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The Effect of Pain Management Educational Program based on KERN's Educational Model on Nurses' Performance in Surgical Wards

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Abstract

Background: Pain management is a crucial aspect of nursing care for postoperative patients. Educational models offer a valuable approach to enhance nurses' knowledge and skills in this domain.

Aim: The present study was conducted with aim to evaluate the effect of a pain management educational program based on Kern's educational model on the performance of nurses in surgical wards.

Method: This quasi-experimental study with a pre-test, post-test, and control group design was conducted on nurses from surgical wards of three hospitals affiliated with Babol University of Medical Sciences. The intervention group received a six-step pain management educational program relying on Kern's model. Data were collected using the Nurses' Knowledge and Attitudes Survey Regarding Pain (NKASRP) and the Nurse's Care Behavior Questionnaire related to Pain Management (NCBPQ). Data were analyzed using SPSS software (version 16) and independent sample t-test and paired sample t-test. $p<0.05$ was considered significant.

Results: After the intervention, the mean score of the nurses' performance reached 183.39 ± 23.05 in the intervention group and 154.14 ± 52.55 in the control group ($p<0.001$), and the mean score of the nurses' knowledge and attitude were 10.02 ± 1.40, 30.36 ± 3.39 in the intervention group and 8.04 ± 2.01, 24.19 ± 3.68 in the control group ($p<0.001$). In the intervention group, nurses' knowledge, attitude and performance improved at post-test ($p<0.001$), but in the control group, this difference was not significant ($p<0.05$).

Implications for Practice: The pain management educational program based on Kern's educational model improves the nurses' knowledge, attitude and performance about pain management in surgical wards. It is suggested to use this educational model for the effectiveness and durability of training.

Keywords: Attitude, Kern's Educational Model, Knowledge, Pain Management, Performance

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Introduction

Various factors such as surgical procedures and trauma can contribute to patients experiencing pain following surgery. Studies indicate that over 80% of patients encounter acute postoperative pain, with approximately 75% describing its severity as moderate, severe, or extreme (1). Inadequate pain management can result in physical harm, psychological repercussions, and complications such as prolonged recovery, extended hospital stays, escalated healthcare expenses, and diminished patient satisfaction (2,3). On the other hand, effective postoperative pain management offers numerous benefits, including facilitating early mobility, reducing hospitalization duration and costs, enhancing sleep quality, and fostering higher levels of patient satisfaction and positive outlook (4-8).

Nurses play a crucial role in alleviating patients' pain (9, 10); however, their efficacy may be hindered by insufficient knowledge, leading to potentially inappropriate actions. There are several obstacles to pain management by nurses, including inadequate equipment, inadequate training among nurses and inadequate pain monitoring equipment (11,12). Jaleta et al. (2020) found that only 28.9% of nurses use pain assessment tools, and only 55.6% of pain relief provided to patients is documented in nursing records (13). Pain assessment tools can not only provide effective measures to quantify pain intensity, but can also help evaluate the effectiveness of pain relief measures (11). Utilizing pain assessment tools can enhance the nurse-patient relationship and provide more effective pain relief (14). According to Bahrami et al. (2016), 39.8% of patients were fully satisfied with their pain control, but only 4.2% of nurses believed that pain management was appropriately applied. Notably, 99.2% of nurses thought patients overused analgesics, while only 27.9% of patients believed that they need more pain medication. These discrepancies suggest a difference in perceptions between patients and nurses (15). Furthermore, patient education by nurses can improve patients' pain management. It is beneficial for nurses to educate patients about the importance and methods of pain assessment before surgery, which requires nurses to have sufficient knowledge (8). Jaleta et al. (2020) observed that trained nurses were twice as likely to perform well (13). In addition to knowledge and skills, nurses' attitudes toward pain management can impact postoperative pain management (12). Therefore, pain management educational programs can positively influence nurses' attitudes as well as knowledge (6). In this context, using standardized and validated educational models is crucial in medical sciences, particularly in nursing. Given their comprehensive coverage of all learning stages, educational models offer a suitable approach for designing and refining educational programs (16).

