Pain Management Nursing 25 (2024) 249–257

Contents lists available at ScienceDirect

Pain Management Nursing

journal homepage: www.painmanagementnursing.org

Original Research

Online Learning to Improve Nurses' Knowledge, Attitudes, and Self-Efficacy About Managing Postoperative Pain in Older Adults

Phichpraorn Youngcharoen, PhD, RN*,[1], Chayada Piyakhachornrot, MNS, RN†

* Ramathibodi School of Nursing, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand
† Nursing Department, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

ARTICLE INFO

Article history:
Received 10 January 2023
Received in revised form 28 January 2024
Accepted 11 February 2024

ABSTRACT

Background: Older adults undergoing total knee arthroplasty may develop chronic pain without effective postoperative pain management. Increasing nurses' knowledge, changing their attitudes, and developing their pain management self-efficacy could improve the effectiveness of pain management.
Aim: To determine the effectiveness of an online learning program to help registered nurses to manage postoperative pain in older adults undergoing total knee arthroplasty.
Design: A quasi-experimental pre-test–post-test design with intervention and control groups.
Method: Six inpatient units were randomly selected at a large tertiary care medical center. Sixty nurses were evenly divided between intervention and control groups to participate in online learning about postoperative pain management in patients undergoing total knee arthroplasty. The content was based on Kolb's experiential learning theory. Data were collected on nurses' knowledge and attitudes toward pain management and pain management self-efficacy at baseline and after completion. Data were analyzed using descriptive statistics, chi-square tests, paired *t*-tests, and independent *t*-tests.
Results: The knowledge and attitudes about pain management and pain management self-efficacy toward older adults undergoing total knee arthroplasty of nurses in the intervention group significantly improved compared to the baseline and were also significantly higher than in the control group.
Conclusions: An online learning program improves nurses' understanding and ability to manage pain in older adults undergoing total knee arthroplasty. This was therefore an effective learning method.

© 2024 The Authors. Published by Elsevier Inc. on behalf of American Society for Pain Management Nursing.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

Introduction

Knee osteoarthritis (OA) is among the most common musculoskeletal problems in older adults, increasing the cost of care and healthcare utilization (Summanen et al., 2021). A recent study found that the global prevalence of knee OA was 16%, and the global incidence was 203 per 10,000 people (Cui et al., 2020). The highest prevalence of knee OA is in older adults aged 60-64 years old (Summanen et al., 2021). As the population ages, the number of older adults with knee OA will also increase (Long et al., 2022).

Pain is a significant symptom of knee OA that leads to disability and poor quality of life (Montero et al., 2016). In one meta-analytic review of neuropathic pain in people with OA, the prevalence was 23% (French et al., 2017). In another review, the prevalence of pain sensitization, a key determinant of knee OA-related pain, was 20% (Previtali et al., 2022). Total knee arthroplasty (TKA) is an elective procedure that reduces pain and improves knee function for people with severe knee OA. By 2040, the annual number of TKAs is expected to increase fourfold in older adults with OA (Singh et al., 2019).

People who undergo TKA report various levels of postoperative pain. Approximately half of older adults who received TKAs in Thailand experienced moderate to severe pain during the first 24 hours (Iamaroon et al., 2020). In a recent study that reported pain scores from postanesthesia to discharge, pain scores in people who had undergone TKA ranged from 0 to 7, with an aver-

[1] Address correspondence to: Phichpraorn Youngcharoen, PhD, RN, Ramathibodi School of Nursing, Faculty of Medicine Ramathibodi Hospital, Mahidol University, 270 Rama6 Road, Ratchathewi, Bangkok 10400, Thailand.
E-mail address: phichpraorn.you@mahidol.edu (P. Youngcharoen).

https://doi.org/10.1016/j.pmn.2024.02.007
1524-9042/© 2024 The Authors. Published by Elsevier Inc. on behalf of American Society for Pain Management Nursing. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

age score of 3 (Chalmers et al., 2023). Among 177 Chinese older adults who had undergone TKA, most patients had mild postoperative pain at rest and severe pain with movement during the first 24 hours (Tang et al., 2023). Nurses have an essential role in managing postoperative pain, and reducing pain can enhance post-TKA outcomes by improving knee function, ability to achieve activities of daily living, and quality of life. Improving nurses' interventions to support postoperative pain management would therefore benefit patient outcomes.

Background

Ineffective management of acute postoperative pain following TKA may result in several adverse outcomes, including limitation of physical function, prolonged opioid use during hospitalization, a slow recovery period requiring extended rehabilitation, lower patient satisfaction, and increased cost of care (Li et al., 2019). It may also be associated with a poorer quality of life (Wylde et al., 2018). Chronic postoperative pain may have negative consequences for patients and their families, including functional limitation, psychological trauma, poorer quality of life, and increased costs of prolonged care (Correll, 2017).

In Japan, the prevalence of moderate to severe chronic postsurgical pain was reported to be 8.80% 1 year after TKA, either at rest or during walking (Aso et al., 2021). Similarly, a study in New Zealand reported that failure to provide sufficient acute postoperative pain management for patients with TKA resulted in a prevalence of moderate to severe persistent postoperative pain of 20% at 6 months and 16% at 12 months (Rice et al., 2018). In China, the prevalence of persistent postoperative pain after TKA was 20.90% (Tang et al., 2023). Effective postoperative pain management by nurses is crucial to prevent the progression from acute to chronic postoperative pain, and unwanted complications.

However, evidence suggests that nurses may provide insufficient pain management. In one study of older adults undergoing surgery in three hospitals in Thailand, approximately three-fourths of the nurses used a numeric rating scale to assess pain. Overall, 58% administered *pro re nata* opioid analgesics only to those in severe pain (Youngcharoen et al., 2016). The nurses' knowledge, attitudes, and self-efficacy were barriers to pain management. Nurses had inadequate knowledge and negative attitudes about managing pain in older adults. In a comparative study of Jordanian and Irish nurses, around half could correctly answer questions about knowledge of pain management and attitudes toward pain in older adults (Al Omari et al., 2021). Increased general knowledge and an improved attitude toward pain management were related to better performance in pain management practices among all nurses. Similarly, a majority of Vietnamese nurses (72.20%) who cared for older adults in a geriatric hospital had poor knowledge of, and attitudes toward, pain management, especially pain assessment and opioid administration for cancer patients (Nguyen et al., 2021). Nurses in Thailand have reported negative attitudes toward pain management in older adults, believing that opioid analgesics might lead to respiratory distress, a decreased level of consciousness, sedation, or drug addiction (Youngcharoen et al., 2017).

