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The Incidence of Chronic Postoperative Pain and Its Risk Factors: A Systematic Review

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Abstract

Background: Chronic postoperative pain (CPP) is the most frequent consequence of surgeries with big impact on the equality of life of the patient. The aim of this study is to analyze and summarize the incidence of chronic pain, its risk factors and interventions after surgery.

Methods: The systematic review was conducted using PubMed, Medline and Cochrane Library databases for the systematic reviews and meta-analysis that focused on chronic postoperative pain in adult patients in any type of surgery before April 2025.

Results: 54 articles were analyzed. Narrative review was conducted to report the risk factors of chronic postoperative pain and interventions methods. The incidence of CPP at 3 to 6 months after surgery was reported depending on the surgery type: Inguinal hernia repair (5-60%), thoracotomy (38-57%), Cesarean section (4-42%), Breast surgery (50%), knee arthroplasty (20%), cardiac surgery (37%), abdominal surgery (20-30%). The most common patient related risk factors are perioperative pain level, female sex and younger age. The psychological factors like preoperative anxiety, depression and catastrophizing can be considered as predictors of CPP.

Conclusion: The most common risk factors of CPP are preoperative pain, female sex, younger age, acute postoperative pain and psychological state of the patient. Inguinal hernia repair surgery has the highest rate of persistent postsurgical pain incidence at 5-60%. Multimodal analgesia is the most recommended and effective method to manage CPP. There is a need for more research towards non-pharmacological treatment methods, particularly focusing on psychological interventions.

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Introduction

Chronic postoperative pain (CPP) is one of the frequent consequences of surgical procedures where patients experience persistent pain after surgery, and 20-30% of patients report pain 6-12 months after surgery (Rosenberger & Pogatzki-Zahn, 2022). According to the International Association for the Study of Pain (IASP) (Schug et al., 2019), chronic postoperative pain is defined as "pain that persists or recurs for more than 3 months after a surgical procedure". Other possible reasons for the pain have to be excluded, and pain should be focused on the surgery site (Schug et al., 2019). Inadequate pain management during the acute period, nerve injury from surgery, or increased pain sensitivity (central sensitization) can all lead to CPP (Schug et al., 2019). The prevalence of CPP varies depending on the type of surgery performed. In the study by Montes et al. (2015), between 30 and 50 percent of patients who had breast surgery, thoracotomy, or inguinal hernia repair experienced persistent postoperative pain. Less invasive laparoscopic surgeries had a slightly lower incidence of persistent pain (Rosenberger & Pogatzki-Zahn, 2022).

CPP can influence patients' health outcomes, leading to lower quality of life mental health problems. Patients' everyday life can affected by persistent long-term pain, which leads to reduced functional impairment, reduced participation in social and work activities, extended hospital visits, and dependence on long-term pain treatment strategies, like opioids (Gan, 2017). There is also significant impact on the mental health of patients and their families, including depression and anxiety (Gan, 2017). Despite such big consequences, the incidence of CPP is anywhere from 5 to 85%, depending on the type of surgery and other key factors (Rosenberger &

Pogatzki-Zahn, 2022). This systematic review aims to summarize data about the incidence of CPP, its risk factors, and treatment options in recent studies.

A systematic review by Correll (2017) reported "various incidences of CPP for abdominal (17-31%), breast (30-60%), cardiac (4-43%), hysterectomy (26%), inguinal hernia (9-43%), orthopedic (19-22%), total knee arthroplasty (16-58%), thoracotomy (39-57%), and thyroidectomy (37%) surgeries." Outpatient surgeries such as urology, plastic, general, and orthopedic surgeries have a CPP incidence of 15% (Correll, 2017). Other than surgery type, risk factors that have been associated with the development of CPP can include experiencing preoperative pain, psychological factors (e.g., anxiety, catastrophizing), demographic characteristics (e.g., younger age and female gender), surgical approach, and the intensity of acute postoperative pain (APP).

Most of the risk factors mentioned above are confirmed to influence CPP in some surgical procedures: "female gender (in abdominal and cardiac surgery), younger age (in abdominal, breast, cardiac, and inguinal hernia surgery), preoperative pain (in abdominal, breast, and outpatient surgery, hysterectomy, TKA, and thoracotomy), psychological states (anxiety in abdominal surgery and thyroidectomy, distress and PTSD in breast surgery, catastrophizing in cardiac surgery and lumbar laminectomy, and fear and lack of optimism in outpatient surgery), and postoperative pain (in breast, cardiac, shoulder replacement, and outpatient surgery, hysterectomy, and thoracotomy)" (Correll, 2017). All the varying factors in different types of surgery make it hard to create a unified pain management or treatment protocol.