Current pain management educational programs in most colleges and hospitals provide limited instruction, typically only one hour of teaching in nursing curricula and in-service training. This is concerning because many nurses, particularly novice nurses, often lack sufficient clinical experience and training to provide optimal care for patients experiencing postoperative pain (17). Additionally, nurses' pain management practices are complex and involve various interconnected and interdependent management structures. These factors underscore the need for educational models to guide pain management education (18). Eventually, suboptimal pain management persists as a pervasive concern in healthcare environments, jeopardizing patient well-being and recovery. Nurses occupy a crucial role in pain assessment and management; however, their knowledge and skills may vary, impacting the caliber of care delivered. Despite the fact that the effect of pain management training has been examined in some previous studies (3, 19, 20), no study has been conducted in relation to the developing of educational content in accordance with the needs' assessment. The Kern Model is a comprehensive model for developing educational programs specifically for use in medical education. It is cost-effective, improves education, and effectively evaluates the impact of education in the clinic. It is an operational approach that has been widely used over the past two decades. The continuous and interactive nature of Kern's six-step approach, including problem identification and general needs assessment, needs assessment of target learners, general and specific objectives, educational strategies, implementation, and evaluation and feedback, has proven to be very helpful in evaluating nursing education programs (21). The present study was conducted with aim to evaluate the effect of a pain management educational program based on Kern's educational model on the performance of nurses in surgical wards.

Methods

This quasi-experimental study with a pre-test-post-test design was conducted in 2023 on all nurses at the teaching hospitals affiliated with Babol University of Medical Sciences, namely Shahid

Yahyanejad, Ayatollah Rouhani, and Shahid Beheshti hospitals. The study was implemented in the surgical wards of the mentioned hospitals. The staff nurses responsible for providing bedside nursing care in these wards were recruited. The inclusion criteria encompassed possessing a bachelor's degree or higher qualification, being employed within surgical wards (both general and/or orthopedics), and having a minimum of 6 months of experience in such settings. Nurses who were relocated from the surgical ward to another department, or were absent due to vacation or illness, were excluded from the study. The Pocock formula was used to estimate the sample size, considering α=0.05, statistical power=0.90, and effect size (d)=0.20, which indicates the minimum required sample size of 37 participants in each group, that considering 10% attrition, the sample size of 40 participants were determined (a total of 80 in both groups) (22). Considering the number of nurses working in the surgical departments of these centers and the type of the intervention, which was the implementation of a face-to-face pain management program, the samples were clustered at the hospital level based on geographical location, and Shahid Beheshti Hospital was selected for the intervention group due to its largest surgical department, and the other two hospitals for the control group. Considering the fact that the three centers are academic, the written training programs for all three centers regarding pain management were the same and received from the Vice-Chancellor of Babol University of Medical Sciences. A total of 40 nurses were included in the intervention group and 42 nurses in the control group. Of the nurses who initially entered the study, two from the intervention group (one due to unwillingness to continue research and one due to illness) and one from the control group (due to illness) were excluded from the study. Finally, 79 nurses remained at the end of the study (Figure 1).