Nurses' low self-efficacy may be another factor in their inability to manage pain effectively. Self-efficacy is the dynamic cognitive, social, and emotional processes that affect individual perceptions of personal competence to execute behavior (Bandura, 1997). For nurses, pain management self-efficacy is their confidence and perceived ability to assess pain adequately and initiate pain treatment (Macindo et al., 2018). Two determinants influence behavior: the expectation of the ability to engage in and master that behavior (efficacy beliefs) and belief in the likelihood of consequences from engaging in the behavior (outcome expectations; Bandura, 1997). To gain self-efficacy, a person must practice until they succeed (enactive mastery), observe how others succeed in performing the behavior (vicarious experience), be persuaded of their ability (verbal persuasion), and achieve appropriate physical and emotional conditions (physiological and affective states).

Alzghoul and Abdullah (2020) found a significant relationship between nurses' self-efficacy, knowledge, and attitudes toward pain management. They reported that achieving a more positive attitude toward pain management could increase nurses' self-efficacy in managing patients' pain. Conversely, the statistical model predicting performance practice did not predict a high level of self-rated competency in pain management among nurses in Ireland and Jordan (Al Omari et al., 2021). In that study, the researchers were cautious that an inflated sense of self-competency might produce the opposite effect. The concept of self-efficacy in managing pain therefore warrants further investigation.

Nguyen et al. (2021) reported that nurses who received instruction about pain as part of their academic education achieved greater knowledge and had more positive attitudes toward pain management than those without this type of preparation. Instruction in pain management was the key predictor of Thai nurses' ability to manage postoperative pain in older adults (Youngcharoen & Aree-Ue, 2023). Studies have shown that instruction in pain management increases nurses' knowledge (Parvizy et al., 2020), fosters positive attitudes (Arzani et al., 2020; Parvizy et al., 2020), strengthens self-efficacy (Parvizy et al., 2020), improves performance on pain management in pediatric patients (Arzani et al., 2020; Ozawa et al., 2022), enhances knowledge and clinical practice of pain management in surgical nurses (Liu et al., 2021), and boosts awareness of pain management among critical care nurses (Sedighie et al., 2020).

Pain management instruction via online learning is an innovative educational method and a time-friendly way for users to improve their knowledge (Liossi et al., 2018). Online education has been widely used to improve professional knowledge and healthcare competencies (Liossi et al., 2018). It has been successfully used to educate pediatric nurses about pain management (Arzani et al., 2020; Ozawa et al., 2022), and assessing pain in patients unable to self-report (Muñoz-Narbona et al., 2020). Nurses may access various online healthcare resources, but there is no formal learning program about pain management for older adults after TKA.

Developing an online learning program that combines pain management knowledge with effective pain assessment tools and postoperative pain management guidelines would benefit nurses in their care of older adults undergoing TKA (Piyakhachornrot & Youngcharoen, 2024). An online program would allow nurses to study pain management at their convenience (Ozawa et al., 2022). Instruction in pain management is related to improved postoperative pain management in older adults. Developing instructional material using an online learning program should therefore improve nurses' knowledge of care in older adults undergoing TKA.

Theoretical Framework

The study to improve nurses' competency in pain management was guided by Benner's model (2001) for the stages of clinical competence from novice to expert. Benner applied the Dreyfus model of skill acquisition to nursing practice. To maximize nurses' skills and performance, they must advance through five stages: novice, advanced beginner, competent, proficient, and expert (Benner, 2001). To become experts, nurses must first learn and combine theoretical knowledge with nursing practice to optimize their practical skills. Expert nurses must acquire theoretical and experiential knowledge to develop their intuitive thinking, facilitating clinical decision-making.

Study Aims

The study aimed to determine the effectiveness for registered nurses of using an online learning program about managing postoperative pain in older adults undergoing TKA. Primary outcomes were the nurses' knowledge and attitudes, and self-efficacy about managing pain in older adults undergoing TKA.

Hypotheses

It was hypothesized that registered nurses who participated in an online learning program about postoperative pain management for older adults undergoing TKA would:

1. Significantly improve their pain management scores on knowledge and attitudes, and self-efficacy from baseline to intervention completion; and
2. Have significantly higher scores than the control group on knowledge and attitudes and pain management self-efficacy.

Methods

Design

This quasi-experimental study used a pre-test–post-test design that compared outcomes within and between intervention and control groups.

Settings

The study was conducted at a large tertiary care medical center in Bangkok, Thailand, with four hospital facilities, each containing orthopedic surgical units, because in 2019 TKA accounted for approximately 8% of 9,735 TKA cases performed in Thailand (National Health Security Office, 2023). In addition to the increased availability of people undergoing TKA, the medical center has used a TKA clinical pathway since 2016, which represents quality of care. A multistage sampling process was undertaken (Fig. 1). To avoid potential study bias, the process to generate the random allocation sequence was conducted by one person, who was not otherwise involved in this study. Three steps were followed. During step 1, computer-generated simple random sampling was used to select two of the four inpatient medical center facilities that provided care for older adults undergoing TKA. The first facility had one intermediate, one general, and one private orthopedic unit for adults and older adults with bone and joint injuries or musculoskeletal diseases. Older adults were admitted to the intermediate orthopedic unit if they had comorbidities, such as atrial fibrillation and congestive heart failure, or were considered a possible surgical risk. Older adults with low surgical risk were admitted to a general or private orthopedic unit. The second facility includes five private inpatient surgical units that admit older adults undergoing TKA. Admission criteria were similar to the general or private orthopedic surgical units in facility 1, and older adults undergoing TKA were only eligible for admission if they were considered to have a low risk from surgery.

The hospital's admission criteria were based on older adults' surgical risk, but it is mandatory for nurses to follow a TKA clinical pathway to ensure that all patients undergoing TKA obtain the same standard of care in all units. Patients who have undergone TKA in all inpatient units follow standard postoperative pain management protocols. Any who develop severe postoperative complications are transferred to the facility's intensive care unit.

