Rehabilitation Program for Patients Undergoing Anterior Cruciate Ligament Reconstruction Surgery

Naglaa Abd ElKareem Moghazy Basuony [(1)], Nadia Mohamed Taha [(2)], Mona Tarek Abd Elghaffar[(3)], Howida Kameel Zatton [(4)]

(1) Assistant Prof. of Medical Surgical Nursing, Faculty of Nursing, Zagazig University, Egypt,
(2) Prof. of Medical Surgical Nursing, Faculty of Nursing, Zagazig University, Egypt,
(3) Physiotherapist, Zagazig University Hospitals, Egypt,
(4) Assistant Prof. of Medical Surgical Nursing, Faculty of Nursing, Zagazig University, Egypt,

Abstract

Background: The most common orthopedic operation carried out globally is anterior cruciate ligament reconstruction surgery (ACLRs), which is still the gold standard for managing anterior cruciate ligament injury (ACLI). The success of ACLRs is influenced by effective rehabilitation, which is a crucial part of the post-ACLRs recovery process that assures a quicker recovery and helps patients resume an active lifestyle. **Study aim:** Evaluate the effect of the rehabilitation program on patients undergoing anterior cruciate ligament reconstruction surgery. **Design:** Quasi-experimental design was used. **Setting:** Orthopedic surgery department and orthopedic outpatient clinic at Zagazig University Hospitals, Al Sharkia Governorate, Egypt. **Subject:** A purposive sample of 70 adult patients with ACLI who are undergoing ACLRs. **Tools:** Interview questionnaire; self-care practices questionnaire; functional and clinical status rating scale. **Results:** There was a highly statistically significant improvement and difference in overall patients' knowledge and their self-care practices score regarding ACLRs in the post- and follow-up phases of the rehabilitation program compared to the pre-phase ($p<0.001$), which resulted in enhanced functional and clinical status as there was a statistically significant positive correlation of functional and clinical status improvement with knowledge and self-care practices across various program phases. **Conclusions:** The rehabilitation program that is based on patients' previously determined needs plays an effective role in improving knowledge and self-care practices, as well as the functional and clinical status of patients undergoing ACLRs. **Recommendations:** The developed rehabilitation program should be implemented on a wide scale in study settings as well as all similar ones, including all governmental hospitals.

Keywords: Anterior Cruciate Ligament, Reconstruction Surgery, Rehabilitation Program.

I. Introduction:

As a key weight-bearing joint, the knee aids in balance when standing and offers stability and movement during physical activity. The knee's ligaments aid with joint stability. One of the two cruciate ligaments, the anterior cruciate ligament (ACL), regulates anterior tibial movement and prevents severe tibial rotation. It also helps stabilize the knee joint, especially during weaving, pivoting, or kicking motions **(Refaat et al., 2020)**.

The knee ligament that sustains injuries most frequently is the ACL. Injuries usually arise from engaging in sports or activities that require abrupt direction changes, rapid acceleration or deceleration while sprinting or jumping, and unusual landings. Around 70% of patients would have acute swelling as a result of haemarthrosis, and the majority would complain of hearing and feeling a sudden "pop" along with severe knee pain. Additional symptoms that have been documented include reduced knee range of motion (ROM), difficulty walking, and knee giving way **(Evans et al., 2023)**.

With a torn ACL, the knee becomes unstable, and the joint may deteriorate over time **(Refaat et al., 2020)**. Meniscal tears, chondral lesions, and early-onset osteoarthritis are among the long-term clinical consequences that are associated with ACL injuries. To prevent long-term morbidity, reduce pain, and stop future deterioration, anterior cruciate ligament injuries (ACLI) need to be diagnosed and treated promptly. Both conservative and surgical methods can be used to treat ACLI; achieving the patient's maximum functional level while minimizing the chance of further injuries or degenerative knee changes is the aim in both scenarios, as a successful outcomes of treatment has been indicated by a

return to a high level of activity **(Alghanim et al., 2018)**.

The "RICE" therapy, which includes rest, ice, compression of the injured knee, and elevation of the affected lower extremity, is the conservative or non-operative treatment for ACLI. Patients should also avoid bearing any weight and, if needed, use a wheelchair or crutches in addition to non-steroidal anti-inflammatory drug (NSAID) medication for pain relief, though this is usually at the discretion of the treating physician. Generally, acute symptomatic treatment is done in non-operative treatment, and 12 weeks of supervised physical therapy follow; however, because of recurrent "giving way" episodes, non-operative care has been linked to a higher risk of meniscal and cartilage injury **(Giummarra et al., 2022)**.

Reconstruction surgery, the surgical method for treating ACL injuries, has become the norm to stop the onset of unfavorable musculoskeletal effects after ACLI. This is because long-term research has demonstrated that delayed reconstruction is significantly more likely to result in menisci and articular cartilage damage **(Van et al., 2019)**. To return the knee joint to almost normal stability and function, anterior cruciate ligament reconstruction surgery (ACLRs) reconstructs the ruptured ligament using a graft positioned in an isometric region **(Cerulli et al., 2013)**. For ACLRs, the graft may be synthetic, autograft, or allograft **(Shom et al., 2023)**.

Both complete and partial ACL injuries with functional instability would require reconstruction surgery, as the ACLR procedure is recommended more for younger or older active patients (over 40). Restoring anterior and rotational stability of the knee is the main goal of anatomical ACL reconstructions, which also reduce the risk of secondary meniscal or chondral injuries. To obtain a full range of motion as before surgery and lower the risk of arthrofibrosis postoperatively, patients with ACLI need to get rehabilitation **(Musahl et al., 2022)**. So, rehabilitation programs should be added to the care of patients undergoing ACLRs **(Cerulli et al., 2013)**.

While effective rehabilitation is seen to be a critical part of the recovery process following ACLRs **(Kotsifaki et al., 2023)**, it also plays a role in the success of reconstruction surgery **(Glattke, 2022)**. Additionally, patients' adherence to the rehabilitation program is crucial and has a significant impact on their outcomes **(Chong, 2019)**. As the disease progresses, patients with ACL injuries experience increasing physical limitations, pain, and functional restrictions that interfere with their ability to perform daily tasks, as well as losses in their social, recreational, and occupational lives and lower quality of sleep, all of which lower their quality of life (QoL). As a result, the focus should be on improving these patients' functional and clinical status **(Sutbeyaz et al., 2018)**.

Therefore, it is recommended that rehabilitation programs be implemented to reduce disability, pain, swelling, and depression; encourage tissue healing; boost functionality; and enhance QoL, particularly for the active population **(Feyzioğlu, 2019)**. Moreover, early knee function recovery, the restoration of normal functional movements related to activities, and self-efficacy, which promotes fear avoidance, will be supported by health education given to patients as part of the rehabilitation program regarding symptom management, crutch use, and therapeutic exercises **(Manske et al., 2012)**.

Significance of the study:

Nearly half of all knee injuries occur to the ACL, making it the most frequently torn ligament in the knee. In the United States, there are roughly 400,000 ACL reconstruction surgeries performed annually **(Dean &LaPrade, 2020)**. Due to a lack of patient health education, exercise regimens, and ACL injury prevention programs, the Alsharkia Governorate's ACL injury rate is predicted to be 9.4, with a mean of 1000 cases each year **(Mohammed et al., 2019)**. The ACLI impairs knee function and drastically alters the patient's life; thus, prompt management is necessary to control pain, prevent long-term morbidity and subsequent deterioration. The ACLI management often entails reconstruction surgery, followed by rehabilitation to lessen its negative effects on patients **(Ardern, 2015)**, as it increases the possibility of cartilage breakdown onset and causes deterioration of the components surrounding the knee joint **(Cheung et al., 2020)**. Over the last 30 years, advances in postoperative rehabilitation programs have resulted in a dramatic improvement in the

operative outcomes of these injuries. Notably, patients 40 years of age and older have saw the largest increase in ACLRs, making rehabilitation a crucial component of ACLI management **(John Roberts et al., 2023)**.

Aim of the study:

The current study aimed to evaluate the effect of the rehabilitation program on patients undergoing anterior cruciate ligament reconstruction surgery (ACLRs) through the following:

- Assess the patients' level of knowledge regarding ACLRs.
- Assess the patients' level of self-care practices regarding ACLRs.
- Assess the functional and clinical status of patients undergoing ACLRs.
- Design and implement a rehabilitation program for patients undergoing ACLRs based on previously explored actual needs.
- Evaluate the effect of the rehabilitation program on the knowledge and self-care practices as well as the functional and clinical status of patients undergoing ACLRs.

Research hypotheses:

The following research hypotheses were created to reach the study's objective:

H1: It is anticipated that patients undergoing ACLRs will have better scores of knowledge, self-care practices, and functional and clinical status through the post- and follow-up phases of the rehabilitation program than they had before it.

H2: A statistically significant correlation will be found between patients' knowledge, self-care practices, and their functional and clinical status improvement in the rehabilitation program's post- and follow-up phases.