According to De Hert et al. (2004), APP is a main predictive factor for the development of chronic postoperative pain. APP is defined as "pain occurring within the first hours to weeks following the surgery and with peak intensity within the first 48 hours" (Gan, 2017). The

duration of severe pain in the first 24 hours postoperatively was reported to predict the chance of CPP (Correll, 2017). Acute postoperative pain can vary in severity from mild to severe and is usually treated using a combination of pharmacological and non-pharmacological methods. However, according to Gan, (2017) “80% of patients still experience moderate to severe pain within 24 hours after surgery”, despite various pain relief strategies that were used. The causes of APP can range from nociceptive pain resulting from tissue injury to inflammatory pain due to surgical trauma (Gan, 2017). A number of factors, including the type of operation, patient’s preoperative health status, age, anxiety, pain management strategies used, and preoperative pain status, can influence the presence and intensity of postoperative pain (Ip et al., 2009; Montes et al., 2015).

Similar to CPP, one of the main factors that might influence the severity and incidence of APP is the type of surgery. For example, after major abdominal surgeries, thoracic procedures, and orthopedic operations, levels of acute pain are higher compared to minor surgeries (Gan, 2017). A review by Gan et al. (2017) reported that 86% of patients report moderate to severe pain and approximately 80% of patients experience some level of postoperative pain. The prevalence of acute postoperative pain remains high despite the recent advancements in surgical techniques and anesthetic care, which include perioperative and postoperative pain management.

Proper pain management improves early mobility and reduces the risk of myocardial infarction, ileus, and urine retention (Vadivelu et al., 2010). Also, when physiological complications are better managed, patients and their families are better equipped to handle stress and cope with the patient's circumstances (Apfelbaum et al., 2003; Wells et al., 2008). Furthermore, reduced length of stay, lower readmission rates, an earlier overall recovery, enhanced productivity, better quality of life, and lower expenses for patients and the healthcare system are further advantages of effective pain management (Rosenberger & Pogatzki-Zahn, 2022).

Treatment for CPP mainly includes pharmacological options, like local anesthetic blockades. Suggested preventive treatment is also pharmacological and consists of preoperative or postoperative administration of drugs like pregabalin or ketamine (with different success rates). Other pharmacological treatments include nefopam, bupivacaine, gabapentin, a multimodal regimen of opioids, spinal anesthesia, femoral and sciatic nerve blocks, and epidurals. The use and effectiveness of these also depend on surgery type. Non-pharmacological options for management of postoperative pain were focused on different surgery techniques or procedures. There is a lack of research for other non-pharmacological options, like acupuncture, electrical nerve stimulation, and cognitive-behavioral therapy. The emergence of new technologies (e.g., AI and VR headsets) and the rise in popularity of psychologically based therapies might increase the number of different options for treatment and management of CPP.

One of the first nationwide quality improvement initiatives was created by the American Pain Society, where the focus was moved from the efficient delivery of pain management to quantifiable patient outcomes like shorter hospital stays, lower hospital expenses, and higher patient satisfaction (Gupta et al., 2010). To evaluate the existing evidence, this study will focus on these research questions:

- What is the incidence of chronic postoperative pain when stratified by surgery types?
- What are the best pain management strategies for chronic postoperative pain?
- What risk factors influence the development and incidence of chronic postoperative pain?

Objectives of the study:

This study aims to synthesize and analyze available evidence on chronic postoperative pain, focusing on its incidence, risk factors, preventative strategies, associated comorbidities, and effective pain management practices. Additionally, this systematic review aims to:

- To evaluate the incidence of chronic postoperative pain in different surgical settings and patient populations.
- To determine rick factors associated with the development and intensity of chronic postoperative pain.

Methods

Design

The research method for this study is systematic review. Systematic review entails finding all primary research that is pertinent to the stated research question, evaluating it critically, and synthesizing the results (Pollock & Berge, 2018). The systematic review in this study was planned and performed according to PRISMA guidelines. The protocol was registered in the PROSPERO registry (ID-CRD42025642380).

Search strategy

The research team searched for systematic reviews in PubMed, Medline, and Cochrane Library databases that were published before April 2025. The following search terms or their combinations were used during the search: ((chronic postoperative pain) OR (chronic post-surgical pain)) OR (persistent postoperative pain)) OR (persistent post-surgical pain)) OR (chronic pain)) OR (postoperative pain)) OR (pain after surgery) OR (long-term pain)) AND (incidence)) OR (risk factors)) OR (treatment)) OR (prevention)) OR (pain management)) OR (predictors)) OR (prevalence). Two authors independently screened for the articles, and in case of any disagreements, a third author was brought in.