After step 1, 22 nurses were excluded because they did not meet the inclusion criteria. During step 2, inpatient surgical units from each facility were cluster randomized using simple random sampling into intervention and control groups to minimize the differences in characteristics of units and patients resulting from simple random sampling in step 1. Simple random sampling was used to assign inpatient units from facility 1 into either an intervention group (Unit A) or control group (Unit B). For facility 2, simple random sampling was used to assign inpatient units to an intervention group (Units D and F) and control group (Units E and H). This method ensured that inpatient units in both facilities have an equal chance of being assigned to the intervention and control groups. Following this step, nurses were automatically assigned either to the intervention or control groups based on their working unit to prevent contamination. In step 3, nurses were informed about a study and those who expressed an interest were recruited for participation.

Sample

The inclusion criteria for participants were that they were registered nurses who (a) provided direct patient care to older adults $\geq$ 60 years old undergoing TKA, (b) had at least 1 year of professional nursing experience, (c) were able to communicate in Thai, and (d) had a smartphone or computer to access the online learning program. Exclusion criteria were (a) having an administrative role or (b) working part time (less than 20 hours a week). The sample size was calculated using a power analysis via G-power version 3.1.9. The effect size in this study was calculated from an average effect size reported by a previous systematic review and meta-analysis (Liossi et al., 2018). It was set at 0.86 with a test power $(1-\beta)$ of 0.80 and a significance level of 0.05 for an estimated sample size of 46 participants because of anticipated attrition and a recommended minimum sample size for intervention studies of 30 participants per group (Grove et al., 2013). Recruitment took place from May through June 2021. During the study, 14 of the 44 participants in the intervention group and 23 of the 53 in the control group dropped out because they no longer wished to participate or failed to complete the post-test. Overall, 60 participants completed the study: 30 in the intervention group and 30 in the control group.

Procedure

The researchers met with eligible participants to inform them about the study's objectives. The participants in the intervention and control groups completed the online sociodemographic questionnaire, the Nurses' Knowledge and Attitudes toward Pain Management for Older Adults Undergoing TKA, and the Pain Management Self-Efficacy Questionnaire to establish a pre-test baseline. To prevent contamination, participants in the control group took part in a 1-month self-study program about the clinical management of acute postoperative pain (E-book) before the intervention group. After finishing the E-book, the control group's participants completed the online post-test to measure outcomes. After the control group finished the E-book, participants in the intervention group began online pain management education for 1 month using online learning. At the end of the month, participants completed the online post-test to measure outcomes. Data were collected from August through December 2021. A research assistant blinded to participants' group status exported all data from the online learning program.

Intervention Group

Kolb's experiential learning theory (Kolb, 1984) guided the online learning program developed for this study. The intervention

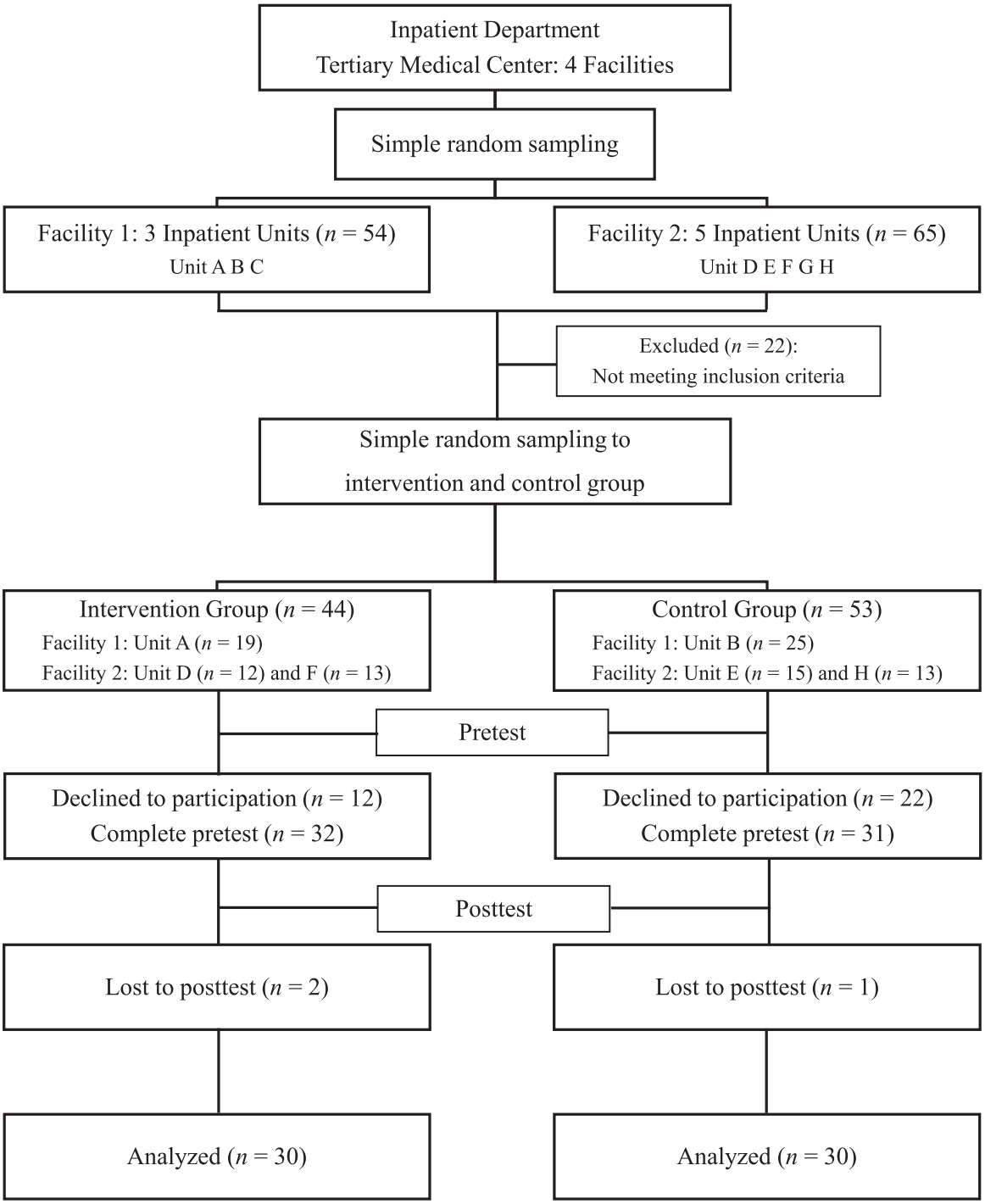


Figure 1. Flow diagram of participants.

was a modular education program for registered nurses to improve their knowledge about postoperative pain management, minimize negative attitudes toward pain management, and enhance pain management self-efficacy in older adults undergoing TKA.