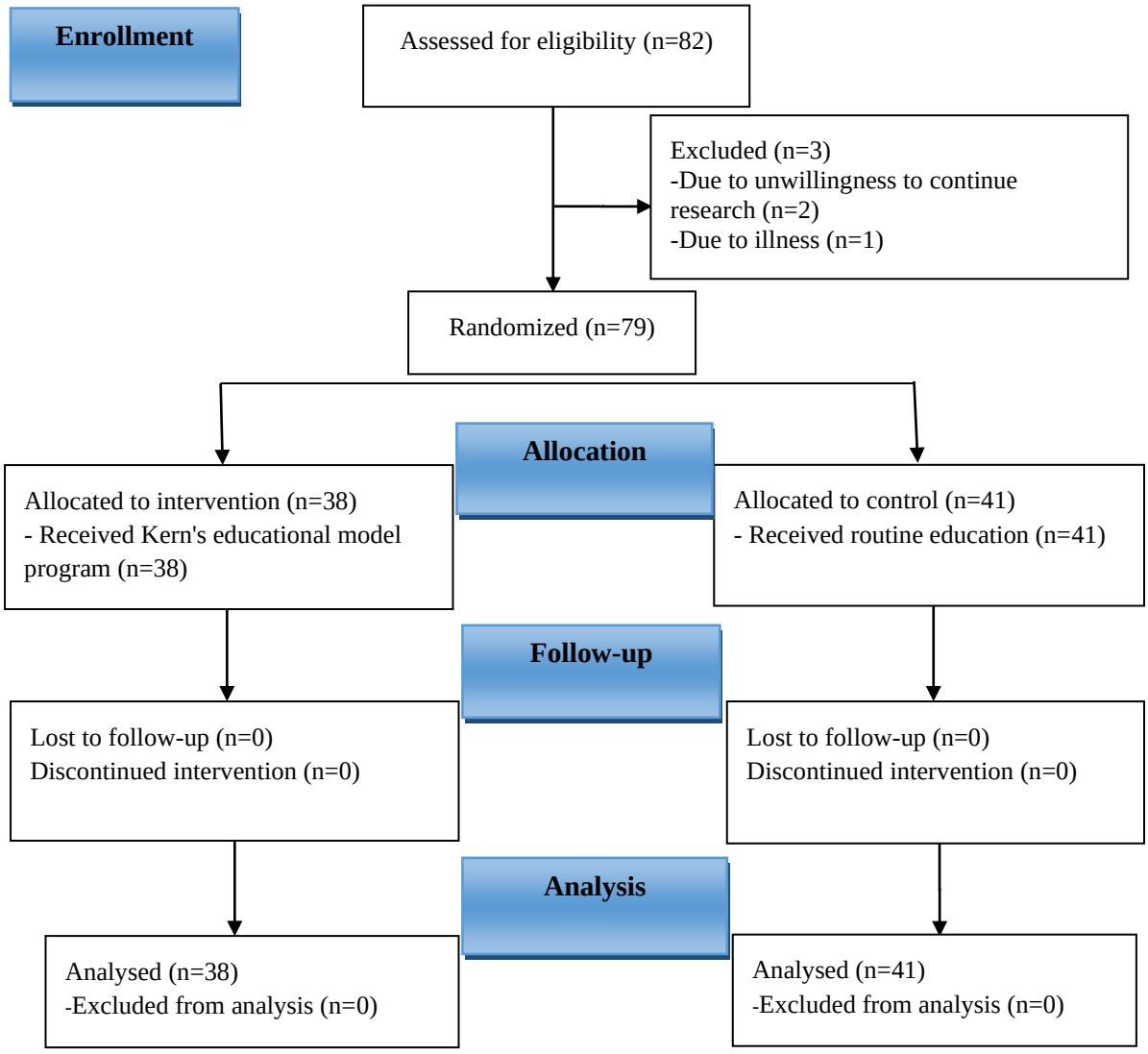

Figure 1. Flowchart of the effect of Kern's educational model on the performance of nurses

Kern's six-stage model was employed to guide the research process. This framework delineates six sequential steps aimed at achieving the research objectives. In this section, important challenges in pain management included revealing challenges in pain management attributed to nurses' knowledge and attitudes, ultimately impacting their performance (problem identification). In the literature review to extract articles, books, programs and educational manuals to determine the challenges, needs and intervention programs for patients' pain management, reliable and available English databases and search engines including Scopus, PubMed, Google Scholar, Science Direct and Persian databases SID, Iranmedex and Magiran were used without time limitation. Then, after extracting the challenges and needs, they were categorized according to the steps of the Kern model (Table 1). Subsequently, the needs of nurses concerning pain management were assessed using the Nurses' Knowledge and Attitudes Survey Regarding Pain (NKASRP) (Ferrell and McCaffery, 2008) for knowledge and attitude evaluation and the Nurse's Care Behavior Questionnaire related to Pain Management (NCBPQ) (Erniyati, 2002) for performance evaluation (needs assessment). After these two stages (reviewing the literature and completing the pre-test questionnaire), the initial content of the program was developed in accordance with the needs of nurses in the field of pain management, focusing on pain identification, treatment, and reassessment. For validation, the training content was provided to five faculty members and experts (pain specialists, physiotherapists, nurses working in the surgical department, and nursing professors who are experts in pain management). After reviewing the experts' opinions, additional content was completed and amendments were made. To examine the face validity, the content of the program was provided to two surgical department nurses outside the participants, and their opinions regarding the ease of use of the program, satisfaction with the structure (shapes, clarity of words, cheerfulness, understandability, and word size) were reviewed, and structural changes were made based on the opinions. Subsequently, the program was provided to three experts to examine the program in terms of structure, content, and usability, and after making the necessary amendments, the program was ready for use (design and planning). Next, appropriate training strategies were determined, with an emphasis on ongoing training to adapt to the nurses' circumstances and maximize participation (determination of methods and solutions). Then, the program was implemented, followed by a final re-evaluation stage using the NKASRP (Farrell & McCaffrey, 2008) and NCBPQ (Erniati, 2002) to measure the effectiveness of the intervention (re-evaluation).