Screening

Screening of the articles was conducted independently by only one author. In case of any confusion, other authors were consulted. Screenings were based on titles, then abstracts, and then full texts.

Eligibility Criteria

Inclusion criteria

The inclusion criteria were as follows:

- Population: adults (>18 years old) experiencing chronic postoperative pain after any type of surgery;
- No restrictions on the type of surgery;
- Study designs: systematic reviews and meta-analysis;
- Interventions: include any pharmacological, non-pharmacological, or multimodal pain management strategies (e.g., physical therapy, nerve blocks, new types of suturing, techniques, or methods during the pre- or postoperative period) that are aimed at reducing or managing chronic postoperative pain.

Exclusion criteria

The exclusion criteria included the following:

- Animal studies;
- Non-systematic reviews and meta-analyses (case controls, observational studies, RCT);
- Editorials, narrative or topical reviews;
- Pediatric studies;

- There is a language restriction. Only articles published fully in English were included in the study.

Assessment of methodological quality

The authors used the AMSTAR-2 (A MeaSurement Tool to Assess systematic Reviews) tool to assess the methodological quality of studies, which evaluates 16 domains. The AMSTAR-2 was developed to evaluate systematic reviews and meta-analyses. The domains assess the quality of the methodology of systematic reviews, and each domain was rated as "yes," "partial yes," or "no" (Shea et al., 2017). Overall confidence was rated High, Moderate, or Low based on critical flaws. Critical flaws include domains 2, 4, 7, 9, 11, 13, and 15 (Shea et al., 2017). Reviews with no or one non-critical weakness were rated "High"; reviews with more than one non-critical weakness were rated "Moderate"; and those with one critical flaw were rated as "Low" (Shea et al., 2017).