II. Subjects and Methods:

Research design:

The research design employed in this study was quasi-experimental, involving one group and pre-, post-, and follow-up intervention testing. The quasi-experimental study method examines if the independent and dependent variables have a cause-and-effect relationship. The independent variable is the influencing variable, whereas the dependent variable is the impacted variable **(Loewen & Plonsky, 2016)**.

Setting:

The study was conducted at Zagazig University Hospitals in the Al Sharkia governorate of Egypt, at two locations: the orthopedic surgery department and the orthopedic outpatient clinic.

Subjects:

A purposive sample of 70 adult patients with anterior cruciate ligament injury who were undergoing ACLRs at the above-mentioned facility met the following sampling inclusion criteria: Adult patients aged 18 and up of both sexes who are conscious and able to communicate, have acceptance to participate in the study, and are free from any cognitive or mental impairment, while sampling exclusion criteria included patients with chronic disease or cancer that would disable them from safely completing the requirements of the study and patients with mental and behavioral problems.

Sample size:

The sample size was 70 patients to achieve a power of 80% and a level of significance of 5% (two-sided), assuming the standard deviation of the differences to be 2.500 between pairs. The sample size was calculated based on **Ronser, (2016)** using the following equation:

$$n = \left(\frac{Z_{1-\alpha/2} + Z_{1-\beta}}{ES} \right)^2$$

The standard normal deviate for $\alpha = Z\alpha = 1.960$
The standard normal deviate for $\beta = Z\beta = 0.842$
$A = 2.500$
$B = (Z\alpha+Z\beta)$ $C = (E/S\ (\Delta))2 = 0.1024$
$AB/C = 69.6491.$
$n = 70$

Tools of data collection:

Three data collection tools were used:

Tool I: An Interview Questionnaire:

It was designed by researchers after an extensive review of pertinent literature **(Liao et al., 2023; Ali et al., 2021; Emmanuel, 2021;**

Tayeb et al., 2020; AbdElghany et al., 2019); it included 64 items and covered two parts as follows:

- **Part I**: **Patient's demographic characteristics**: This part was concerned with assessing the demographic characteristics of patients undergoing ACLRs. It contained seven items covering the age, gender, marital status, residence, education level, occupation, and income of the studied patients.
- **Part II: Patient's Knowledge Regarding ACLRs:** This part was intended to assess patients' knowledge regarding ACLRs. It included 57 items that involved three parts of knowledge: *the first part* covered the patients' knowledge about ACL, which included "7 items," *the second part* covered the patients' knowledge about ACLRs and the rehabilitation process, which included "10 items," and *the third part* included "40 items," which covered the patients' knowledge about followed measures before ACLRs (the patients' preparations before surgery, 13 items), on the day of ACLRs (the patients' preparations on the day of surgery, 6 items), and after ACLRs (the actions to be taken by the patient after ACLRS, 21 items).

- ***Knowledge scoring system:*** Multiple-choice questions with four alternative answers or true-false questions comprised of each knowledge item. One point was awarded for a right response, and zero for a wrong one. The item scores for each area of knowledge were added up, the total was divided by the number of items, and the mean score for the area was obtained. These mean scores were then transformed into percent scores. Data entry and statistical analysis determined that knowledge scores of 60% or higher were regarded as satisfactory, while scores of less than 60% were judged unsatisfactory.

Tool II: Self-Care Practices Questionnaire:

This tool was adapted from **Ali et al., (2021)** to assess the self-care practices (self reported practices) of patients undergoing ACLRS, then modified by researchers after an extensive review of pertinent literature **(Kotsifaki et al., 2023; Dai et al., 2022; Rhim et al., 2020; AbdElghany et al., 2019)**. It included 57 items that classified into five areas of self-care practices: *the first area* covered managing knee pain and swelling (6 steps); *the second area* covered practicing of rehabilitation exercises (25 steps) such as Immediate postoperative exercises (Ankle pumping exercises, 2 steps), Range of Motion Exercises (19 steps) which included seven exercises (long sitting knee bends exercise "3 steps", heel slides exercise "3 steps", hip flexor stretch exercise "3 steps", seated hamstring stretch exercise "3 steps", prolonged extension stretch exercise "2 steps", calf stretch exercise "3 steps"**,** and prone leg hangs "2 steps")**,** and Muscle Strengthening Exercises (Quad set in a standing exercise, 4 steps); *the third area* covered using crutches on stairs (11 steps); *the fourth area* covered the walking with crutches (7 steps); *the fifth area* covered followed safety and security measures (8 steps).

- ***Practice scoring system:*** Each practice item that was seen to be done was given a score of "1," while those that were not done received a score of "zero." To determine the mean score for each practice area, the sum of the item scores was divided by the total number of items. The percentage scores for these scores were computed. Based on data entry and statistical analysis, a practice was deemed satisfactory if its percent score was ≥60% and unsatisfactory if it was <60%.

Tool III: Functional and clinical status rating scale:

To assess the functional and clinical status of patients undergoing ACLRs, the researchers was adopted from **Noyes et al., (1989)** scale called *Modified Cincinnati Knee Rating Scale (MCKRS)* which is a subjective scoring system that used to assess the functional and clinical status through evaluate the patients' symptoms, sports activities, and activities of daily living (ADL). The MCKRS is composed of "8 domains" covered the pain intensity "6 items", swelling "6 items", giving way "6 items", overall activity level "6 items", walking ability "5 items", use of stairs "5 items", running activity "5 items", and jumping or twisting ability "5 items", these domains query how patients' knee symptoms affect their capacity to perform general daily activities and how their knee condition influences their capacity to perform specific functional tasks.

Each domain of MCKRS is composed of several items; each item takes a specific total score, with a higher score representing no symptoms and the best function ability of the knee, and vice versa.

- ***Scoring system of functional and clinical status:*** The MCKR scale that used to assess patients' functional and clinical status is a subjective scoring system that consists of eight domains present in the summary score. Generally, these domains covered pain, swelling, function, and activity level. The MCKRS score is calculated as (MCKRS score = [sum of items/maximum possible score] x 100). The higher score represents better functional and clinical status of patient. The functional and clinical status scores were graded as poor, fair, good, and excellent; it considered poor if the score was (<30), fair (30 to 54), good (55 to 79), and excellent (>80) based on the MCKRS.

Rehabilitation Program:

The researchers created it based on the needs of the patients that were previously evaluated and determined throughout the assessment phase. It was intended to enhance the knowledge and self-care practices of patients undergoing ACLRs that will be reflect on their functional and clinical status. It is written in simple Arabic and is intended to be a booklet about ACLRs and the associated rehabilitation process. It is based on the opinions of experts and a review of pertinent material, including nursing textbooks, periodicals, and online resources. To evaluate the effect of the rehabilitation program, patients' knowledge, self-care practice, functional and clinical status were evaluated before (pre-phase) and after (post- and follow-up phase) rehabilitation program implementation.

Tools validity and reliability:

A panel of five experts representing various nursing and medical disciplines evaluated the preliminary versions of the data collection tools in order to assess their content validity. Three medical-surgical nursing professors from the nursing faculty and two orthopedic surgery professors from Zagazig University Hospital participated in the panel. These specialists examined the instruments for applicability, thoroughness, comprehensibility, and simplicity of use. In accordance with the expert's advice, minor adjustments were made. A Cronbach's alpha test was used to determine the internal consistency and reliability of each tool items. For patients' knowledge (tool I), self-care practices (tool II) regarding ACLRs, and functional and clinical status rating scale or MCKRS (tool III), the scores were 0.75, 0.84, and 0.86, respectively.

Ethical consideration:

Before beginning the study, the approval of the ethical committee and the dean of the faculty of nursing at Zagazig University were obtained as well as an official consent was received from the directors of the previously stated study settings. Also, to guarantee maximal cooperation and to make plans for their presence, an oral agreement was obtained from participating patients before data collection. These patients were told about the nature, goal, and techniques of the study. Additionally, the participants were made aware of their freedom to discontinue participation in the study at any moment. Throughout the study, strict confidentiality was maintained, and all patients were assured that their information would only be used for research purposes.

Pilot study:

Tests of the instruments' clarity, relevance, comprehensiveness, understanding, applicability, and ease of implementation were conducted on 10% (seven patients) of the main study sample. The pilot study also helped to estimate the time needed to fill in the forms. Since no modifications were made to the tools, patients who participated in the pilot study were included in the actual study sample.

Fieldwork:

The study's fulfillment comprised four phases: assessment, planning, implementation, and evaluation.

(1) Assessment phase:

- The present study's data was gathered from beginning of March 2023 to October 2023. The rehabilitation program was implemented over eight months, divided into one month for the assessment phase, one month for the theoretical sessions, three months for the practical sessions, and three months for follow-up phase. During the assessment phase, the researchers obtained the essential

clearances from the Director of Zagazig University Hospital and the study setting directors to maintain their cooperation during data collection and to establish a schedule that would facilitate data gathering, the researchers visited the study locations, spoke with the directors, and explained the purpose of the study as well as the methodology.