First Step: Problem Identification and General Needs Assessment

Upon visiting the designated hospitals and adhering to ethical guidelines, the researcher elucidated the study's objectives to the nurses while ensuring the confidentiality and anonymity of their information. Following the acquisition of informed written consent, free from any form of coercion, the research instruments—comprising a demographic questionnaire, the NKASRP (for assessing knowledge and attitude), and the NCBPQ (for evaluating performance)—were distributed among the participants. Each nurse required approximately 15 to 20 minutes to complete the questionnaires. To encompass the entire nursing population, the researcher accommodated nurses across different shifts (morning, evening, and night) by being present in the study environment. Additionally, a nursing master's student, employed within the ward and trusted by the researcher, facilitated the distribution and collection of questionnaires, ensuring their presence during some completions. The researcher's contact information was provided for any queries or clarifications. To complete the questionnaires, the researcher, after being present in the field, and according to the time conditions and according to the time specified by the nurse, mostly in the ward conference room, where all three surgical departments of the treatment centers were equipped.

Second Step: Targeted Needs Assessment

Informed by the collected data, the need assessment process was conducted in accordance with the 2nd stage of Kern's model to guide the design and development of the educational program. In this section, qualitative assessment of questionnaires was used to formulate educational needs in pain management. In fact, the items that nurses answered incorrectly in the knowledge and performance questionnaire, along with data extracted from the literature review and the opinion of the expert group, were used to arrive at the headings of the educational program and formulate the needs.

Third Step: Goals and Objectives

This phase involved setting goals and objectives. In managing the training program, the objectives focused on the following, which were based on a literature review, pre-test evaluation, and expert

opinion:
-Goals may be too broad, such as “improve pain management,” without measurable outcomes.
-Lack of alignment between curriculum goals and hospital/institution pain policies.
-Difficulty in defining objectives that balance pain control with safe opioid use.
-Weakness in the nurse's understanding of how to correctly assess the type and severity of pain, select the appropriate type of medication, and how to reassess the effectiveness of the medication, and ultimately clearly document the pain management process

Fourth Step: Educational Strategies

The stage involved devising educational strategies. After establishing the study's objectives and selecting curriculum content, various methods and solutions were evaluated. Given the nurses' circumstances and the importance of maximum attendance, implementing the program through ongoing training was deemed most effective. A program tailored to the nurses' needs was designed and validated by experts. Collaborating with an anesthesiologist (an anesthesiology critical care medicine fellowship), educational objectives were outlined to acquaint participants with pain management significance, analgesics, non-pharmacological pain control methods, the correlation between pain and vital signs, pain assessment tools, cultural background factors influencing pain perception and management, and patients' rights regarding pain relief. The educational program was delivered in a workshop format with feedback sessions (considering the nurses' different shifts), the content of the training program was organized into a 120-minute workshop. This workshop was held on three different days, two in the morning and one in the evening, as coordinated by the hospital's senior supervisor. The nurses participated in the desired session according to the work schedule and program.). Following the educational sessions, nurses in the intervention group received a concise manual on pain assessment and management.

Fifth Step: Implementation

During the fifth phase, which entailed program implementation, collaboration with the educational supervisor of Shahid Beheshti Hospital facilitated the execution of the educational program. It took in the form of workshops featuring feedback sessions, conducted in a single session spread across three different days and hours, ensuring accessibility for all nurses through continuous training. Following the educational sessions, a concise manual on pain assessment and management was distributed to nurses in the intervention group. Additionally, the researcher actively monitored program attendance and implementation across various shifts within the wards, addressing any queries raised by the nurses.

Sixth step: Evaluation and Feedback

In the final stage, one month later, evaluation and feedback were conducted by administering the questionnaires once again to both the intervention and control groups. The data collection comprises a demographic questionnaire for nurses, covering various aspects such as age, gender, marital status, educational background, work experience, holding multiple jobs, employment status, engagement in shift work, and attendance at pain management seminars or workshops. Additionally, it includes a questionnaire on knowledge and attitude adapted from Nurses’ Knowledge and Attitudes Survey Regarding Pain (NKASRP), along with an assessment of nurses' performance in pain management utilizing the Nurse's Care Behavior Questionnaire related to Pain Management (NCBPQ).

Nurses’ Knowledge and Attitudes Survey Regarding Pain (NKASRP)

Nurses’ Knowledge and Attitudes Survey Regarding Pain (NKASRP) (Ferrel & McCaffery 2008) questionnaire contains 27 questions and two parts. The first part includes: the knowledge scale consisted of 13 true-false questions about pain management. Nurses' knowledge levels were categorized as sufficient or insufficient based on the percentage of respondents who achieved more than half of the possible points on a 13-point knowledge assessment scale. Respondents who scored 7 or less were deemed to have insufficient knowledge, while those who scored 8 or higher were considered to have sufficient knowledge about postoperative management (23).

The second part includes 14 attitude questions scored based on the Likert scale, so that the option "I agree" gets a score of 3, "I don't know" a score of 2, and "I disagree" gets a score of 1. The range of attitude scores was between 14-42 (23). Higher scores on the survey indicated better attitude.