According to Kolb's experiential learning theory (Kolb, 1984), knowledge is created by grasping and transforming experience. To do so, learners need a concrete experience and must then conceptualize this in the abstract. Learning occurs when experience is transformed through reflective observation and active experimentation. The learning cycle includes four stages: (a) provide an opportunity for learners to be exposed to or participate in an experience (concrete experience), (b) allow learners to reflect on that experience (reflective observation), (c) let learners think through and analyze a problem to understand the situation (abstract conceptualization), and (d) let learners take action based on what they have learned (active experimentation).

We developed the program's content from an extensive literature review and three rounds of focus groups with seven or eight

Table 1
Schedule and Intervention Content.

Methods	Concept	Pain Assessment Week 1	Pain Management Week 2	Materials
Online lectures	**Module 1:** Pain in older adults (20 minutes) • Definition • Pain mechanism • Types • Prevalence • Physiological changes related with pain • Barriers of pain management • Negative consequences **Module 2:** Pain in older adults undergoing TKA (20 minutes) • Knee OA (Definition, symptom, risk factors, negative consequences, treatments) • Prevalence of pain in TKA • Post-TKA pain mechanism • Negative impact of inadequate pain in TKA	**Module 3:** Pain assessment in older adults (30 minutes) • Principle • Technics • Pain assessment tool (Uni-dimensional, multi-dimensional, non-verbal patients, specific tool for TKA) • Patient history taking and physical examination • Psychosocial factors related with pain and assessment	**Module 4:** Pharmacological and non-pharmacological pain management in older adults undergoing TKA – 7 sessions, 15-45 minutes/sessions • Pain pathways and pharmacological pain management • Guidelines on pain management • Acetaminophen and non-opioids (NSAIDs and adjuvants) • Opioids and patient-controlled analgesia (PCA) • Medication administration (oral, intravenous, intrathecal, epidural, and peripheral nerve blockade) • Multimodal analgesia • Non-pharmacological pain management and nursing care	Evidence-based PowerPoint e-presentation
		Week 3	Week 4	
Online case scenarios	Intervention Program Based on Kolb's Learning Theory 4 Stages:			
	Concrete Experience	Description of older adults undergoing TKA in various time post-operation with six different pain assessment scenarios: 1. Verbal patient without cognitive problem 2. Unable to rate pain using self-report 3. Mild cognitive impairment with postoperative delirium 4. Expressing pain at movement 5. Severe pain with smiling face 6. Representing psychosocial problems related with pain	Description of older adults undergoing TKA in various time post-operation with eight different pain management scenarios: 1. Severe pain after administering strong opioids 2. History of drug allergy that should be caution with NSAIDs 3. Severe pain after spinal morphine 4. Problem with intermittent epidural analgesia 5. Having ischemic heart disease and NSAIDs prescription 6. Unrelieved pain after IV PCA 7. Pain medication errors (overdose) 8. Representing pain medication side effects	Online case study vignettes
	Reflective Observation	Nurses were asked to reflect to this question for each scenario. "What other information you need to assess pain for this patient?"	Nurses were asked to reflect to this question for each scenario. "What do you think about the pain management problem for this patient?"	Open-ended questions
	Abstract Conceptualization	Evidence related with pain assessment following each scenario.	Evidence related with pain management following each scenario.	Evidence-based PowerPoint e-presentation
	Active Experience	For each scenario, nurses were asked to select the appropriate tool for use to assess pain for this patient from 4 multiple choice answers.	For each scenario, nurses were asked to select the appropriate action regarding pain management for this patient from 4 multiple choice answers.	Pop-up message with correct answer and rationale

registered nurses per group who had at least 1 year of experience in providing nursing care for older adults undergoing TKA and one focus group with a pain management committee (an orthopedic department's chief nursing officer, an orthopedic and rehabilitation nurse supervisor, an orthopedic inpatient unit's head nurse, an advanced practice nurse specializing in orthopedic nursing, and a nurse specialist as part of an acute pain team).

The online learning program, as an intervention, included a combination of online lectures and case scenarios. The schedule and contents of the intervention are shown in Table 1. The online lectures contained four learning modules to improve nurses' knowledge and correct misconceptions. The password-protected program could be accessed from a smartphone or computer. Participants could log in, log out, or resume modules anytime. They could also contact the researchers by e-mail and use the application's asynchronous threaded messaging feature if they had any questions, comments, or concerns. The researchers checked for messages and replied daily.

After 2 weeks of didactic modules, participants began an online learning experience program. The modules began with six case study vignettes on pain assessment and eight case study vignettes on pain management to provide various experiences (concrete experience). Nurses were allowed to reflect on each situation (reflective observation). We then provided evidence of postoperative pain management in older adults undergoing TKA (abstract conceptualization). Lastly, participants chose which actions they would take on pain management (active experimentation). The correct answer was shown with the explanation based on available evidence.

Five experts reviewed and approved the content of the online learning program: a joint arthroplasty orthopedist, an anesthesiologist, an orthopedic clinical pharmacist, a nurse specialist in acute pain service, and an orthopedic clinical nursing instructor.

Control Group

Nurses in the control group underwent a 1-month self-study program about the clinical guidance for acute postoperative pain management (E-book). During the 4-week period, they were required to read online material at any time at their convenience.