- Four days a week, data was collected from patients undergoing ACLRs who had already been admitted to the hospital in preparation for surgery, as well as from patients who were on the waiting list for surgery after obtaining their phone numbers from the hospital and meeting them in the outpatient clinic. Initially, the patients were met by the researchers, who introduced themselves, explained the purpose of the study and the procedure for gathering data, and offered them to participate after being made aware of their rights. After each patient agreed to participate, the researchers began the data-gathering procedure by conducting an individual interview with them using the data collection tools. 30 to 35 minutes were needed to finish the data-gathering tools.

(2) The planning phase:

- After the assessment phase was finished, all data were analyzed to ascertain the knowledge and self-care practices needs of patients undergoing ACLRs as well as their functional and clinical status. Based on the patients' previously assessed needs, the researchers designed an Arabic rehabilitation program booklet, drawing on relevant literature and expert opinions.

(3) The implementation phase:

- The rehabilitation program and its booklet were established to equip patients with knowledge and self-care practices regarding ACLRs in order to improve their functional and clinical status. After providing each patient under study with an explanation of the rehabilitation program and its booklet, each participant patient was given a copy of rehabilitation program booklet. The researchers scheduled the educational sessions with patients, and the patients were split up into ten smaller groups, with seven patients in each. Four days a week, in the morning and afternoon shifts, the researchers were present. Researchers conducted the rehabilitation program over "12" educational sessions, with four sessions for the theoretical part and eight for the practical part, as follows:

A. ***The theoretical part*** was implemented through 4 sessions; *the first session* covered knowledge about ACL injury (Brief about knee joint and ACL; causes, symptoms, methods of diagnosing, risk factors, complications, prevention, and management methods of ACLI). *The second and third sessions* covered ACLRs (Brief about ACLRs, reasons and cases requiring ACLRs, methods of performing ACLRs, followed measures before, on the day of, and after ACLRs, follow-up and treatment after surgery, risks and warning signs after ACLRs). *The fourth session* covered the rehabilitation process after ACLRs (introduction to rehabilitation and rehabilitative programs, definition of rehabilitation and the rehabilitative program, the goal and stages of the rehabilitation). The theoretical sessions were implemented preoperatively; each session took 30–35 minutes.

B. ***The practical part*** was implemented through 8 practical sessions covered the self-care practices of patients. *The first session* covered pain and swelling management procedure. *The second, third, fourth, and fifth* sessions covered the rehabilitation or therapeutic exercises such as Immediate postoperative exercises (ankle pumping exercises), Range of motion exercises which included seven exercises such as (long sitting knee bends exercise, heels slides exercise, hip flexor stretch exercise, seated hamstring stretch exercise, prolonged extension stretch exercise, calf stretch exercise, and prone leg hangs), and Muscle Strengthening Exercises (quad set in standing exercise). *The sixth* session covered the procedure of using crutches on stairs (a weight-bearing procedure while going up and down the stairs). *The seventh* session covered the walking with crutches procedure. *The eighth* session covered the safety and security followed measures. The practical sessions were conducted

postoperatively over three months; each practical session took 45–60 minutes.

- Usually, the first few minutes of each new session are dedicated to reviewing the topics from the prior ones and outlining the objectives. By praising and/or acknowledging the interested patient during the implementation of the rehabilitation program, the patient's motivation was maintained. To carry out a rehabilitation program, a presentation, lecture, and discussion were utilized for theoretical part while demonstration and re-demonstration were utilized for practical part. A rehabilitation program booklet was provided to each patient at the start of the program, along with other appropriate teaching aids such as colored handouts, brochures, posters, and videos. Additionally, the researchers connected with the patients during the follow-up period in the physiotherapy clinic as well as over the phone to provide education and reinforcement.

(4) The evaluation phase:

- Using the same data collection tools as the pretest (pre-phase assessment), the study patients' knowledge, self-care practices, and functional and clinical status were assessed after (post- and follow-up phase) the implementation of the program to evaluate the effect of the rehabilitation program on patients undergoing ACLRs. The presence or absence of changes or differences between the rehabilitation program's pre-phase (baseline evaluation), post-phase (after three months), and follow-up phase (after six months) evaluated the program's efficacy.

Statistical analysis of the data:

SPSS 20.0 for Windows (SPSS Inc., Chicago, IL, USA, 2011) was used to gather, tabulate, and statistically analyze all of the data. The mean ± SD was used to convey quantitative data, while absolute frequencies (number) and relative frequencies (%) were used to express qualitative data. To compare two dependent groups of normally distributed variables, a paired t-test was employed. To compare two dependent groups of non-normally distributed variables, the Wilcoxon signed rank test was employed. The Mcnemar test, or marginal homogeneity, was employed to compare categorical data between two dependent groups; when comparing percentages of categorical variables, the Fisher's exact test or the Chi-square test was used. To evaluate the link between the study variables, the Pearson correlation coefficient was determined; a (+) sign denotes direct association, and a (-) sign denotes inverse correlation. The factors influencing functional and clinical status were also predicted using multiple linear regressions (step-wise). P-values $\leq$ 0.05 was regarded as statistically significant (S), p-values < 0.001 as highly statistically significant (HS), and p-values > 0.05 as statistically insignificant (NS).

III. Results:

Table 1 demonstrates that the mean age of studied patients was 42 ± 15.59 and the greatest percentage of the patients (51.4%) were between the ages of 20 and 40, while the lowest percentage (20%) of the patients were older than 60. Additionally, 65.7%, 80.0%, and 54.3% of the patients under study were males, married, and residing in rural areas, respectively. Furthermore, there were 74.3% of educated patients, 57.1% of working patients, and 51.4% of patients with not enough income.

Table 2 indicates that mean patient knowledge scores about ACLI, ACLRs, and the rehabilitation process, followed measures before, on the day of, and after ACLRs, were increased statistically significantly ($p<0.001$) at the post- and the follow-up phases of the rehabilitation program as compared to the pre-phase, as they rose from (2.65±0.83, 2.45±1.72, 5.62±1.56, 2.22±0.96, 9.02±1.65, respectively) at the pre-phase to (6.82±0.44, 8.17±0.70, 11.42±0.77, 5.20±0.40, 18.02±0.97) at the post-phase and (5.08±0.73, 6.91±0.60, 9.68±0.75, 4.40±0.49, 15.77±1.15) at the follow-up phase, although mean patients' knowledge domains scores decreased slightly during the follow-up phase than the post-phase.

Concerning patients' overall knowledge score regarding ACLRs, **figure 1** shows that, during the pre-phase of the rehabilitation program, only 5.7% of patients possessed satisfactory overall knowledge; by the post-phase, this percentage had improved to 80%, and at the follow-up phase, it was 72.9%. Generally, there was a highly statistically significant difference and improvement in patients' overall knowledge regarding ACLRs

post- and follow-up phases of the rehabilitation program as compared to pre-phase ($p<0.001$), although the patients' overall knowledge score was slightly lower in the follow-up phase (72.9%) than the post-phase (80%).

Table 3 clarifies that at the post- and follow-up phases of the rehabilitation program, as compared to the pre-phase, there were statistically significant increases in the mean scores of patients' self-care practices domains such as managing knee pain and swelling, practicing rehabilitation exercises, using crutches on stairs (weight bearing on stairs), walking with crutches, and follow safety and security measures ($p<0.001$), as it increased from (1.31±0.75, 3.02±4.57, 2.45±3.67, 2.77±1.94, 2.97±1.21, respectively) at the pre-phase to (5.20±0.40, 19.91±4.33, 9.20±2.08, 6.08±1.00, 7.42±1.32) at the post-phase and (3.57±0.49, 13.20±2.56, 7.54±1.41, 4.85±0.68, 5.82±0.77) at the follow-up phase, although mean patients' self-care practice domains scores decreased slightly during the follow-up phase than the post-phase.

The results presented in **Table 4** indicate a statistically significant increase in the mean scores of patients' practice of rehabilitation exercises such as Immediate postoperative exercises (ankle pumping exercise), Range of motion exercises (long sitting knee bends exercise, heels slides exercise, hip flexor stretch exercise, seated hamstring stretch exercise, prolonged extension stretch exercise, calf stretch exercise, prone leg hangs exercise), and Muscle strengthening exercises (quad set in standing exercise). This increase was observed in the post- and the follow-up phases of the rehabilitation program compared to the pre-phase ($p<0.001$). Overall, the total mean scores of patients' practice for rehabilitation exercises showed a significant improvement and difference between the pre-and post-phases of the program, as well as between the pre-and follow-up phases ($p<0.001$), rising from 3.02±4.57 at the pre-phase to 19.91±4.33 at the post-phase and 13.20±2.56 at the follow-up phase, although the total mean score of patients' practice for rehabilitation exercises dipped slightly at the follow-up phase compared to the post-phase.