Nurse's Care Behavior Questionnaire related to Pain Management (NCBPQ)

The Nurse's Care Behavior Questionnaire related to Pain Management (NCBPQ) (Erniyati2002) was used to check the performance of nurses. It included 36 questions about the three stages of pain

management (pain assessment, appropriate intervention for pain relief and re-evaluation after the intervention). This tool included 36 items and the participants marked their performance on a seven-point Likert scale, from one to seven (never to always). For each item, a score of seven was given for always and a score of one for never. The score ranged from 36 to 252. Higher scores on the survey indicated that nurses engaged in a greater number of actions to alleviate postoperative pain.

The survey questions primarily assessed nurses' proficiency in pain assessment and management practices. Specific areas of focus included the utilization of age-appropriate pain measurement tools, the implementation of both pharmacological and non-pharmacological pain management strategies, the nurses' understanding and preparation for potential adverse effects of pain medications, and their adherence to regular pain reassessments to gauge the efficacy of analgesics. Additionally, the survey examined the frequency of PRN (Pro Re Nata) analgesic administration for pain management. Nurses' performance scores were converted to percentage. Nurses' performance in pain management was evaluated using McDonald's learning outcome classifications, which categorize multiple-choice test results into five grades: very high (100%-90.00%), high (89.99%-80.00%), moderate (79.99%-70.00%), low (69.99%-60.00%), and very low (less than 60%) (24).

All the three questionnaires (NKASRP (having 2 parts) and NCBPQ) were translated and validated by the researcher. Permission was obtained for the translation of the questionnaires. The instruments were originally developed in English and were translated into Persian. For the confirmation of the content validity of this questionnaire, the method of calculating content validity index (CVI) and content validity ratio (CVR) was used. For this purpose, the questionnaire was given to 10 faculty members of Babol Midwifery Nursing Faculty. Based on the findings, the content validity index (CVI 0.85) for all three questionnaires and the content validity ratio (CVR 0.71) were confirmed. It is necessary to explain that, considering the number of experts and the Lawshe formula, the minimum acceptable value of the CVR case is 0.63 and the CVA is 0.79, which was acceptable for the present tool for these two indicators (25).

The reliability of the research instrument was evaluated using the internal consistency testing method by calculating Cronbach's alpha coefficient (α). In this study, Cronbach's alpha was calculated to be 0.71, indicating an acceptable level of internal consistency and reliability for the study instrument.

Data were analyzed using SPSS software (version 16). Initially, descriptive statistics including statistical tables, graphs, and measures such as mean, standard deviation (SD), frequency, and percentage were employed to characterize the data. Subsequently, inferential statistics were applied, guided by the results of the Smirnov Kolmogorov test, encompassing comparisons of scores through paired t-tests for pre-and-post assessments, as well as between-group comparisons via independent t-tests and analysis of variance. In all statistical analyses, $p<0.05$ was deemed statistically significant.

Ethical Consideration

The study received approval from the Ethics Committee of the Clinical Development Unit of Loghman Hakim Hospital, Tehran, Iran (ethics code: IR.SBMU.RETECH.REC.1402.146). Additionally, the study was registered in the Iranian Registry of Clinical Trials (IRCT20231127060198N1). Written informed consent was obtained from each participant prior to their inclusion in the study.

Results

A total of 79 nurses (41 in the control group and 38 in the intervention group) participated in the present study. The two groups were statistically comparable in terms of demographic characteristics that were homogeneous (Table 2).

Prior to the intervention, the mean knowledge score of nurses in the intervention group was 7.86 ± 1.56, while in the control group was 7.95 ± 2.07 ($p=0.84$). Following the intervention, the mean knowledge score in the intervention group significantly improved to 10.02 ± 1.40, whereas in the control group it remained at 8.04 ± 2.01 ($p<0.001$). Within the intervention group, nurses' knowledge showed a significant improvement from pre-test to post-test ($p<0.001$). However, within the control group, no statistically significant change was observed in nurses' knowledge scores from pre-test to post-test ($p=0.16$) (Table 3).