Outcome Measures

The nurses' knowledge and attitudes toward pain management for older adults undergoing TKA (NKA-TKA)

The measure was modified from two previous questionnaires that combined knowledge and attitudes as one outcome: (a) nurses' knowledge and attitudes about postoperative pain management in older adults (Teerasangchan, 2006) and (b) a Thai version of a survey of nurses' knowledge and attitudes about pain (Prasertsri et al., 2014) that was originally developed by Ferrell and McCaffery (1987). After a literature review, the researchers added items related to TKA, such as "ineffective postoperative pain management could result in developing chronic pain after TKA" (Aso et al., 2021; Tang et al., 2023) and "multimodal analgesia is an efficient method for managing postoperative pain after TKA" (Thai Association for the Study of Pain, 2019). The 30-item NKA-TKA measures five dimensions: (a) pain in older adults, (b) pain in older adults undergoing TKA, (c) pain assessment, (d) pain management, and (e) pain management in older adults undergoing TKA. The response options for 24 items are true–false (1 or 0), and six questions are multiple-choice. Scores can range from 0 to 30, with higher scores indicating increased knowledge and attitudes toward pain management. Because the NKA-TKA was adapted and included additional items for this study, content validity was examined by five experts, including a joint arthroplasty orthopedist, an anesthesiologist, an orthopedic clinical pharmacist, a nurse specialist in acute pain, and an orthopedic clinical nursing instructor. The content validity index for items (I-CVI) was 0.96, and the content validity index for the five-dimensional subscales (S-CVI) was 0.80. The NKA-TKA was pilot-tested with 20 nurses with experience in providing care for older adults with TKA to ensure its reliability and feasibility. The Kuder-Richardson 20 for internal reliability was 0.83 in the pilot study and 0.73 in the main study.

The Pain Management Self-Efficacy Questionnaire (PMSEQ)

The 21-item PMSEQ was originally developed by Macindo et al. (2018), and measures nurses' pain management self-efficacy across three dimensions: comprehensive, evaluative, and supplemental pain management self-efficacy. It has five response options from 0 (Not confident at all) to 5 (Highly confident). Total scores range from 0 to 105. Higher scores indicate an increased perception of pain management self-efficacy. The PMSEQ was translated into Thai using the back translation method. A bilingual nurse educator, fluent in Thai and English, translated the questionnaire from English to Thai. A second bilingual nurse educator back-translated the Thai version to English. A monolingual English speaker evaluated the equivalency of the back-translated version with the original. Five Thai experts (a joint arthroplasty orthopedist, an anesthesiologist, an orthopedic clinical pharmacist, a nurse specialist in acute pain, and an orthopedic clinical nursing instructor) reviewed the content validity of the PMSEQ-Thai. The I-CVI and the S-CVI of the PMSEQ-Thai were both 1.00. To ensure measure specification, the PMSEQ-Thai was pilot-tested with 20 nurses who were experienced in providing care for older adults with TKA. The Cronbach's alpha coefficient of the PMSEQ-Thai version was 0.93 in both the pilot and the main study.

Ethical Consideration

The study was approved by the Mahidol University Faculty of Medicine institutional review board (IRB) (MURA2020/1377). Eligible participants were informed that they could cease participation or withdraw at any time during the study and that the results would be aggregated as mean scores. Participation would also not affect their work performance evaluation. No personal identifiers were collected, and all data were secured under computer password protection. Following IRB approval and after participants signed informed consent, data collection began.

Data Analysis

Data were analyzed using descriptive statistics, chi-square tests, paired *t*-tests, and independent *t*-tests using IBM® SPSS® version 21 software. The assumptions for the *t*-test, including normality, were examined before data analysis. The homogeneity test of sample characteristics was performed on data at the baseline before starting the intervention. Different units and patient characteristics may influence nurses' learning outcomes, and we therefore performed subgroup analysis. Within-group analysis was undertaken separately to test the effect of the intervention on knowledge and attitudes and pain management self-efficacy among nurses who provided care for older adults with a possible risk from TKA surgery in the first facility. We also tested the effect of the intervention among nurses who provided care for older adults with low risk from TKA surgery, by comparing knowledge and attitudes and pain management self-efficacy between nurses in the intervention group and control group.

Results

There were no statistical differences in sociodemographic characteristics between participants in the control and intervention groups (Table 2). There were also no statistical differences in mean scores on knowledge of, and attitudes toward, pain management or pain management self-efficacy at baseline. Most participants in both groups were female, single and had completed a bachelor's degree in nursing. Most had also not received any pain management training in the previous 6 months. On average, participants in the control group had practiced nursing for around 1.5 years longer than those in the intervention group, but the differences were not statistically significant.

Hypotheses

Hypothesis 1

As shown in Table 3, the mean scores for nurses' knowledge of and attitudes toward pain management and pain management self-efficacy for older adults undergoing TKA in the intervention group were significantly higher after completing the intervention than at baseline ($p < .001$). The first hypothesis was therefore supported.

Hypothesis 2

Table 4 shows that after completing the intervention, the mean scores for nurses' knowledge and attitudes toward pain management ($p < .001$) and pain management self-efficacy ($p < .05$) for older adults undergoing TKA were significantly higher in the intervention group than the control group. The second hypothesis was therefore also supported.

Table 2
Characteristics of Participants in the Intervention and Control Groups at Baseline ($N = 60$).

Characteristics	Control Group ($n = 30$) n (%) or Mean ± SD	Intervention Group ($n = 30$) n (%) or Mean ± SD	X^2 or t	p
Age	29.03 ± 3.57	28.77 ± 2.59	1.532	.131
Gender				
Male	0	1 (3.33)	1.017	.313
Female	30 (100)	29 (96.67)		
Educational level				
Bachelor's degree	28 (93.33)	29 (96.67)	.351	.554
Master's degree	2 (6.67)	1 (3.33)		
Marital status				
Married	1 (3.33)	5 (16.67)	2.963	.085
Single	29 (96.67)	25 (83.33)		
Years of nursing experience	6.57 ± 3.57	5.13 ± 2.50	1.801	.077
Pain management training within the past 6 months				
Yes	2 (93.33)	7 (23.33)	3.268	.071
No	28 (6.67)	23 (76.67)		
Knowledge and attitudes toward pain management	19.27 ± 3.07	19.07 ± 3.27	.244	.808
Pain management self-efficacy	76.63 ± 9.70	76.90 ± 11.62	-0.096	.923

Table 3
Comparison of Knowledge and Attitudes and Pain Management Self-Efficacy Between Pre-test and Post-test of the Intervention Group ($N = 30$).