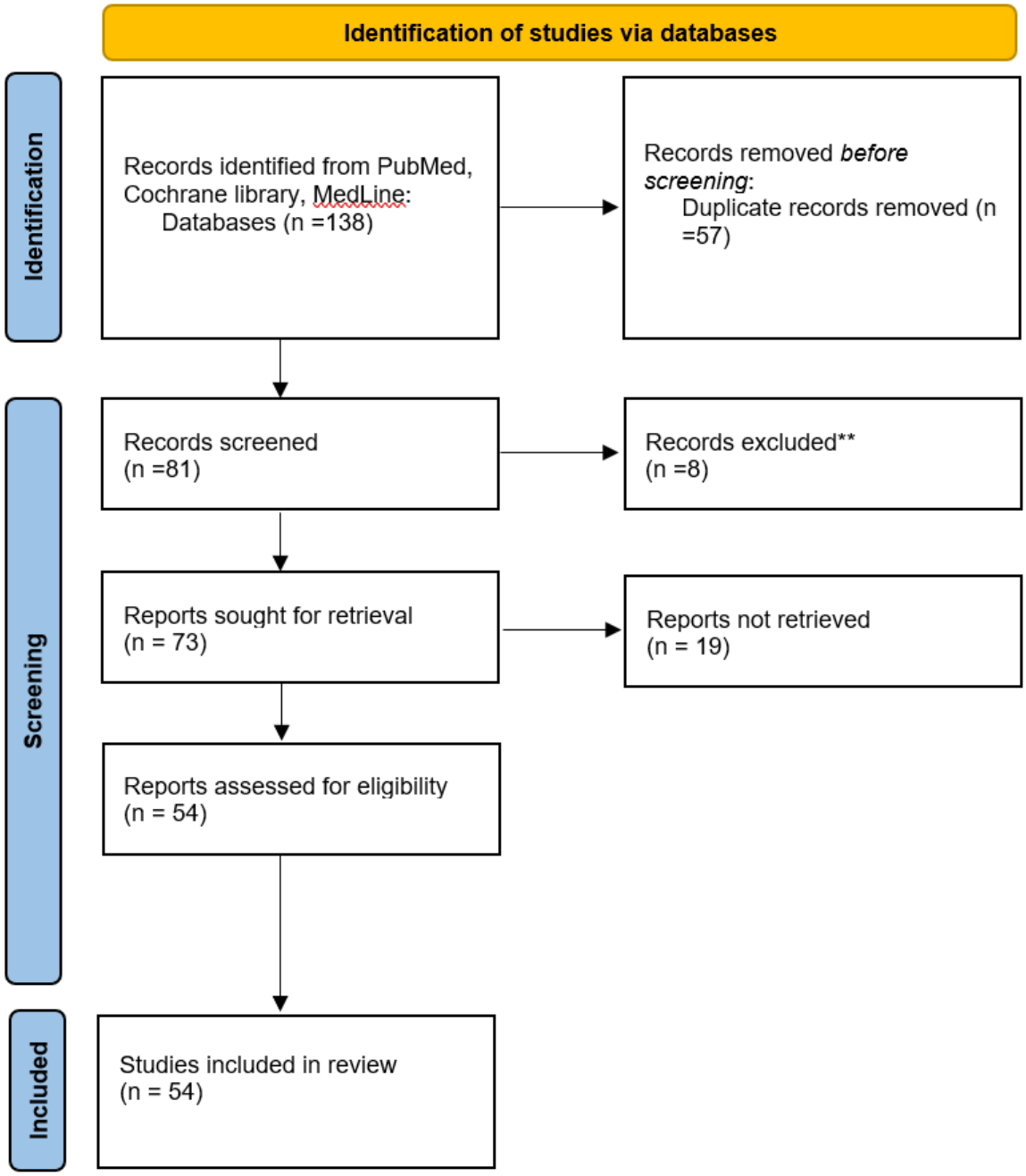

Figure 1. PRISMA flow diagram

Data extraction

The author extracted the data using a Word table. Study characteristics, such as first authors, patient characteristics, study design, number of studies included in the systematic reviews, number of patients included in the meta-analysis, treatment received and treatment for pain, and study conclusion, were extracted into Table 1.

Results

Included studies

The systematic search retrieved 138 original articles (Figure 1). After duplicate studies (57) were removed from 81 possible articles screened, 54 articles were eligible and included in the review.

Table1. Study characteristics (n=54)

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
1	Viderman D.	Systematic review with meta-analysis	Patients after knee and hip surgery	15	1320	Surgery (hip and knee)	Medical(gabapentinoids)	Gabapentinoids were associated with reduced postoperative pain intensity, morphine consumption.
2	Guidi Lyra V.	Systematic review and meta-analysis	Patients with abdominal wall hernias who had surgeries with Lichtenstein technique or TEP/TAPP techniques	13		Lichtenstein technique or TEP/TAPP techniques		Laparoscopic TEP/TAPP technique showed reduced presence of chronic postoperative pain
3	Guimaraes-Pereira, L	Systematic review and meta-analysis	Cardiac patients experiencing chronic postoperative pain	23	11057	Cardiac surgery	N/A	Incidence of CPP is 37%

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
4	Li J.	Systematic review	patients undergoing total knee replacement	32	18,792	Surgery	N/A	Preoperative sleep disturbances and poor health beliefs are strongly associated with chronic postoperative pain.
5	Du H.	Systematic review and meta-analysis	Women undergoing cesarean section.	21	1976	Cesarean section	Quadratus lumborum block (QLB)	QLB reduces acute pain scores and morphine consumption.
6	Oostvogels L.	Systematic review of RCT	Postoperative patients undergoing general anesthesia	64	3973	Surgery	Erector spinae plane block (ESPB)	Postoperative pain intensity is reduced when ESPB is used with standard care
7	Feenstra ML.	Systematic review and meta-analysis	Patients who underwent general anesthesia.	38		surgical	opioid based versus opioid-free anesthesia	Authors did not recommend either method.
8	Akhtar M.	Systematic review	Pectus excavatum	10	1135	Surgical Nuss procedure		After Nuss procedure adult patients experience chronic pain and bar displacement more often than children and adolescents.
9	Park S.	Systematic review and meta-	Adult patients after any type of surgery with	18	958	Any type of surgery	Peripheral magnetic stimulatio	PMS decreased acute pain but showed no statistical difference in

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
		analysis	perioperative PMS use				n (PMS)	chronic pain outcomes
10	Wang L	Systematic review and meta-analysis	Adult patients after cesarean section	48	-	Cesarean section	N/A	The incidence of CPP at 3 months was 15.2%
11	Wang L.	Systematic review and meta-analysis	Adult patient undergoing surgery	24	2197	Any type of surgery	Perioperative SSRIs, SNRIs	Perioperative administration of SNRIs decreased CPP and opioid consumption and increased patient satisfaction, with no apparent side affects
12	Chen, W	Systematic review and meta-analysis	Adult patients who underwent video assisted thoracoscopic surgery	17	10525	Video assisted thoracoscopic surgery	N/A	The incidence of CPP after surgery was 35.3%.
13	Schnabel A.	Systematic review and meta-analysis	Adult patients undergoing surgery	14	908	Surgical	Perioperative administrations SSNRI (duloxetine)	Compared to placebo, 60 mg of duloxetine reduced postoperative pain after 24h and 48h
14	Rodriguez Cairoli F.	Systematic review	Adult patients undergoing surgery or in chronic pain	5		Surgical	PGx-guided opioid therapy	PGx-guided interventions lead to decreased requirement for analgesics