Table 1. Important challenges of pain management based on Kern model and literature review

Kern's Step	Main Pain Management Challenge
1. Problem Identification	Lack of consistency and cultural competence in pain care
2. Needs Assessment	Educational and confidence gaps among nurses
3. Goals & Objectives	Poorly defined goals that don't reflect real-world practice constraints
4. Educational Strategies	Passive learning, low engagement, not adapted to real nursing workflow
5. Implementation	Time, staffing, interprofessional barriers
6. Evaluation & Feedback	Subjective pain outcomes, poor feedback systems, data inconsistency

Table 2. Distribution of frequency and percentage of nurses' demographic characteristics

Variable	Control group N (%)	Intervention Group N (%)	Result of statistical test
Age (years)			
20-30	22 (53.7)	15 (39.5)	
31-40	13 (31.7)	14 (36.8)	t=1.32
41-50	6 (14.6)	5 (13.2)	p= 0.18*
51-60	0 (0)	4 (10.5)	
Mean ± SD	32.56 ± 6.46	34.92 ± 9.23	
Work Experience (years), Mean ± SD	6.95 ± 4.70	8.21 ± 4.92	t=1.16 p= 0.24*
Experience in Surgical Ward (years), Mean ± SD	4.39 ± 2.70	4.60 ± 2.75	t=0.35 p= 0.72*
Gender			
Male	10 (24.4)	16 (42.1)	p= 0.15**
Female	31 (75.6)	22 (57.9)	
Marital Status			
Single/Divorced	17 (41.5)	11 (28.9)	p= 0.34**
Married	24 (58.5)	27 (71.1)	
Level of Education			
Bachelor	41(100)	37 (97.4)	p= 0.48**
Master	0 (0)	1 (2.6)	
Employment Status			
Official	25 (61)	31 (81.6)	
Obligation	6 (14.6)	5 (13.2)	p= 0.07***
Contractual	8 (19.5)	1 (2.6)	
Corporate	2 (4.9)	1 (2.6)	
Shift work			
Morning	5 (12.2)	4 (10.5)	
Evening	2 (4.9)	8 (21.1)	
Night	0 (0)	1 (2.6)	p= 0.17***
Morning and evening	4 (9.8)	5 (13.2)	
Evening and night	1 (2.4)	1 (2.6)	
Rotating shift	29 (70.7)	19 (50)	
Two Jobs			
Yes	35 (85.4)	36 (94.7)	p= 0.26**
No	6 (14.6)	2 (5.3)	
Pain Management Workshop			
Yes	6 (14.6)	8 (21.1)	p= 0.56**
No	35 (85.4)	30 (78.9)	

SD: Standard Deviation, *Independent t-test, **Fisher's exact test, ***Chi-square test

Prior to the intervention, the mean attitude score of nurses in the intervention group was 24.31 ± 3.69, while in the control group it was 24.04 ± 3.84 (p=0.75). Following the intervention, the mean attitude score in the intervention group significantly improved to 30.36 ± 3.39, whereas in the control group it remained at 24.19 ± 3.68 (p<0.001). In the intervention group, nurses' attitudes

showed a significant improvement from pre-test to post-test (p<0.001). However, in the control group, no statistically significant change was observed in nurses' attitude scores from pre-test to post-test (p=0.22) (Table 4).

Table 3. Mean score of nurses' knowledge before and after the intervention in two groups

Knowledge	Pre-Test Mean ± SD	Post-Test Mean ± SD	Test result*
Intervention Group	7.86 ± 1.56	10.02 ± 1.40	t=-11.10 *p*< 0.001
Control Group	7.95 ± 2.07	8.04 ± 2.01	t=-1.43 *p*=0.16
Test result**	t=-0.19 *p*=0.84	t=5.02 *p*< 0.001	

*Independent *t*-test, ** paired sample t-test

Table 4. The mean score of nurses' attitude before and after the intervention in two groups

Attitude	Pre-Test Mean ± SD	Post-Test Mean ± SD	Test result*
Intervention Group	24.31±3.69	30.36±3.39	t=-9.36 *p*< 0.001
Control Group	24.04±3.84	24.19±3.68	t=-1.33 *p*=0.22
Test result**	t=0.75 *p*=0.31	t=7.72 *p*< 0.001	

*Independent *t*-test, ** paired sample t-test

Prior to the intervention, the mean performance score of nurses in the intervention group was 159.36 ± 30.33, while in the control group was 153.70 ± 53.28 (p=0.56). Following the intervention, the mean performance score in the intervention group significantly improved to 183.39 ± 23.05, whereas in the control group it remained at 154.14 ± 52.55 (p<0.001). In the intervention group, nurses' performance showed a significant improvement from pre-test to post-test (p<0.001). However, in the control group, no statistically significant change was observed in nurses' performance scores from pre-test to post-test (p=0.16) (Table 5).