Variables	Pretest ($n = 30$)		Post-test ($n = 30$)		95% CI	t	p
	Mean	SD	Mean	SD			
Knowledge and attitudes toward pain management	19.07	3.27	24.03	2.59	(4.03, 5.90)	10.890	<.001
Pain management self-efficacy	76.90	11.62	89.70	12.69	(6.29, 19.31)	4.021	<.001

Table 4
Comparison of Knowledge and Attitudes and Pain Management Self-Efficacy Between Two Groups ($N = 60$).

Variables	Control Group ($n = 30$)		Intervention Group ($n = 30$)		Mean Difference	95% CI	t	p
	Mean	*SD*	Mean	SD				
Knowledge and attitudes toward pain management	20.00	3.06	24.03	2.59	4.03	(2.57, 5.50)	5.505	<.001
Pain management self-efficacy	82.87	11.88	89.70	12.69	6.83	(0.48, 13.19)	2.154	.035

Sub-group analysis

In the intervention group in the first facility (Supplementary file: Table 5), the mean scores for knowledge and attitudes toward pain management and pain management self-efficacy among nurses caring for older adults at possible risk from TKA surgery were significantly higher after the intervention than at baseline. Among nurses who provided care for older adults at low risk from surgery, the mean scores for knowledge and attitudes toward pain management and pain management self-efficacy were significantly higher in the intervention group than the control group (Supplementary file: Table 6).

Discussion

This study aimed to determine the effectiveness for registered nurses of using an online learning program to improve their management of postoperative pain in older adults undergoing TKA. The outcomes were nurses' knowledge and attitudes and pain management self-efficacy in caring for older adults undergoing TKA. After completing the program, nurses in the intervention group had significantly better knowledge and attitudes toward pain management and pain management self-efficacy.

Our results reflect the findings of a systematic review that concluded that continuing education by online learning could improve nurses' knowledge, attitudes, and self-efficacy (Rouleau et al., 2019). They are also consistent with a meta-analytic review that found that online pain resources effectively improved nurses' knowledge and attitudes toward pain management (Liossi et al., 2018). More recently, Muñoz-Narbona et al. (2020) concluded that online learning increased nurses' knowledge of pain assessment. Online learning is therefore a cost-effective method that can serve many people compared to in-person programs. Online lectures are also a useful way to access accurate and updated information (Phillips, 2020).

Nurses in the intervention group had higher mean scores for knowledge and attitudes toward pain management both after the invention and compared to the control group. Our results were consistent with the results in previous studies that found that training could improve nurses' knowledge on pain management (Liu et al., 2021; Ozawa et al., 2022; Parvizy et al., 2020) and create more positive attitudes (Arzani et al., 2020; Parvizy et al., 2020). Kolb's experiential learning theory (Kolb, 1984) was used to guide the program's development, in that we integrated the theory's four learning stages. These stages helped capture the four learning styles posted by Kolb and Kolb (2006): diverging, assimilating, converging, and accommodating. Our online lectures provided evidence-based content about pain management in older adults undergoing TKA, which provided a useful overview of background information and clarified complex content, providing accurate and up-to-date information for students (Rowles, 2012). The use of on-

line lectures with case study vignettes stimulates critical thinking (Liu et al., 2021). A previous study found that this approach enabled participants to recall important information from lecture materials and safely practice problem-solving and decision-making skills (Phillips, 2020). The combination of online lectures and vignettes stimulates thought and emotions, promotes self-awareness about postoperative pain, and enhances the nurses' ability to assess the patient's pain (Liu et al., 2021).

We found that the nurses had better pain management self-efficacy after the intervention. Knowledge and attitudes about pain management are determinants of pain management self-efficacy (Alzghoul & Abdullah, 2020). Our results may reflect improvements in knowledge and positive attitudes toward pain management, leading to an enhanced perception of successful pain management self-efficacy and quality of nursing care. However, our results were inconsistent with those from a previous study (Parvizy et al., 2020) in which training did not improve nurses' self-efficacy for pediatric pain management. According to Bandura's self-efficacy theory (Bandura, 1997), the most important source of self-efficacy is enhancing enactive mastery experience. Our online case scenarios included several experiences of pain assessment and management for older adults undergoing TKA, and nurses could practice selecting the required action as many times as they wished to develop their enactive mastery experience. When people are encouraged to practice a skill, and recognize their ability to perform a behavior, they develop individual self-efficacy (Bandura, 1997). Pain management self-efficacy is one important indicator of behavior change and promotes the quality of nursing care (Macindo et al., 2018).

The acuteness of patients' conditions has been reported to influence nurses' pain assessment and analgesic medication practice (Latimer et al., 2010). However, our sub-group analysis results indicated that our intervention could improve knowledge and attitudes toward pain management and pain management self-efficacy in nurses who provided care for older adults at both low and possible risk from TKA surgery. When a hospital's TKA clinical pathway was used, older adults were less likely to develop negative consequences (Foni et al., 2020). Our intervention program included pain management scenarios at both levels of risk, and the effect of the online learning program was therefore robust enough to improve nurses' learning outcomes in all facilities.

Limitations

This study had some limitations. In particular, data were only collected from registered nurses in one large tertiary care medical center complex in Bangkok, limiting the results' generalizability. The hospital's admission criteria mean that the characteristics of both units and patients might not be directly comparable. The pre-test–post-test design also did not test the nurses' long-term retention of knowledge, attitudes, and self-efficacy following the intervention. We did not assess the nurses' pain management clinical practice or how continuing education affected patient outcomes. Future studies should examine these educational and clinical outcomes as quality of care indicators.

Implications for Practice

The two frameworks played an essential role in this study. Kolb's experiential learning theory facilitated the development of online pain education to improve nurses' knowledge, attitudes, and self-efficacy about managing pain. Expertise in these outcomes is significant for nurses in developing professional competencies, as proposed by Benner. The two frameworks should be employed in future studies to create interventions that promote competencies related to nurses' pain management in patients with different types of pain. An online learning program is a flexible and effective learning resource for nurses. The importance of pain management should be emphasized to nurses, and nurse administrators should also understand why it is important to improve nurses' knowledge, attitudes, and perceptions of their own abilities to manage pain. An online learning program should be implemented as continuing education for new and current nursing staff who provide postoperative care for older adults undergoing TKA. Combining online lectures with case scenarios is an effective teaching method for this purpose.