Figure 2 illustrates that while the majority of studied patients (85.7%) and more than three-quarters of them (77.1%) had satisfactory overall self-care practices regarding ACLRs in the post-and follow-up phases of the rehabilitation program, respectively, only 5.7% of studied patients had satisfactory overall self-care practices in the pre-phase. In total, studied patients showed statistically significant differences and improvements in overall self-care practices at the post- and follow-up phases of the rehabilitation program compared to the pre-phase ($p<0.001$). However, patients' overall self-care practices score was slightly lower in the follow-up phase (77.1%) than in the post-phase (85.7%).

According to **Table 6**, patients' functional and clinical status domains (pain intensity, swelling, giving way, overall activity level, walking ability, use of stairs, running activity, and jumping or twisting ability) mean scores had statistically significant improvements in the post-and follow-up phases of the rehabilitation program compared to the pre-phase ($p<0.001$), and according to the MCKR scale, higher scores of functional domains represent symptoms improvement and better functional and clinical status of the patients. In general, the mean scores of all functional and clinical status domains have improved more at the follow-up phase than at the pre-and post-phases.

As shown in **Figure 3**, the highest percentage of the patients (68.6%) had poor functional and clinical status in the pre-phase of the rehabilitation program, followed by less than one-third (31.4%) with fair functional and clinical status, and none of them had good or excellent functional and clinical status. Conversely, in the post-phase, the percentage of patients with poor functional and clinical status was the lowest (11.4%), while the percentage with fair functional and clinical status was the highest (57.1%). Furthermore, 28.6% and 2.9% of patients achieved good and excellent functional and clinical status, respectively. However, compared to the pre-and post-phases, these percentages improved more in the follow-up phase as none of the patients had poor functional and clinical status, and the greatest percentage of patients (64.3%) had good functional and clinical status, with

14.3% having excellent functional and clinical status. In total, at the post- and follow-up phases of the rehabilitation program, studied patients' overall functional and clinical status scores showed a substantial improvement and statistically significant difference from the pre-phase ($p<0.001$).

As clarified in **Table 7**, at the pre-phase ($p=0.003$) and follow-up phase ($p=0.032$) of the rehabilitation program, patients' functional and clinical status and self-care practices score showed a highly statistically significant positive correlation, while at the post-phase, patients' functional and clinical status showed a statistically significant positive correlation with both knowledge ($p=0.021$) and self-care practices score ($p=0.001$).

Table 8 indicates that age is the main statistically significant independent negative predictor of patients' functional and clinical status, since functional and clinical status decline with age. On the other hand, the patient's functional and clinical status score was not significantly influenced by any of the other patients' variables. According to the R-square value, the model accounts for 60% of the variation in the functional and clinical status score.

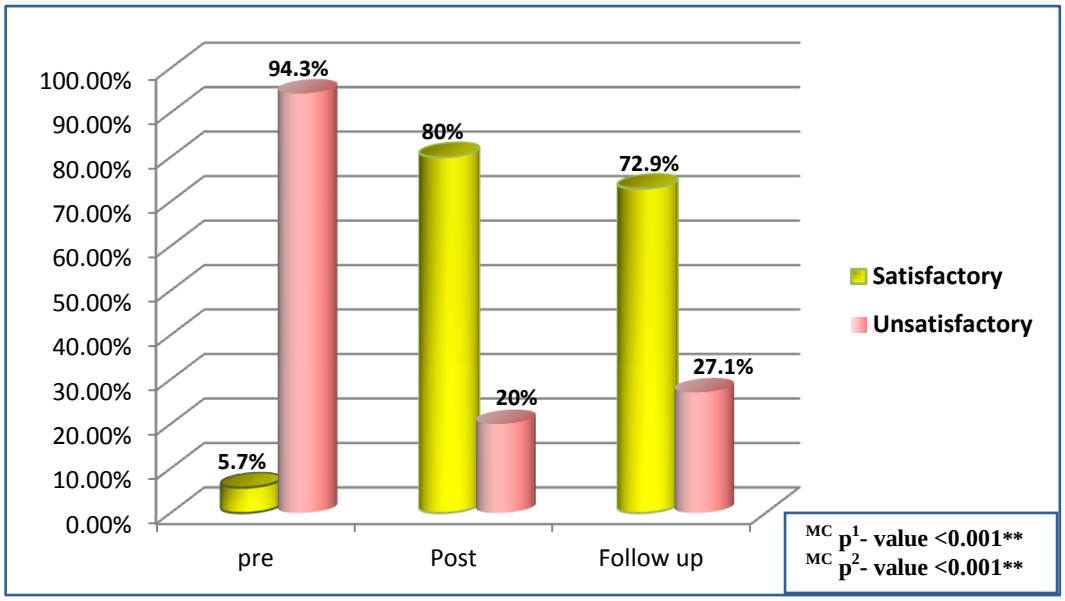
Table (1): Frequency and Percentage Distribution of Socio-Demographic Characteristics for Studied Patients (n = 70):

Socio-demographic characteristics	No.	%
Age:		
- 20 - 40	**36**	**51.4**
- > 40 - 60	**20**	**28.6**
- > 60	**14**	**20.0**
Mean ±SD	**42 ±15.59**	
Range	**20-70**	
Gender:		
- Male	**46**	**65.7**
- Female	**24**	**34.3**
Marital status:		
- Married	**56**	**80.0**
- Unmarried	**14**	**20.0**
Residence:		
- Rural	**38**	**54.3**
- Urban	**32**	**45.7**
Education:		
- Educated	**52**	**74.3**
- Not Educated	**18**	**25.7**
Occupation:		
- Work	**40**	**57.1**
- Not work	**30**	**42.9**
Income:		
- Enough	**34**	**48.6**
- Not Enough	**36**	**51.4**

Table (2): Knowledge Domains Mean Scores of Studied Patients throughout Rehabilitation Program Phases (n = 70):

Knowledge Domains	Rehabilitation Program Phases			Paired t-test	
	Pre	Post	Follow Up	P^1 Pre-post	P^2 Pre-FU
	Mean± SD				
Patients' knowledge about ACLI.	2.65±0.83	6.82±0.44	5.08±0.73	<0.001**	<0.001**
Patients' knowledge about ACLRs and rehabilitation process.	2.45±1.72	8.17±0.70	6.91±0.60	<0.001**	<0.001**
Patients' knowledge about the followed measures before ACLRs.	5.62±1.56	11.42±0.77	9.68±0.75	<0.001**	<0.001**
Patients' knowledge about the followed measures on the day of ACLRs.	2.22±0.96	5.20±0.40	4.40±0.49	<0.001**	<0.001**
Patients' knowledge about the followed measures after ACLRs.	9.02±1.65	18.02±0.97	15.77±1.15	<0.001**	<0.001**

Paired t-test was used, ** statistically highly significant (p<0.001); P^1: for comparison between pre and post-phase of rehabilitation program;
P^2: for comparison between pre and follow-up phase.



MC: Mcnemar test; Insignificant (p>0.05), **: statistically highly significant (p<0.001);
P^1: for comparison between pre and post-phase of rehabilitation program;
P^2: for comparison between pre and follow-up phase of rehabilitation program.

Figure (1): Patients' Overall Knowledge Score Regarding ACLRs throughout Rehabilitation Program Phases (n = 70)

Table (3): Self-Care Practices Domains Mean Scores Regarding ACLRs of Studied Patients throughout Rehabilitation Program Phases (n = 70):

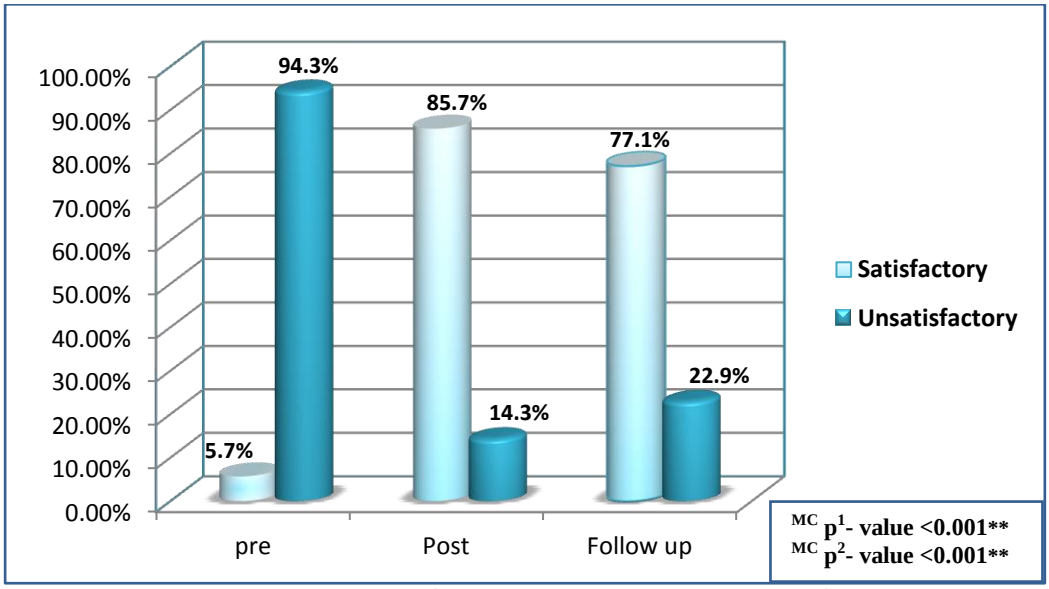
Self-Care Practices Domains	Rehabilitation Program Phases			Paired t-test	
	Pre	Post	Follow Up	P^1 Pre-post	P^2 Pre-FU
	Mean± SD				
Managing knee pain and swelling.	1.31±0.75	5.20±0.40	3.57±0.49	<0.001**	<0.001**
Practicing of rehabilitation exercises.	3.02±4.57	19.91±4.33	13.20±2.56	<0.001**	<0.001**
Using crutches on stairs (weight bearing on stairs).	2.45±3.67	9.20±2.08	7.54±1.41	<0.001**	<0.001**
Walking with crutches.	2.77±1.94	6.08±1.00	4.85±0.68	<0.001**	<0.001**
Follow safety and security measures	2.97±1.21	7.42±1.32	5.82±0.77	<0.001**	<0.001**