Table 5. Comparison of the mean score of nurses' performance before and after the intervention in two groups

Performance	Pre-Test Mean ± SD	Post-Test Mean ± SD	Test result*
Intervention Group	159.36 (63.24) ±30.33	183.39 (72.77) ±23.05	t=-9.64 *p*< 0.001
Control Group	153.70 (60.99) ±30.33	154.14 (61.17) ±52.55	t=-1.42 *p*=0.16
Test result**	t=0.57 *p*=0.56	t=3.15 *p*=0.002	

*Independent *t*-test, ** paired sample t-test, *** Nurses' performance scores were converted to percentage for McDonald's learning outcome classifications (very high (100%-90.00%), high (89.99%-80.00%), moderate (79.99%-70.00%), low (69.99%-60.00), and very low (less than 60%)).

Discussion

Nurses are pivotal in pain assessment and management due to their close and continuous interactions with patients. Their responsibilities encompass conducting thorough assessments, administering tailored interventions, and evaluating the effectiveness of pain management plans over time (26). Collaboration with interdisciplinary teams is essential to prevent acute pain from transitioning into

chronic pain. Nurses contribute to this effort by effectively controlling pain levels, employing multimodal analgesia, preventing pain crises through adequate analgesia, and actively educating patients and families on self-management techniques (26). Nurses' knowledge and attitudes toward pain management significantly impact the quality of care provided to postoperative patients (11, 13). Continuous professional development and education are vital during and after graduation. Systematic training programs and curriculum enhancements can enhance nurses' understanding and positive attitudes toward pain management, ultimately improving patient outcomes (27).

In the present study, prior to the educational intervention, both groups of nurses had a borderline level of knowledge about the topic, which was considered insufficient based on the pre-defined cut-off point. The control group had slightly higher knowledge scores, but the difference was not statistically significant. After the intervention, the knowledge scores in the intervention group increased significantly compared to both their pre-intervention scores and the scores of the control group. This increase in the level of knowledge in the intervention group is in line with the results of previous studies (3, 11, 27, 28). Previous studies have consistently shown that educational interventions can positively influence nurses' knowledge and attitudes; therefore, merely evaluating the general impact of education is no longer novel unless the focus is on a specific instructional method. The present study specifically examined the effectiveness of the Kern's educational model, a structured and needs-based approach, compared to conventional methods. The findings are in line with those of other studies which reported significant improvements in nurses' or nursing students' knowledge, attitudes, or skills following the interventions designed using Kern's model (16,21). Our findings align with several previous investigations that employed Kern's six-step approach in nursing education. Similarly, Aslan et al. (2024) reported a notable increase in knowledge scores—rising from 61.76 to 81.10—among newly employed nurses who received orientation training designed using the same model (21). These results confirm the effectiveness of tailored, needs-based educational programs in enhancing core competencies. Furthermore, Heidari et al. (2023) found that a training program based on Kern's model significantly improved nursing students' knowledge and skills in infection control, with effects sustained over time (up to two months post-intervention) (16). The convergence of these findings with our study reinforces the value of needs assessment and structured curriculum design in promoting long-term improvement in nurses' knowledge, attitudes, and performance in pain management.

The application of this educational model, which involved identifying the educational needs of nurses through a questionnaire and designing and implementing a comprehensive program based on expert opinions, has been effective in improving nurses' knowledge. While this study is the first to measure the impact of an educational model based on needs assessment, and resource limitations prevented the inclusion of a third group trained without needs assessment, the results showed a significant improvement in nurses' performance, knowledge, and attitudes in the intervention group compared to the control group; however, no significant changes were observed in the control group. Despite confirming the effectiveness of the educational program based on Kern's model, future research should include a comparison group trained without needs assessment to better determine the added value of this approach. This optimization makes training and education delivery more feasible and accessible, eliminating unnecessary expenditures (29).

In this study, prior to the educational intervention, both groups exhibited comparable levels of attitude toward pain management, with no statistically significant difference. This finding aligns with that of McNamara et al. (2012), who reported no significant difference between the two groups in nurses' attitudes toward pain management prior to the intervention (30). However, our findings showed that, following the intervention, the intervention group had a significant improvement in attitude compared to their pre-intervention levels and the attitude of the control group. Similarly, Seyedamini's quasi-experimental study (2023) on the impact of education on nursing students' knowledge and attitudes toward pediatric pain management found a statistically significant difference in attitudes between the two groups after the intervention which was significantly improved in the intervention group (31). Nevertheless, due to resource limitations prevented the inclusion of a third group trained without needs assessment, we are not able to assume the superiority of the current model. Tailoring educational interventions to the specific needs of nurses, as identified through comprehensive assessments, can foster a positive attitude toward training and its content. This approach eliminates ineffective mandatory education, promotes self-directed and practical learning opportunities, and