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
15	van den Beukel BAW.	Systematic review	Adult patients experiencing chronic postoperative pain related to adhesions	4		Abdominal surgery	Analgesic	Pregabalin might improve midterm results of pain, quality of life and sleep disturbance signs.
16	Andreolettti, H	Systematic review and meta-analysis	Adult patients after any type of non-obstetric surgery	71		Surgery	N/A	Demographic characteristics related to the development of CPP.
17	Wang L.	Systematic review and meta-analysis	Breast cancer patients experiencing post operative pain	197	297 612	Surgery	n/a	Incidence of chronic pain after breast cancer surgery
18	Whale K.	Systematic review	Patients who experienced postoperative pain after having total knee replacement surgery and had psychological intervention	12	1299	surgery	Psychological intervention	More research is needed
19	van Steensel S.	Meta analysis	Adult patients having inguinal hernia repair using a flat	23	5190	Surgery	adhesional/self-gripping and sutured	There was no significant difference in the incidence of persistent pain12 months after between suture and non-

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
			sutured mesh or glue or self-gripping mesh fixation				single-layer open mesh fixations	suture fixation groups.
20	Klatt E.	Systematic review and meta analysis	Adult patients experiencing postoperative pain that used ketamine intra- and postoperatively	10	784	Surgery	peri- and intraop-eratively admineste red NMDA-receptor antagonist ketamine	No sufficient evidence in favor of perioperative administration of ketamine.
21	Rai AS.	Systematic review and meta-analysis	Adults undergoing breast surgery	12	725	Breast cancer surgery	Gabapentin and pregabalin	Both drugs reduce the use of opioids consumption in the recovery room.
22	Martinez V.	Systematic review and meta-analysis	Adult patients who had surgery	18	2485	surgery	Perioperative pregabalin	Perioperative pregabalin is not effective for prevention of persistent pain after surgery
23	Chaparro LE.	Systematic review and meta-analysis	Adult patients who received systemic drugs before, during or after surgery	40		Surgery	Pharmacotherapy	The efficacy of drugs is not proven.
24	Theunisse	Systemati	Adult surgery	29		Surgery	n/a	Evidence suggests that

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
	n M.	c review and meta-analysis	patients					anxiety and catastrophe play a role in the development of chronic pain after surgery
25	Johner A.	Systematic review and meta-analysis	Adults undergoing open inguinal hernia repair with planned elective inguinal nerve division	4	1074	Surgery	Planned ilioinguinal nerve excision	A planned ilioinguinal nerve excision with nerve preservation reduces the incidence of persistent post-surgical pain.
26	Morales-Conde S.	Systematic review	Adults having abdominal wall surgery			surgery	Fibrin sealant	Fibrin sealant reduced the occurrence of acute and chronic postoperative pain and decreased number of hemorrhagic complications.
27	Ypsilantis E.	Systematic review	Adult patients who underwent lower limb amputation as a result of critical ischemia of peripheral vascular disease	11		amputation	Preemptive analgesia	Use of preemptive analgesia has proven effective in relieving acute postoperative stump pain
28	Varallo, G.	Systemati	Patients	18		Surgery	NA	Preoperative sleep

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
		c review and meta-analysis	undergoing any type of surgery	studies (12 in meta-analysis)				disorders and sleep disturbances are risk factors for chronic postoperative pain severity.
29	Lakhan, S.	Systematic review and meta-analysis	Adult patients undergoing any type of surgery	12			Aromatherapy	Aromatherapy is effective in managing chronic postoperative pain when combined with standard treatment.
30	Ghoshal, A.	Systematic review	Adult patients experiencing total hip joint (THR) or total knee joint replacement (TKR)	81	171,354	Surgery (TKR and THR)	N/A	Chronic postoperative pain after TKR is influenced by preoperative anxiety and depression
31	Wang, K.	Systematic review and meta-analysis	Adult patients with breast cancer who underwent surgery, radiotherapy or combination of treatment	177		Surgery, radiotherapy, or combination	N/A	The overall pain prevalence rate was highest in post-surgery group
32	Giusti, E. M.	Systematic review and meta-	Adult patients experiencing CPP after any type of	41	40784	Surgery	N/A	State anxiety has the most significant association with CPP among other