Paired t-test was used, ** statistically highly significant (p<0.001); P^1: for comparison between pre and post-phase of rehabilitation program;
P^2: for comparison between pre and follow-up phase.

Table (4): Studied Patients' Practice Mean Scores of Rehabilitation Exercises throughout Rehabilitation Program Phases (n = 70):

Rehabilitation Exercises	Rehabilitation Program Phases			$^W P^1$ Pre-post	$^W P^2$ Pre-FU
	Pre	Post	Follow Up		
	Mean± SD				
Immediate post operative exercises: - Ankle pumping exercise.	0.31±0.71	1.97±0.16	1.28±0.45	<0.001**	<0.001**
Range of motion (ROM) exercises:					
- Long sitting knee bends exercise.	0.08±0.50	2.68±0.86	2.05±0.63	<0.001**	<0.001**
- Heels slides exercise.	0.14±0.59	2.54±0.73	1.62±0.54	<0.001**	<0.001**
- Hip flexor stretch exercise.	0.62±1.18	2.51±0.74	1.54±0.55	<0.001**	<0.001**
- Seated hamstring stretch exercise.	0.31±0.89	2.54±0.77	1.54±0.65	<0.001**	<0.001**
- Prolonged extension stretch exercise.	0.51±0.88	1.77±0.48	1.22±0.48	<0.001**	<0.001**
- Calf stretch exercise.	0.57±1.16	2.48±0.84	1.60±0.59	<0.001**	<0.001**
- Prone leg hangs exercise.	0.22±0.64	1.45±0.85	0.94±0.63	<0.001**	<0.001**
Muscle strengthening exercises: - Quad set in standing exercise.	0.23±0.93	1.94±1.83	1.37±1.29	<0.001**	<0.001**
Total mean score of rehabilitative exercises	**3.02±4.57**	**19.91±4.33**	**13.20±2.56**	**<0.001****	**<0.001****

W: Wilcoxon Signed Ranks Test, **: statistically highly significant (p<0.001), P1: for comparison between pre and post- phase of rehabilitation program; P^2: for comparison between pre and follow-up phase.



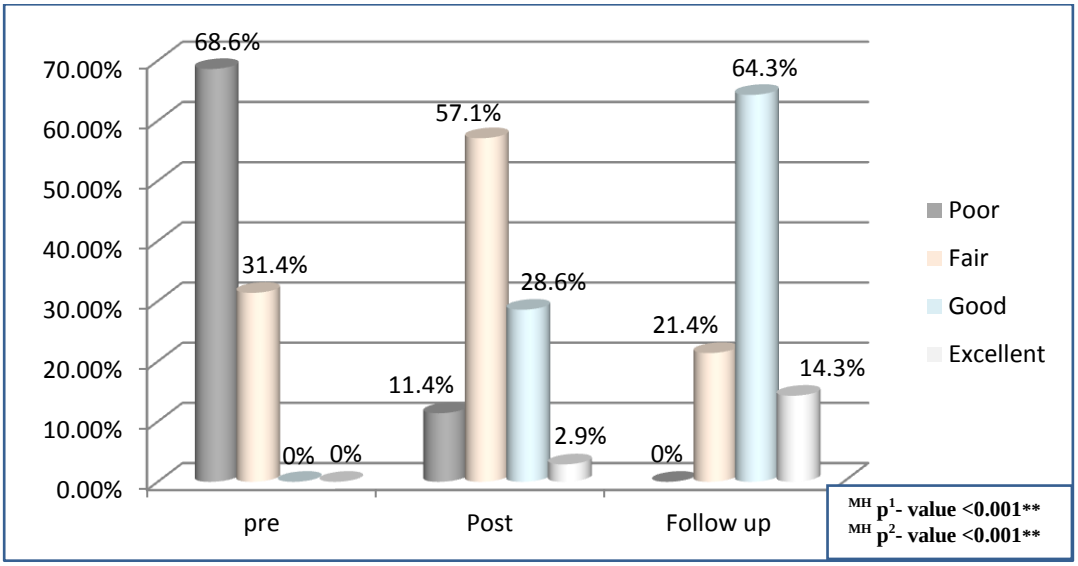
MC: Mcnemar test; statistically significant (p≤0.05), **: statistically highly significant (p<0.001);
P1: for comparison between pre and post-phase of rehabilitation program;
P^2: for comparison between pre and follow-up phase of rehabilitation program.

Figure (2): Patients' Overall Self-Care Practices Score Regarding ACLRs throughout Rehabilitation Program Phases (n = 70)

Table (5): Studied Patients' Functional and Clinical Status Domains Mean Scores according to the Modified Cincinnati Knee Rating Scale (MCKRS) throughout Rehabilitation Program Phases (n = 70):

Functional and Clinical Status Domains	Rehabilitation Program Phases			Paired t-test	
	Pre	Post	Follow Up	P^1	P^2
	Mean± SD			Pre-post	Pre-FU
Pain intensity	5.14±2.27	9.60±3.09	13.60±2.07	<0.001**	<0.001**
Swelling	4.22±1.78	6.28±1.61	8.28±1.51	<0.001**	<0.001**
Giving way	5.60±2.75	10.51±2.92	14.51±3.90	<0.001**	<0.001**
Overall activity level	5.48±2.05	10.05±2.63	14.05±3.61	<0.001**	<0.001**
Walking ability	3.54±1.18	5.77±0.94	7.77±1.93	<0.001**	<0.001**
Use of Stairs	3.42±1.02	5.31±1.07	7.31±2.07	<0.001**	<0.001**
Running activity	1.51±0.60	2.45±0.65	3.45±0.45	<0.001**	<0.001**
Jumping or twisting ability	1.40±0.54	2.28±0.62	3.28±0.51	<0.001**	<0.001**

Paired t-test was used, ** statistically highly significant (p<0.001); P^1: for comparison between pre and post-phase of rehabilitation program; P^2: for comparison between pre and follow-up phase.



MH: Marginal Homogeneity test, **: statistically highly significant (p<0.001);
P^1: for comparison between pre and post-phase of rehabilitation program;
P^2: for comparison between pre and follow-up phase of rehabilitation program.

Figure (3): Patients' Overall Functional and Clinical Status Score throughout Rehabilitation Program Phases (n = 70)

Table (7): Correlation Matrix between Patients' Overall Knowledge, Self-Care Practices, and Functional and Clinical Status Score throughout Rehabilitation Program Phases (n=70):

Parameters	Rehabilitation Program Phases					
	Pre phase		Post phase		Follow-UP phase	
	Functional and clinical status score		Functional and clinical status score		Functional and clinical status score	
	r	p	r	P	r	p
Knowledge score	0.152	0.210	0.275	0.021*	0.130	0.283
Self-care practices score	0 .354	0 .003**	0 .406	0.001**	0.256	0.032*

(r) Correlation coefficient; Non significant (p>0.05); *: significant (p≤0.05),
****: statistically highly significant (p<0.001).**

Table (8): Best Fitting Multiple Linear Regression Model for the Functional and Clinical Status Score among Studied Patients (n = 70):

Model	Unstandardized Coefficients		Standardized Coefficients	t-test	p-value	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower	Upper
Constant	74.888	2.356		31.780	.000	70.186	79.591
Age	-.538-	.053	-.778-	-10.22	<0.001**	-.643-	-.433-

****: Statistically highly significant (p<0.001), R-square = 0.60; ANOVA: F= 104.498, P<0.001;**

Variables entered and excluded: gender, marital status, education, occupation, residence, income, knowledge, and self-care practices.