addresses organizational barriers to education. By addressing these factors, nurses are more likely to embrace training and its content, recognizing its value in enhancing their knowledge and skills (32).
Prior to the educational intervention in this study, both groups demonstrated a low level of performance in pain management, as per McDonald's learning outcome classifications (24). Insufficient knowledge and lack of standardized protocols have hindered nurses' ability to consistently deliver effective pain management care (33) that resulted in a practice heavily reliant on routine rather than evidence-based knowledge (11). Grommi et al. (2023) conducted a systematic review and meta-analysis study to demonstrate the effectiveness of educational interventions incorporating pain nursing content and feedback for nurses. These interventions enhance nurses' ability to implement pain management and assessment techniques, leading to improved patient satisfaction (34). In line with the aforementioned study, our findings demonstrated that following the intervention, the performance level of the intervention group had a significant improvement compared to both their pre-intervention level and the performance level of the control group. This enhancement was substantial, elevating the nurses' performance in the intervention group from low to medium, based on McDonald's learning outcome classifications (21). Dehghan et al. (2022) also announced that training has an effect on the performance of neonatal intensive care nurses in managing the pain of premature infants (35).
This study possesses several notable strengths. Firstly, to our knowledge, it is the pioneering study to develop educational content based on a comprehensive needs' assessment. This ensures that the content directly addresses the identified learning gaps and pain management challenges faced by nurses. Secondly, the pre-test-post-test design with a control group ensures an accurate assessment of the intervention's efficacy. Random participant allocation eliminates selection bias, bolstering the study's internal validity. Thirdly, the comprehensive outcome measures, which encompass knowledge, attitudes, and performance assessments, utilize validated instruments and real-world settings, enhancing the findings' credibility and generalizability.
This study had also several limitations. Firstly, the reliance on self-reported questionnaires introduces the potential for response bias. Nurses' responses may be influenced by social desirability bias, leading them to provide answers that they perceive as socially acceptable or desirable, rather than accurately reflecting their actual knowledge, attitudes, or practices. To minimize response bias in the self-reported questionnaires, anonymity, confidentiality, and carefully crafted questions were ensured. Additionally, a validated instrument, the NKASRP, was employed. Despite these measures, response bias remains a potential limitation, suggesting future research could incorporate objective measures like observed behaviors or standardized patient simulations for further validation. Secondly, the study's findings may not be broadly applicable to other settings or populations as it was conducted in a restricted number of hospitals within a specific region. Thirdly, the study design did not include a long-term follow-up to assess the sustainability of the intervention's effects over time. Additionally, the study did not examine the potential impact of confounding variables, such as nurses' workload or the availability of resources, which may have influenced the effectiveness of the intervention. Eventually, due to the varying conditions of hospital wards and the selection of multiple hospitals, there existed a potential for disparities in implementation constraints based on the specific conditions of each hospital and ward. These disparities were beyond the researcher's control.
To enhance the methodological rigor of future research, several recommendations can be made. Firstly, to minimize response bias, future studies should employ anonymous surveys, utilize validated measurement instruments, and consider triangulation with additional data sources (such as observations or interviews). Secondly, to mitigate limited generalizability, future studies should be conducted in varied settings with larger sample sizes, enabling broader applicability. Additionally, longitudinal follow-ups can be included to assess the intervention's long-term effectiveness. Thirdly, future studies should account for potential confounding variables. Future studies can improve their methodological quality and produce more robust and generalizable findings.

Implications for practice

The findings of this study suggest that a pain management educational program based on Kern's model effectively enhances the knowledge, attitudes, and ultimately, the performance of nurses in surgical wards, which has significant implications for both patient care and nurse satisfaction. This study highlights the importance of adopting evidence-based educational models to improve pain management practices globally. Kern's model, with its emphasis on active learning and skill

development, offers a transferable framework that can be adapted to various healthcare settings and cultural contexts. Implementing similar educational programs can contribute to the standardization of pain management practices across international borders, ensuring that patients receive optimal pain relief and that nurses are equipped with the necessary knowledge and skills to provide effective care. Furthermore, the study encourages ongoing research into the long-term impact of such educational programs, exploring their sustainability and potential for widespread adoption in improving pain management practices worldwide.

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Conflicts of interest
There was no conflict of interest in this study.

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Authors' Contributions
M.G contributed to conceptualization, M.J and M.G performed data curation, M.P participated in methodology, M.P and L.S performed supervision, and M.G contributed to writing—original draft. All authors have read and approved the final manuscript.

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