Conclusion

Guided by Kolb's experiential learning theory, we developed an online learning program combining online lectures and case scenarios, and found that it effectively improved nurses' knowledge and attitudes toward pain management and self-efficacy on postoperative pain management in older adults undergoing TKA. Online learning is recommended for use as a learning resource for nurses.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

This study received funding from the Ramathibodi School of Nursing, Faculty of Medicine Ramathibodi Hospital, Mahidol University. We are grateful to the International Association for the Study of Pain (IASP) for providing financial aid funding to present this study at IASP 2022 World Congress on Pain**.**

Acknowledgments

We are grateful for the nurses who participated in this study. We thank Melissa Leffler, MBA, from Edanz (www.edanz.com/ac) for editing a draft of this manuscript.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.pmn.2024.02.007.

References

Al Omari, D., Alhabahbeh, A., Subih, M., & Aljabery, A. (2021). Pain management in the older adult: The relationship between nurses' knowledge, attitudes and nurses' practice in Ireland and Jordan. *Applied Nursing Research, 57*, Article 151388.

Alzghoul, B. I., & Abdullah, N. A. C. (2020). Pain management practices by nurses: Application of the self-efficacy theory. *Global Journal of Health Science, 12*(9), 44–49.

Arzani, A., Valizadeh, S., Poorkaremi, S., Ezbarami, Z. T., & Ghojazadeh, M. (2020). Evaluating the impact of a multimedia training versus lecture training on attitudes and practices in paediatric nurses in children pain management: A randomized controlled trial. *Nursing Open, 7*(4), 1032–1038.

Aso, K., Ikeuchi, M., Takaya, S., Sugimura, N., Izumi, M., Wada, H., Okanoue, Y., & Dan, J. (2021). Chronic postsurgical pain after total knee arthroplasty: A prospective cohort study in Japanese population. *Modern Rheumatology, 31*(5), 1038–1044.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. W. H. Freeman and company.

Benner, P. E. (2001). *From novice to expert: Excellence and power in clinical nursing practice*. Prentice Hall.

Chalmers, B. P., Puri, S., Chiu, Y. F., Lebowitz, J., Sideris, A., Westrich, G. H., … Gonzalez Della Valle, A. (2023). Patients undergoing primary, cementless TKA had similar pain, opioid utilization, and functional outcomes compared to matched patients with cemented fixation. *The Journal of Arthroplasty, 38*(10), 2131–2136.

Correll, D. (2017). Chronic postoperative pain: Recent findings in understanding and management. *F1000Research, 6*, 1054.

Cui, A., Li, H., Wang, D., Zhong, J., Chen, Y., & Lu, H. (2020). Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. *EClinical Medicine, 29*, Article 100587.

Ferrell, B. R., & .& McCaffery, M. (1987). Knowledge and attitudes survey regarding pain. Retrieved July 4, 2022, from https://prc.coh.org/Knowldege%20%20&%20Attitude%20Survey%207-14%20(1).pdf.

Foni, N. O., Costa, L. A. V., Paião, I. D., de Oliveira, I. O., de Carvalho, R. T., Lenza, M., Antonioli, E., & Ferretti, M. (2020). Clinical pathway improves medical practice in total knee arthroplasty. *PLoS One, 15*(5), Article e0232881.

French, H. P., Smart, K. M., & Doyle, F. (2017). Prevalence of neuropathic pain in knee or hip osteoarthritis: A systematic review and meta-analysis. *Seminars in Arthritis & Rheumatism, 47*(1), 1–8.

Grove, S. K., Burns, N., & Gray, J. R. (2013). *The practice of nursing research: Appraisal, synthesis, and generation of evidence* (7th ed.). Elsevier Saunders.

Iamaroon, A., Siriussawakul, A., Tangwiwat, S., Saetang, S., Rungwattanakit, P., & Thanakiattiwibun, C. (2020). Moderate-to-severe pain after knee arthroplasty: A retrospective study of incidence and risk factors. *Thai Journal of Anesthesiology, 46*(2), 71–79.

Kolb, A. Y., & Kolb, D. A. (2006). Learning styles and learning spaces: A review of the multidisciplinary application of experiential learning theory in higher education. In R. R. Sims, & S. J. Sims (Eds.), *Learning styles and learning* (pp. 45–91). Nova Science Publishers.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.

Latimer, M. A., Ritchie, J. A., & Johnston, C. C. (2010). Individual nurse and organizational context considerations for better knowledge use in pain care. *Journal of Pediatric Nursing, 25*(4), 274–281.

Li, J. W., Ma, Y. S., & Xiao, L. K. (2019). Postoperative pain management in total knee arthroplasty. *Orthopaedic Surgery, 11*(5), 755–761.

Liossi, C., Failo, A., Schoth, D. E., Williams, G., & Howard, R. F. (2018). The effectiveness of online pain resources for health professionals: A systematic review with subset meta-analysis of educational intervention studies. *Pain, 159*(4), 631–643.

Liu, X., Li, L., Wang, L., Herr, K., & Chen, Q. (2021). Implementation and evaluation of a pain management core competency education program for surgical nurses. *International Journal of Nursing Sciences, 8*(1), 51–57.

Long, H., Liu, Q., Yin, H., Wang, K., Diao, N., Zhang, Y., Lin, J., & Guo, A. (2022). Prevalence trends of site-specific osteoarthritis from 1990 to 2019: Findings from the global burden of disease study 2019. *Arthritis & Rheumatology, 74*(7), 1172–1183.

Macindo, J. R. B., Soriano, C. A. F., Gonzales, H. R. M., Simbulan, P. J. T., Torres, G. C. S., & Que, J. C. (2018). Development and psychometric appraisal of the Pain Management Self-Efficacy Questionnaire. *Journal of Advance Nursing, 74*(8), 1993–2004.