IV. Discussion:

Currently, the first line of treatment for an ACLI is reconstruction surgery. Adequate preoperative and postoperative rehabilitation is crucial to the success of ACLRs **(Shom et al., 2023).** The rehabilitation process is thought to be a key component in aiding in the recovery of ACLI, as its goals include restoring pre-injury muscle strength, improving dynamic knee stability, knee function, range of motion, minimizing functional limitations and disability, preventing further injury, and optimizing long-term QoL **(Bogunovic & Matava, 2013)**. Although the exact duration of rehabilitation is unknown, it usually takes six to nine months. Still, it could take up to two years to reach the ultimate objective of full recovery **(Ahmad, 2016)**. Therefore, this study aimed to evaluate the effect of the rehabilitation program on patients undergoing ACLRs. A discussion of the current results will cover five main areas in the following sequence:

Firstly, the Socio-demographic characteristics of studied patients:

Regarding the sociodemographic characteristics of the studied patients, the current study found that the mean age of studied patients was 42 ± 15.59 and the greatest percentage of the patients were between the ages of 20 and 40, while the lowest percentage of the patients were older than sixty years. Additionally, of the patients under study, nearly two-thirds were male, the majority was married, and more than half of them resided in rural areas, respectively. Furthermore, nearly three-quarters of the studied patients were educated, and more than half of them were works but their income was not enough.

From the researchers' point of view, the greatest percentage of the study sample's patients are between the ages of twenty and forty, which suggests that this is the age group most likely to have an active lifestyle and be hyperactive, which raises the risk of ACLI. In addition, the study sample's preponderance of men may be explained by the fact that men are more likely to have jobs that require physical exertion and participate in competitive sports, both of which raise the risk of ACL injuries.

The current results are corroborative with **Almuhaya et al., (2023)**, who discovered that all study participants were male with ACLR in a study conducted in the Kingdom of Saudi Arabia titled "Adding a Structured Educational Session to the Rehabilitation Program of Soccer Players Following Anterior Cruciate Ligament Reconstruction: A Feasibility Study." These findings also align with the findings of **Ali et al., (2022)**, who noted that about two-thirds of the patients were less than 40 years old, over two-thirds were male, the most of patients were married and resided in rural areas, the highest proportion of patients were educated, over half of patients were employed, and nearly three-quarters of patients didn't have sufficient monthly income to meet their basic needs in their study, "Anterior Cruciate Ligament Knee Injuries: Patients' Needs.".

Furthermore, **Emmanuel's (2021)** study, "Prediction of Patient-Reported Outcome after Arthroscopic Anterior Cruciate Ligament Reconstruction," supports these findings by demonstrating that a majority of participants (more than 80%) were under 40 years old and had a male-to-female ratio of 5:1. Additionally, the current results concur with those of **AbdElghany et al., (2019)**, who reported in their study titled "Effect of Exercises Program on Knee Functional Outcomes for Patients after Arthroscopic Anterior Cruciate Ligament Reconstruction" that the highest percentage of patients in both groups were between the ages of 30 and 40, that men predominated over women in both groups, that over half of the patients in the studied groups were married, that the most of both groups had a university education, and that most of the two studied groups had physically demanding jobs.

While the present results are in disagreement with **Magnussen et al., (2016),** who illustrated in a study titled "Effect of High-Grade Preoperative Knee Laxity on Anterior Cruciate Ligament Reconstruction Outcomes" that most of the study sample was single, also, these findings contradict those of **Siegel et al., (2012)**, who noted in their study "Anterior Cruciate Ligament Injuries: Anatomy, Physiology, Biomechanics, and Management" that anterior cruciate ligament injuries are more common in women than in men for a variety of anatomical reasons.

Secondly, patients' knowledge regarding ACLRs throughout the rehabilitation program phases:

Concerning the knowledge domains mean scores of studied patients throughout rehabilitation program phases, the present study revealed that mean patient knowledge scores about ACL injury, ACLRs, and the rehabilitation process, followed measures before, on the day of, and after ACLRs, were increased statistically significantly at the post- and the follow-up phases of the rehabilitation program as compared to the pre-phase, although mean patients' knowledge domains scores decreased slightly during the follow-up phase than the post-phase.

These results are congruence with a study published by **Alyami et al., (2023)** titled "Awareness of Anterior Cruciate Ligament Injury-Preventive Training Programs among Saudi Athletes," which showed that study participants' overall level of awareness of ACL injuries was low, with 971 participants not familiar with the concept of ACL injury, and only 198 participants familiar with it and suggested that medical professionals should make more efforts to raise participant awareness of ACL injuries.

The current results also align with those of **Ali et al., (2022)**, who discovered that all patients possessed inadequate knowledge regarding ACL injury. But the current results contrast with some of their study's findings; like that most of the patients in the study sample had enough understanding of the measures to be followed both before and after ACLRs. Furthermore, **Shaker et al., (2019)** noted in their study "Knowledge and awareness toward anterior cruciate ligament (ACL) injury among a population of Aseer region, Saudi Arabia" that to reduce the incidence and consequences of ACL injuries, more health education, awareness-raising, and program implementation are required for patients.

Moreover, **Mohamed (2018)** found that there was a statistically significant improvement ($P<0.001$) in the patient's knowledge about ACL reconstruction surgery and surgery followed measures throughout program phases in their study, "Effect of a Nursing Rehabilitation Program on Patients' Health Outcomes after Anterior Cruciate Ligament Reconstruction". Likewise, these results concur with those of **Cole et al., (2017)**, who clarified in their study titled "Patient Understanding, Expectations, Outcomes, and Satisfaction Regarding Anterior Cruciate Ligament Injuries and Surgical Management" that patients typically have a poor understanding of ACL injuries, reconstruction surgery, and factors that affect their prognosis without the intervention of health care providers.

On the other hand, **Alqarni et al., (2022)** found in their study "The prevalence and determinants of anterior cruciate ligament rupture among athletes practicing football in Jeddah Avenues 2020" that most participants had an overall level of adequate knowledge about ACL injury and that their awareness and knowledge of ACLI are encouraging. These findings are in contrast to the results of this study. Furthermore, **Abdalrahman et al., (2021)** found that 79.8% of study participants had information about ACL injury and ACLR surgery.

Concerning patients' overall knowledge about ACLRs throughout the Rehabilitation Program Phases, the present study revealed that during the pre-phase of the rehabilitation program, only 5.7% of patients possessed sufficient overall knowledge; while by the post-phase, the majority of patients had satisfactory knowledge, and despite the overall patients' knowledge being slightly decreased in the follow-up phase than the post-phase, except that about three-quarters of patients had satisfactory knowledge at the follow-up phase. Generally, there was a highly statistically significant difference and improvement in patients' overall knowledge regarding ACLRs post- and follow-up phases of the rehabilitation program as compared to pre-phase.

From the researchers' point of view, this lack of knowledge on the part of patients in the pre-phase of the rehabilitation program could be caused by the healthcare providers (nurses and physicians) increasing workload, which could lead to a decline in their role regarding providing health education to these patients. As a result, patients may turn to the Internet, which is highly variable and of questionable quality, to get information.

The present results are consistent with those of **Fouasson-Chailloux et al., (2022)**, who documented in a study titled "Therapeutic Patient

Education after Anterior Cruciate Ligament Reconstruction: Evaluation of the Knowledge and Certitudes with a Self-Report Questionnaire" that therapeutic patient education provided during hospitalization for rehabilitation helps patients better understand the phases of rehabilitation leading up to a return to sport following ACLRs. Additionally, therapeutic education may help patients avoid psychological problems related to their knees and the risks associated with returning to sports.

Also, the results of the study "Anterolateral Ligament Tear in Acute Anterior Cruciate Ligament Rupture: Diagnostic Accuracy of MRI" by **Abdelmonem and Mourad (2019)** align with the current study's findings, as it was found that the majority of patients' knowledge is poor and unsatisfactory without intervention. In the meantime, **Courtot et al., (2019)** reported in their study "Patient Participation During Anterior Cruciate Ligament Reconstruction Improves Comprehension, Satisfaction, and Functional Outcomes: A Simple Way to Improve Our Practices" that following the intervention, postoperative comprehension significantly improved for the participation group, with a mean score increase of 7.1 ± 5.3 points compared to 2.7 ± 5.6 points for the standard group (P =.0024).

Furthermore, the present findings align with the study conducted by **Mohammed et al., (2016)**, which investigated the "Impact of Nursing Rehabilitation Program on Outcome of Patients Undergoing Arthroscopy for Anterior Cruciate Ligament Injury". The study revealed a statistically significant difference and improvement in the knowledge of the study groups before, two weeks, one month, two months, four months, and six months after the nursing rehabilitation program's intervention as compared to the control group.

Thirdly, patients' self-care practices regarding ACLRs throughout rehabilitation program phases:

Concerning studied patients' self-care practices domains throughout Rehabilitation Program Phases, the current study results clarified that at the post- and follow-up phases of the rehabilitation program, as compared to the pre-phase, there were statistically significant increases in the mean scores of patients' self-care practices domains regarding managing knee pain and swelling, practicing rehabilitation exercises, using crutches on stairs (weight bearing on stairs), walking with crutches, and follow safety and security measures.