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
		analysis	surgery					psychological predictors.
33	Ashoorion, V.	Systematic review and meta-analysis	Adult patient who had total knee replacement	30	26517	TKR	N/A	Catastrophizing, moderate to severe acute postoperative pain and younger age increase the risk of chronic postoperative pain.
34	Li, J.	Systematic review and meta-analysis	Adult who underwent laparoscopic inguinal hernia repair	8	1228	Laparoscopic inguinal hernia repair (either with adhesive or staple fixation)	N/A	Adhesive fixation method reduces the incidence of persistent postoperative pain
35	Jiang, Y.	Systematic review and meta-analysis	Adults who underwent breast cancer surgery	9		Surgery	Preoperative use of gabapentin	Gabapentin used before surgery decreased acute pain severity, total morphine uses and incidence of chronic postoperative pain.
36	Doleman, B.	Systematic review and meta-analysis	Adult participants who underwent any surgery	132	23902	Surgery	Non-opioid analgesics	This article suggests lidocaine, gabapentinoids, ketamine and dexmedetomidine reduce incidence of chronic postoperative pain for up to six

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
								months.
37	Sun, W.	Systematic review and meta-analysis	Adults who underwent any surgery	20	1561	surgery	Ketamine IV	Intravenous ketamine may decrease the occurrence of persistent post-surgical pain in patients after 3-5 months after surgery
38	Abouarab, A.	Systematic review and meta-analysis	Adult patient who underwent any surgery	36	3572	surgery	Perioperative intravenous ketamine	Intravenous ketamine decreases the incidence of persistent postoperative pain after 3 months
39	Clephas, P. R. D.	Systematic review and meta-analysis	Adult patients who underwent lung or pleural surgery with 3 months follow up period	56	10038	surgery	N/A	Preoperative pain, longer surgery duration and higher acute post-surgical pain intensity influence the development of chronic postoperative pain after lung and pleural surgery.
40	Droog, W.	Systematic review and meta-analysis	Adult patients who underwent elective upper extremity surgery	14	90666	Surgery (elective upper extremity)	N/A	Upper extremity regional analgesia will not change the severity of chronic postoperative pain.

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
41	Yimer, H.	Systematic review	Patients experiencing chronic pain after cesarean section	17		Cesarean section	N/A	Several social factors are named to affect the development of chronic postoperative pain
42	Pepper, C.	Systematic review and meta-analysis	Adult patients who underwent elective noncardiac surgeries	37	4948	Noncardiac surgery	Regional anesthesia	Regional anesthesia affects the acute postoperative pain intensity
43	Hussain, N.	Systematic review and meta-analysis	Adults who had breast surgery	13	1039	Breast cancer surgery	Perioperative lidocaine infusions	Lidocaine infusions do not reduce the risk of development of persistent postoperative pain 3-6 months after surgery
44	Shekouhi, R.	Systematic review	Adult patient who underwent inguinal hernia repair experience postoperative pain	11	389	Surgery	Neuromodulator interventions	Transcutaneous Electrical Nerve Stimulation (best option), SCS, PNS and acupuncture assistance were evaluated
45	Chu, Z.	Systematic review and meta-analysis	Adult patients who underwent hernia repair surgery	18	29466	hernia repair surgery	N/A	Several sociodemographic factors affect the incidence of persistent postoperative pain
46	Silveira,	Systemati	Adults who	9	8428	inguinal	N/A	Transinguinal

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
	C. A.	c review and meta-analysis	underwent unguinal hernia repair either with TIPP or Lichtenstein open repair technique			hernia repair		preperitoneal (TIPP) group experienced less chronic postoperative pain, paresthesia rates compared to control group
47	Pang, N. Q.	Systematic review and meta-analysis	Patients aged 65 years old and above underwent surgical groin hernia repair	5	2526	Laparoscopic or open hernia repair	N/A	The occurrence of persistent pain was lower in laparoscopic surgery group.
48	Kobayashi, F.	Systematic review and meta-analysis	Adult patients who had laparo-endoscopic repair of groin hernias	25	3668	Laparo-endoscopic hernia repair	N/A	Mesh non-fixation technique affects the return to daily life with no difference to the recurrence of hernia.
49	Zhang, B.	Systematic review and meta-analysis	Adults who underwent any type of cardiac surgery	7	658	Cardiac Surgery	Remifentanil	The incidence of chronic and acute postoperative pain score was not different between intervention and control groups.
50	DesRochers, J.	Systematic review and meta-analysis	Adult patients who experienced post-mastectomy	5		mastectomy	Cryoneurolysis (postoperative)	Clinically significant findings showed a reduction in pain severity and opioid use.