Montero, A., Mulero, J. F., Tornero, C., Guitart, J., & Serrano, M. (2016). Pain, disability and health-related quality of life in osteoarthritis-joint matters: An observational, multi-specialty trans-national follow-up study. *Clinical Rheumatology, 35*(9), 2293–2305.

Muñoz-Narbona, L., Cabrera-Jaime, S., Lluch-Canut, T., Castaño, P. B., & Roldán-Merino, J. (2020). E-learning course for nurses on pain assessment in patients unable to self-report. *Nursing Education in Practice, 43*, Article 102728.

National Health Security Office. (2023). The UCS improves the lives of people living with knee pain. Retrieved January 23, 2024, from https://eng.nhso.go.th/view/1/DescriptionNews/The-UCS-improves-the-lives-of-people-living-with-knee-pain/493/EN-US.

Nguyen, A. T., Dang, A. K., Nguyen, H. T. T., Nguyen, T. X., Nguyen, T. N., Nguyen, T. T. H., Pham, T., Nguyen, A. L., Nguyen, T. T. N., Nguyen Thi, H., Nguyen, T. H., Nguyen, S. H., Tran, B. X., Latkin, C., Ho, R. C. M., Ho, C. S. H., & Vu, H. T. T. (2021). Assessing knowledge and attitudes regarding pain management among nurses working in a geriatric hospital in Vietnam. *Journal of Multidisciplinary Healthcare, 14*, 799–807.

Ozawa, M., Yamashita, K., & Kawano, R. (2022). Effectiveness of a virtual program on nurses' pain-related knowledge and pain-measurement skills. *Pain Management Nursing, 23*(6), 720–727.

Parvizy, S., Tarvirdinasab, S., Raznahan, R., & Aliakbari, M. (2020). The effect of pain management training in workshop on the knowledge, attitude and self-efficacy of pediatric nurses. *Journal of Family Medicine & Primary Care, 9*(6), 2880–2884.

Phillips, J. M. (2020). Strategies to promote student engagement and active learning. In D. M. Billings, & J. A. Halstead (Eds.), *Teaching in nursing: A guide for faculty* (pp. 286–303). Saunders.

Piyakhachornrot, C., & Youngcharoen, P. (2024). Pain management education needs for nurses caring for older adults undergoing total knee replacement. *International Journal of Orthopaedic & Trauma Nursing, 52*, Article 101037.

Prasertsri, N., Teeyapan, W., Charenukul, A., & Jirubapa, M. (2014). Nursing student knowledge and attitudes regarding pain management. *Journal of Nursing & Education, 7*(2), 109–119.

Previtali, D., Capone, G., Marchettini, P., Candrian, C., Zaffagnini, S., & Filardo, G. (2022). High prevalence of pain sensitization in knee osteoarthritis: A meta-analysis with meta-regression. *Cartilage, 13*(1), Article 19476035221087698.

Rice, D. A., Kluger, M. T., McNair, P. J., Lewis, G. N., Somogyi, A. A., Borotkanics, R., Barratt, D. T., & Walker, M. (2018). Persistent postoperative pain after total knee arthroplasty: A prospective cohort study of potential risk factors. *British Journal of Anaesthesia, 121*(4), 804–812.

Rouleau, G., Gagnon, M. P., Côté, J., Payne-Gagnon, J., Hudson, E., Dubois, C. A., & Bouix-Picasso, J. (2019). Effects of e-learning in a continuing education context on nursing care: Systematic review of systematic qualitative, quantitative, and mixed-studies reviews. *Journal of Medical Internet Research, 21*(10), e15118.

Rowles, C. J. (2012). Strategies to promote critical thinking and active learning. In D. M. Billings, & J. A. Halstead (Eds.), *Teaching in nursing: A guide for faculty* (pp. 258–284). Saunders.

Sedighie, L., Bolourchifard, F., Rassouli, M., & Zayeri, F. (2020). Effect of comprehensive pain management training program on awareness and attitude of ICU nurses. *Anesthesiology & Pain Medicine, 10*(2), e98679.

Singh, J. A., Yu, S., Chen, L., & Cleveland, J. D. (2019). Rates of total joint replacement in the United States: Future projections to 2020–2040 using the national inpatient sample. *The Journal of Rheumatology, 46*(9), 1134–1140.

Summanen, M., Ukkola-Vuoti, L., Kurki, S., Tuominen, S., & Madanat, R. (2021). The burden of hip and knee osteoarthritis in Finnish occupational healthcare. *BMC Musculoskeletal Disorders, 22*(1), 501.

Tang, S., Jin, Y., Hou, Y., Wang, W., Zhang, J., Zhu, W., … Ma, Z. (2023). Predictors of chronic pain in elderly patients undergoing total knee and hip arthroplasty: A prospective observational study. *The Journal of Arthroplasty, 38*(9), 1693–1699.

Teerasangchan, T. (2006). Nurses' knowledge, attitude, and pain management for postoperative elderly patients *(Unpublished master's thesis)*. Prince of Songkla University.

Thai Association for the Study of Pain. (2019). *Clinical guidance for acute postoperative pain management*. Retrieved October 17, 2023, from https://www.rcat.org/_files/ugd/82246c_8277684e42ba483c88b44d431ccd3967.pdf.

Wylde, V., Beswick, A., Bruce, J., Blom, A., Howells, N., & Gooberman-Hill, R. (2018). Chronic pain after total knee arthroplasty. *European Federation of National Associations of Orthopaedics & Traumatology Open Reviews, 3*(8), 461–470.

Youngcharoen, P., & Aree-Ue, S. (2023). A cross-sectional study of factors associated with nurses' postoperative pain management practices for older patients. *Nursing Open, 10*, 90–98.

Youngcharoen, P., Vincent, C., & Park, C. G. (2017). Theory of planned behavior constructs associated with nurses' pain assessment and PRN opioid analgesic administration: A cross-sectional study. *Pain Management Nursing, 18*(3), 153–169.

Youngcharoen, P., Vincent, C., Park, C. G., Corte, C., Eisenstein, A. R., & Wilkie, D. J. (2016). Nurses' pain management for hospitalized elderly patients with postoperative pain. *Western Journal of Nursing Research, 38*(11), 1409–1432.