The current findings are consistent with the findings of **Goff et al., (2021)**, who found that while patient education resulted in statistically better short-term pain and function outcomes when compared to conventional therapy, the changes were not statistically significant. To provide statistically significant and clinically meaningful improvements in function when compared to education alone, patient education should be given in conjunction with exercise therapy. This emphasizes the significance of performing rehabilitation exercises regularly.

The present results also align with the findings of **Kaur et al., (2019)**, who noted in their study "Individuals' experiences of the consequences of anterior cruciate ligament reconstruction surgery" that medical professionals should think about long-term, individual-specific maintenance programs that enhance and preserve self-efficacy and confidence, as well as encourage physical activity in patients with ACLRs. As a result, these programs can encourage physical activity among participants, such as walking with crutches to preserve or improve knee health and choosing to climb stairs rather than take the elevator.

Additionally, the current findings are in line with **Haj Hamad et al., (2018)**, who found that therapeutic education in conjunction with rehabilitation resulted in managing pain properly, which led to a reduction in pain and an improvement in joint mobility. After the protocol ended, there was an improvement in the psychological profile, physical function, and overall QoL at three months; this improvement remained a year into the follow-up. These findings are also consistent with **Tengman's (2018)** findings, which showed that the majority of patients with ACLI had poor weight-bearing habits in the absence of training.

Meanwhile, the current findings are in line with **Kennedy et al., (2017),** who confirmed that study patients require additional education and training regarding pain management following surgery. Providing pain management education in various formats that answer commonly asked questions will improve patient participation and

their overall experience and recovery. Furthermore, **Rubinstein et al., (2017)** found that most healthy individuals can increase their range of motion (ROM) with just 30 seconds of stretch exercises in their study, "Effect of knee stability if full hyperextension is restored immediately after autogenous bone-patellar tendon-bone anterior cruciate ligament reconstruction," which reflects the importance of training patients on practicing rehabilitation exercises.

As well, these findings conform to those of **Grindem et al., (2016),** who mentioned that early recovery of knee functions is enhanced by clear instruction and training of patients regarding post-surgical exercises, crutch walking, and safety and security measures following ACLRs. These factors also improve the self-efficacy of patients during rehabilitation, reduce expected postsurgical pain, and foster a realistic perspective of the rehabilitation process. Moreover, these findings are consistent with the findings of **David et al., (2016)**, who explained in their study "Perioperative Pain and Swelling Control in Anterior Cruciate Ligament Reconstruction" that the move from inpatient to outpatient ACLRs has been made easier by effective pain and swelling management.

Too, the current results coincide with **Van Melick et al., (2016),** who found that early weight-bearing training of patients with ACLRs appears helpful and may reduce pain. Additionally, early motion for patients is safe and may help prevent issues with later arthrofibrosis. For these reasons, minimally supervised physical therapy in a select group of motivated patients appears safe and unlikely to cause major complications. **Saka (2014)** further demonstrated that the goal of rehabilitation following ACLRs and before going back to regular activities should be to manage symptoms including pain and swelling, preserve a normal range of motion, and prevent muscle atrophy.

Concerning studied patients' practices for rehabilitation exercises throughout program phases, the current study results indicated a statistically significant increase in the mean scores of patients' practice of rehabilitation exercises such as the Immediate postoperative exercises (ankle pumping exercise), Range of motion exercises (long sitting knee bends exercise, heels slides exercise, hip flexor stretch exercise, seated hamstring stretch exercise, prolonged extension stretch exercise, calf stretch exercise, prone leg hangs exercise), and Muscle strengthening exercises (quad set in standing exercise). This increase was observed in the post- and follow-up phases of the rehabilitation program compared to the pre-phase. Overall, the total mean scores of patients' practice for rehabilitation exercises showed a significant improvement and difference between the pre-and post-phases of the program, as well as between the pre-and follow-up phases.

The present findings are consistent with those of **Moubarak et al., (2023)**, who discovered in a study titled "Effect of Adding Preoperative Exercise to Postoperative Rehabilitation Program of Progressive Exercises on Anterior Cruciate Ligament Reconstruction" that including pre-operative exercises such as Range-of-motion (ROM) exercises (seat flexion, extension), balance/proprioception exercises (standing on one leg, balance board), and lower limb strengthening, with a focus on strengthening the quadriceps muscles (muscle strengthening exercises), which include mini squats, wall squats, straight leg raising, leg press, isometric leg extension, and knee flexion curls, can produce superior outcomes in subjects with ACLRs than only postoperative progressive rehabilitation.

Too, these findings are in line with **Kotsifaki et al., (2023)**, who demonstrated in a study titled "Aspetar clinical practice guideline on rehabilitation after anterior cruciate ligament reconstruction" that exercise interventions should be the cornerstone of ACLR rehabilitation because they can be beneficial as an adjuvant during the early stages of recovery when pain, swelling, and range of motion limitations are evident. These results also support the conclusions drawn by **Rodriguez et al., (2021)** that exercise therapy is beneficial for patients undergoing ACL reconstruction and that it has a direct correlation with functional improvement and the ability to resume regular or sports activities.

As well, these findings conform with **Abd Elghany et al., (2019),** who revealed that at 2nd weeks and 4th weeks of the exercise program intervention, there was an improvement in Range of motion exercises in the study group, as well as a statistically significant difference between the

study and control groups after the 2nd and 4th weeks of the program in ROM exercises. Additionally, not only did the study group's overall mean score for knee flexion improve by 109.0 ± 8.35 compared to the control group's 77.0 ± 10.14, but the study group also considerably outperformed the control group in terms of total knee extension scores.

Moreover, these findings are consistent with a study conducted by **Van Der et al., (2019)** called "Evidence-Based Rehabilitation Following Anterior Cruciate Ligament Reconstruction." This study found that two-thirds of participants had satisfactory practice levels regarding Range of motion exercises after the program intervention. The results of the current study also correspond to those of **Taylor et al., (2015)**, who found that without the intervention program; only a low percentage of participants had practiced standing exercises to a satisfactory level.

Concerning studied patients' overall self-care practices regarding ACLRs throughout Rehabilitation Program Phases, the present study illustrated that while the majority of patients and more than three-quarters of them had satisfactory overall self-care practices regarding ACLRs in the post-and follow-up phases of the rehabilitation program, respectively, only 5.7% of studied patients had satisfactory overall self-care practices in the pre-phase. In total, studied patients showed statistically significant differences and improvements in overall self-care practices at the post- and follow-up phases of the rehabilitation program compared to the pre-phase.

From the researchers' point of view, the unsatisfactory overall practice level regarding ACLRs among the studied patients before implementation of the rehabilitation program may be attributed to the fact that the majority of patients had unsatisfactory knowledge; this is believed to be the primary obstacle to improving their practices.

The present study's findings coincide with those of **Abd Elaty et al., (2021)**, who demonstrated that the implementation of the discharge plan increased the patients' overall knowledge and practice. Furthermore, it was made clear by **Hashem et al., (2020)** that before the implementation of the educational nursing program, the majority of the study and control groups had an inadequate level of practice. At two follow-up periods—before discharge and three months after the program—the study group demonstrated a highly statistically significant improvement in their performance and self-efficacy after the program was implemented compared to before (P-value <0.001).

Additionally, the current results align with those of **Elesawy et al., (2019)**, who demonstrated that the majority of patients experienced positive outcomes following the implementation of the nursing educational program and that there were statistically significant differences between knowledge and skills before and after the program. Furthermore, the current results are consistent with those of **Mohammed et al., (2016)**, who demonstrated a significant statistical difference (P value = 0.001) after a nursing teaching program in the study group's practices prior to, during, and following arthroscopy for ACL injury. The study concluded that orthopedic patients' practices regarding ACL reconstruction surgery were improved as a result of the teaching program.

Fourthly, patients' functional and clinical status throughout rehabilitation program phases:

Concerning functional and clinical status domains Mean scores according to MCKRS among studied patients throughout rehabilitation program phases, the present study results displayed that patients' functional and clinical status domains (pain intensity, swelling, giving way, overall activity level, walking ability, use of stairs, running activity, and jumping or twisting ability) mean scores had statistically significant improvements in the post- and follow-up phases of the rehabilitation program compared to the pre-phase, and according to the MCKR scale, higher scores of functional domains represent symptoms improvement and better functional and clinical status of the patients. In general, the mean scores of all functional and clinical status domains have improved more at the follow-up phase than at the pre-and post-phases.

From the researchers' point of view, this improvement in patients' functional and clinical status in both the post- and follow-up phases of the rehabilitation program is attributed to the effect of rehabilitation program, besides time plays an important role in healing and improving of ACL injury after reconstruction surgery, and

this was confirmed by an increase in functional and clinical status scores in the follow-up phase (after six months) than the post-phase (after three months).

