1): Illustrates the socio-demographic traits of the study and control groups: regarding age; (73.3% and 68.9%, respectively) in both groups age were between 25-50 years old, with mean age (34.6 ± 4.25), the study group and (35. 3 ± 4.38) among the control group, regarding gender, (56.7%) of the study group and (63.3%%) of the control group were males, regarding participants educational level (56.5% & 43.3%) of the study and control groups respectively had school education, and all patients (100%) among both groups were living in urban areas.

Figure (3): Illustrates the percentage of orthopedic problem types. It shows that less than half (30% & 40%) of the study and control groups had minor to moderate orthopedic surgery. Over one-third (40% & 36.7%) of the study and control groups had upper extremity fractures or problems. The lower extremity fracture or problem was (30% & 23.3%) among the study and control groups, respectively.

Table (2): Shows that most of the study group, 93.3%, had high vascular and neurological scores after 3 weeks of using the telehealth program, while the score improvement among the control group was 60%. Furthermore, regarding the respiratory status score, the study group showed (100%) improvement, while the control group showed (70 %) only. Finally, gastrointestinal status scores showed 96.7% & 53.3% improvement among the study and control groups. The results in this table confirm the study hypotheses H1, H2 & H3.

Table (3): Comparison between the study and control groups regarding the total score of knowledge about orthopedic self-care & total functional physical score after 1 week and 3 weeks of nurse-led patient education application using Telehealth and artificial intelligence for the study group only(N=60). This result proves study hypothesis H4, The self-care knowledge score of patients with orthopedic restricted mobility who received a Telehealth teaching program has a significant statistical difference from that of patients with orthopedic restricted mobility who use routine care

Table (4): shows the total score correlation of knowledge about orthopedic self-care & total functional physical score after 1 week and 3 weeks from the application of nurse-led patient education using Telehealth and artificial intelligence among the study group(n = 30). This result supports study hypothesis H4.

Discussion

The current study found that most of the study group had high vascular and neurological scores after 3 weeks of using the telehealth program. Furthermore, the total number of the study group regarding the respiratory status score showed improvement. In addition, the gastrointestinal status score showed significant improvement after implementing Telehealth and artificial intelligence patient education using mobile applications. These findings support the current study hypotheses H1, H2 & H3. Furthermore, those study findings are congruent with **(Puzzitiello et al., 2021)**, who found that both new patient visits and follow-up consultations for orthopedic care are well received by most of the population. On the other hand, people with various chronic diseases and psychological needs may find it difficult to participate in Telehealth, which means that individuals who may stand to gain the most from ongoing care may be the ones who are accidentally left out of this digitalization boom.

In a study by **(Feng et al., 2021)**, they emphasized the extraordinary effort in this area is the use of Telemedicine for Patient education. The presented method accelerates knowledge transmission, enhances patient learning motivation, has a health promotion effect, and effectively increases patient

self-management. Such a patient education method is particularly pertinent in the ongoing global pandemic. This app could help patients unable to travel to the hospital to get the care they need, promote their health status, and better manage their functional physical status.

This is compatible with the current study finding, which revealed a high statistically significant difference between the study and control groups after 1 week and 3 weeks after the application of the nurse-led patient education using Telehealth and artificial intelligence in the study. So that the current study hypothesis H4 is accepted.

To summarize the discussion of the current study, the study findings showed that, after one week and three weeks of program implementation and compared to before program implementation, patients with orthopedic problems in the study group intervened with nurse-led educational programs using Telehealth and artificial intelligence showed improvement regarding the level of knowledge about orthopedic self-care strategies and selected functional physical score. This fully corroborates the hypotheses of the study.

Conclusion:

There was a significant improvement in the total score of patients' knowledge and selected physical outcomes among patients with orthopedic problems after the implementation of the nurse-led patient education using Telehealth and artificial intelligence than before, with a statistically significant difference at ($P \leq 0.001$). Furthermore, and correlation existed between the variables, the total knowledge score and the total functional physical score of the study group after one week and three weeks from the application of the intervention, with a statistically significant difference after one week with ($P < 0.001$) and after three weeks with ($P < 0.001$) which support the study hypothesises.

Recommendation:

1- Develop and apply nurse-led patient education using Telehealth and artificial intelligence for patients with orthopedic problems based on identified needs.
2- Mobile healthcare should be encouraged to facilitate nurse-patient interaction, patient monitoring, and feedback, making it easier to modify nursing care plans for such groups of patients based on needs.
3- Conduct more studies on innovative methods for managing patients with orthopedic disorders using Telemedicine and artificial intelligence.

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