ID	First author	Study design	Patient characteristics	Total number of studies	Total number of patients if there was meta-analysis	Treatment received (medical, surgical, radiological)	Treatment of pain	Study conclusions/comments
			pain syndrome					
51	Kannan, P.	Systematic review and meta-analysis	Women experiencing post-mastectomy pain syndrome (PMPS)	18	1098	mastectomy	Physical therapy	The pooled analysis showed that exercise has a positive effect on Quality of Life (QoL) in general, physical and mental health aspect.
52	Verret, M.	Systematic review and meta-analysis	Adults undergoing elective or emergent surgery	281	24682	Surgery	Gabapentinoids (gabapentin or pregabalin)	Perioperative gabapentinoid use is not clinically significant in management of chronic pain.
53	Wang, L.	Systematic review and meta-analysis	Adult patients who underwent thoracic surgery	90	19001	surgery	N/A	The prevalence of CPP is 38% and 56.5% of patients require opioid use.
54	Maeßen, T.	Systematic review	Adult patients who underwent cardiac surgery via median sternotomy	212		surgery	Pharmacologic therapy	Combination of drugs is recommended for preoperative or intraoperative administration

Incidence

Based on the data from the systematic search, table 2 demonstrates the incidence of chronic postoperative pain in various surgery types.

Table2. Incidence of CPP by surgical procedure

Surgery type	**Incidence of chronic postoperative pain 3-6 months after surgery(%)**
Inguinal hernia repair	5-60
Thoracotomy	38-57
Cesarean section	4-42
Breast	50
Knee arthroplasty	20
Cardiac	37
Abdominal	20-30

Risk factors

Psychological Factors

As mentioned in the literature, psychological factors play a key role in the development of chronic postoperative pain. Evidence in our review suggested anxiety and catastrophizing play a role in the development of CPP (Theunissen et al., 2012). Preoperative sleep disorders and sleep disturbances can be predictors of CPP intensity (Varallo et al., 2022). A study by Giusti et al.

(2021) reported that state anxiety has the most significant association with CPP among other psychological predictors. Other significant psychological factors can include trait anxiety, depression, catastrophizing, and kinesiophobia (Giusti et al., 2021).

Patient-related factors and preoperative pain

Comprehensive study on TKR and THR surgeries showed that severe acute postoperative pain and high preoperatice pain scores were associated with a higher risk of CPP. There are other factors that were independently associated with CPP in that study, like catastrophizing female sex, high BMI and younger age, but the evidence was contradictory (Ghoshal et al., 2023). Another systematic review that reviewed patients after TKR also suggested that catastrophizing, moderate to severe APP, and younger age increase the risk of CPP. Moderate evidence found high preoperative pain scores and female sex might influence the development of CPP (Ashoorion et al., 2023). Two other systematic reviews supported that experiencing severe preoperative pain, being female and being young are main predictors of CPP (Andreoletti et al., 2022; Chu et al., 2024). A study by Yimer & Woldie, (2019) on cesarean sections noted that "among different types of factors, sociodemographic factors such as lack of health insurance, history of neuropathic pain, poor mental-based quality of life, and prenatal and postnatal depression were associated with the increase of the incidence of CPP". These results let us identify important socio-demographic factors that can be used as a further evaluation and risk management tool.

Surgical factors

Surgical factors can range from surgery type to duration and include technical factors and acute postoperative pain. According to Clephas et al. (2023), who reviewed patients after lung surgery or any type of pleural surgery, preoperative pain, longer surgery duration, and higher acute postoperative pain intensity are predictors for the development of CPP. The factors that

decreased CPP were reported to be intercostal nerve block and video-assisted thoracic surgery. In this study, the authors noted that the sex and age of the patients cannot be reported as risk factors for CPP (Clephas et al., 2023). Among women after cesarean section, the most common independent risk factor that affects the development of CPP is identified as acute postoperative pain (Yimer & Woldie, 2019). For patients with CPP after hernia repair surgery, some surgical risk factors were the presence of other postoperative complications, hernia sac defect, and having a history of ipsilateral inguinal hernia repair (Chu et al., 2024).

Abdominal surgery

There have been several studies focused on different pain management methods for abdominal surgery. In pharmacological treatment, pregabalin showed good results in improving sleep quality, quality of life, and slightly reducing chronic pain (van den Beukel et al., 2022). Nerve modulation was reported to show improvement in chronic abdominal pain and opioid use. (van den Beukel et al., 2022). Fibrin sealant use reduced the prevalence of acute and chronic postoperative pain and reduced the number of complications compared to mechanical methods of postoperative mesh fixation of the abdominal wall (Morales-Conde et al., 2011).