The present findings concur with those of **Moubarak et al., (2023)**, who discovered that including progressive preoperative rehabilitation in the postoperative rehabilitation program led to a significant improvement in the subjects with ACLR knee pain, knee symptoms, activities of daily living, sport, and recreation function, one-leg hop test (jumping), global function, and knee-related quality of life. Furthermore, **Gsangaya et al., (2023)** disclosed that after the program, there were significant differences between the study group and control group with respect to the improvement of pain levels ($p = 0.012$) and knee function scores ($p = 0.024$).

These results are further supported by **Mahmoud et al., (2022)** findings, which showed that the study group's ability to perform particular functional tasks, such as walking, use of stairs, standing, kneeling in front of the knee, squatting, sitting on a bent knee, and rising from a chair, differed significantly ($P < 0.001$) from the control group after the program was implemented. Additionally, the study group experienced less pain and improved knee muscle strength and knee function (KOS-ADLS) more than the control group.

Likewise, these findings are in concordance with the findings of **Shu et al., (2022)**, who explained in a study titled "Effect of Rehabilitation Training on Cruciate Ligament Injury" that an early, systematic rehabilitation training program can lessen pain and swelling and enhance knee joint function following ACLR surgery. Too, **Taha & Ibrahim (2021)** discovered that the educational program had a statistically significant effect on the lower extremity function score, with the study group patients having better functional outcomes than the control at two weeks post-surgery and one month later.

The present results are corroborative with those of **AbdElghany et al., (2019)**, who reported that following the implementation of an exercise program, the study group experienced a greater improvement in knee function, pain reduction, and knee muscle strength than the control group. Additionally, a statistically significant improvement was observed in the total mean score of overall activity level among patients with ACLRs in the study group (70.57 ± 3.87) as compared to patients in the control group (40.86 ± 3.37).

Furthermore, these results align with those of **Chen et al., (2018)**, who found that early recovery outcomes following surgery, such as decreased inflammation, improved muscle strength and neuromuscular control, and restored mobility, are often facilitated by preoperative rehabilitation. Similarly, **Mohammed et al., (2016)** elucidated that following the implementation of a nursing rehabilitation program, there was a high level of statistical significance difference and improvement concerning pain intensity, swelling, giving way, overall activity level, walking, use of stairs, running activity, jumping, or twisting at two weeks, one month, two months, and four months from arthroscopy for ACLI.

Concerning patients' overall functional and clinical status score throughout rehabilitation program phases, the present study results revealed that the highest percentage of the patients had poor functional and clinical status in the pre-phase of the rehabilitation program and none of them had good or excellent functional and clinical status. Conversely, in the post-phase, the percentage of patients with poor functional and clinical status was the lowest, while the percentage with fair functional and clinical status was the highest. Furthermore, 28.6% and 2.9% of patients achieved good and excellent functional and clinical status, respectively. However, compared to the pre-and post- phases, these percentages improved more in the follow-up phase, as none of the patients had poor functional and clinical status, and the greatest percentage of patients had good functional and clinical status, with 14.3% having excellent functional and clinical status. In total, at the post- and follow-up phases of the rehabilitation program, studied patients' overall functional and clinical status scores showed a substantial improvement and statistically significant difference from the pre-phase.

The findings of the present study are in line with those of **Mazhar et al., (2023)**, who found that physical therapy rehabilitation program following ACLRs significantly improved knee

flexion and extension range of motion and demonstrated the importance of physical therapy rehabilitation for the restoration of knee function following ACL surgery, with 87.5% of participants showing normal knee functional status (knee flexion and extension range) and 12.5% showing post-operatively knee functional status above normal at the 6-week following the program, in a study entitled "Effect of the Rehabilitation Program on knee Range of motion and muscle power after Anterior Cruciate Ligament Reconstruction Surgery".

Additionally, the results of this study correspond with those of **Zhang et al., (2022)**, who reported in a study titled "Effects of Functional Training on Postoperative Anterior Cruciate Injury in Athletes Hospitalized" that, following a two-month follow-up period of functional training program, 11 cases had excellent functional status, 17 cases had good functional status, and the excellent and good index was 93.3%. It was also determined that there was a statistically significant difference ($P<0.05$) between the observation group and the control group and that the knee joint functional score was significantly higher after training.

As well, these results are consistent with the findings of **Jiang et al., (2022)**, who explained in "The Effect of Proprioception Training on Knee Kinematics after Anterior Cruciate Ligament Reconstruction: A Randomized Control Trial" that knee joint functional performance was improved by rehabilitation training in populations who have had ACL reconstruction. Besides, **Mardani-Kivi et al., (2019)** showed in their study "Arthroscopic ACL and PCL reconstruction using allograft Achilles tendon" that there was a significant difference in the functional status of the knee over time and that all patients had normal flexion and extension ranges six weeks after surgery.

Moreover, **Abd Elghany et al., (2019)**, who found that an exercise program following arthroscopic ACLR significantly improved patients' knee functional status, corroborate the current findings. Further, **Gupta et al., (2017)** showed that 35%–60% of patients were able to regain their pre-injury level following ACLRs with rehabilitation at the 6-month of follow-up following ACLRs, **Risberg et al., (2007)** demonstrated an improvement in the Knee functional status scores for patient share in the neuromuscular training program.

Fifthly, correlation between the study variables:

Concerning the correlation between patients' overall knowledge, self-care practices, and functional and clinical status score throughout rehabilitation program phases, the current study results found that at the pre- and follow-up phases of the rehabilitation program, patients' functional and clinical status and self-care practices score showed a highly statistically significant positive correlation, while at the post-phase, patients' functional and clinical status showed a statistically significant positive correlation with both knowledge and self-care practices score.

These findings are confirmed by **Legnani et al., (2023),** who reported that patients with greater values of practices after injury demonstrated superior functional and clinical status as well as enhanced performance six months following ACL reconstruction surgery. These results additionally correspond with those of **Abd-Ella et al., (2021)**, who showed statistically significant relationships between patients' functional status before and three months after the discharge plan was implemented and their level of knowledge. Furthermore, **Emmanuel (2021)** showed that completing six to nine months of physiotherapy practice was predictive of positive functional status, while not engaging in any physical activity was linked to negative outcomes.

Too, the current findings agree with **Middlebrook et al., (2020)**, who clarified that knowledge of physical prognostic factors, such as quadriceps strength, has a significant effect on functional status after ACL reconstruction and is critical for guiding rehabilitation. Additionally, **Courtot et al., (2019)** concluded that patients who participate in their ACL reconstruction surgery have greater knowledge and comprehension of the process, which results in better outcomes postoperatively and higher levels of satisfaction. According to **Mohamed (2018)**, there was a statistically significant correlation between the overall knowledge score of the patients under study after ACLRs and their health status or outcomes three months following the program.

Concerning the best-fitting multiple linear regression models for the functional and clinical status score among studied patients, the current study indicated that age is the main statistically significant independent negative predictor of patients' functional and clinical status, since functional and clinical status decline with age. On the other hand, the patient's functional and clinical status score was not significantly influenced by any of the other variables. The current finding is consistent with **Ketema et al., (2023),** who revealed that 57.6% of patients had good knee functional status. The factors found to increase the odds of poor functional status were age, gender, postoperative infection, soft tissue injuries, and comminuted fracture patterns.

In the meantime, **Niederer et al., (2023)** demonstrated that age, gender, pain, graft type, time since reconstruction, time between injury and repair, and concurrent injuries were multiple interrelated predictors of functional status following ACLR. Moreover, these findings are in line with **Pizzari et al., (2005)** who reported that age is a predictor of patients' outcomes and home exercise adherence. Specifically, for participants under 30, there was a significant relationship between home exercise adherence and many outcomes. Also, **Wang et al., (2007)** found that among older persons, perceived age and body mass index were significant predictors of functional ability.

Conclusion:

The current study led to the conclusion that the rehabilitation program, which is based on patients' previously determined needs, plays an effective role in improving knowledge, self-care practices, and the functional and clinical status of patients undergoing ACLRs. As in the pre-phase of the rehabilitation program, the majority of the studied patients had unsatisfactory overall knowledge and self-care practices regarding ACLRs, and they also had poor functional and clinical status. In contrast, in the post- and follow-up phases, patients' knowledge and self-care practices, as well as functional and clinical status, improved in comparison to the pre-phase, which indicates the efficacy of the rehabilitation program. Additionally, the current study's conclusion affirms the significance of improving the knowledge and self-care practices of patients to enhance their functional and clinical status, where the correlation analysis revealed a statistically significant positive correlation between patients' functional and clinical status improvement and knowledge as well as their self-care practices across various program intervention phases, thereby supporting the current study's hypotheses.

Recommendation:

In view of the study results, the study recommends the following:

- Provision of colorful posters, handouts, and educational rehabilitation booklets regarding ACLRs and rehabilitative exercises for patients at the orthopedic surgery department and orthopedic outpatient's clinic.
- Assign specialized rehabilitative nurses at the orthopedic surgery department to assist in clarifying and explaining all aspects of ACLRs to patients.
- The developed rehabilitation program should be implemented on a wide scale in study settings and all similar ones, including all governmental hospitals.

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