Breast surgery

A study by Wang et al. (2020) reported that half of all women experience chronic postoperative pain after breast surgery. The review suggests that chronic pain persists for years without changes, and a quarter of women have severe chronic pain (Wang et al., 2020). Another study supported it by suggesting that disturbance of sensory nerves during breast surgery may cause significant chronic pain for 8 years post-surgery (Wang et al., 2018). When compared with other treatment options, the overall pain prevalence is highest in the post-surgery group compared to the radiotherapy group or combination group (Wang et al., 2018). It can be added that axillary lymph node dissections (ALND) were associated with the highest number of comorbidities

(Wang et al., 2018). In the study by Rai et al. (2017), it was found that despite reducing the use of opioids and gabapentin reducing acute pain 24 hours after surgery, neither gabapentin nor pregabalin affect chronic postoperative pain. Contrary to that, another study found that preoperative gabapentin use decreased acute pain intensity and incidence of CPP (Jiang et al., 2018).

Cardiac surgery

Incidence of CPP after cardiac surgery is reported to be 37% 6 months after surgery and 17% in two years (Guimaraes-Pereira et al., 2017). A study by Zhan et al. (2024) compared the incidence of CPP and other outcomes between groups with standard care and groups who had remifentanil in addition to standard care. The incidence of CPP and acute postoperative pain score was not statistically significantly different between the intervention and control groups. There is slight evidence that the remifentanil group had a higher consumption of morphine compared to the control group (Zhang et al., 2024). Other pharmacological treatment was a combination of NSAIDs and paracetamol recommended preoperatively or intraoperatively and continued to the postoperative period with opioid administration (Maeßen et al., 2023). An extensive report by Maeßen et al. (2023) reported that dexmedetomidine and magnesium are recommended when basic analgesics are not administered. Parasternal block intraoperatively can be effective for reduction in CPP incidence. Non-pharmacological options such as massage and music can be used as adjuncts to pharmacological therapy (Maeßen et al., 2023).

Hysterectomy/cesarean

The pooled incidence of CPP 3 months after cesarean section was 15.2%, 9.5% at 6 months, and 5% at 12 months post-surgery (Wang et al., 2025). There was a lower incidence of CPP in low- and middle-income countries at 6 and 12 months after surgery. Most women reported mild or moderate pain that relieved over time, and some reported a neuropathic pain component (Wang

et al., 2025). During the cesarean section, use of QLB (quadratus lumborum block) proved to reduce acute postoperative pain and morphine consumption but had no effect on CPP (Du et al., 2024). “Perioperative use of anti-inflammatory drugs, breastfeeding, use of Pfannenstiel incision, and higher doses of bupivacaine (>10 mg local anesthetic) with opioids for spinal anesthesia reduce the incidence of CPP after cesarean section” as reported by Yimer & Woldie, (2019).

Inguinal hernia surgery

For inguinal hernia surgery, different surgical techniques/procedures were tested. Laparoscopic surgery is correlated with persistent postsurgical pain. The laparoscopic TEP/TAPP technique resulted in a decreased presence of CPP compared to the Lichtenstein technique when treating abdominal wall hernias (Guidi Lyra et al., 2024). Even for adult patients aged 65 years and older, the incidence of CPP was lower in the laparoscopic surgery group (Pang et al., 2022). Also, laparoscopic hernia repair was associated with shorter length of hospital stay and reduced incidence of wound infection (Pang et al., 2022). For laparo-endoscopic hernia repair, the mesh non-fixation technique improved return to daily life with no effect on the possibility of recurrence of hernia (Kobayashi et al., 2023). However, there was no difference in incidence of CPP compared to the control group (Kobayashi et al., 2023). In contrast, planned ilioinguinal nerve excision with nerve preservation reduces the incidence of CPP (Johner et al., 2011). When comparing two different procedures for inguinal hernia repair, the transinguinal preperitoneal (TIPP) repair method resulted in less chronic postoperative pain and paresthesia rates compared to Lichtenstein open repair (Silveira et al., 2023). TIPP was also associated with a lower 14-day postoperative pain score (Silveira et al., 2023).

A study by van Steensel et al. (2019) showed differences in different types of suture methods and their effect on postoperative pain. It was discovered that despite the slight decrease in acute postoperative pain in the non-suture group, there is no difference in incidence of CPP at 12

months between suture and non-suture groups (van Steensel et al., 2019). For laparoscopic inguinal hernia repair, the adhesive fixation method was associated with a reduced incidence of CPP compared to staple fixation (Li et al., 2015).

Total knee arthroplasty/replacement

In the study by Li et al. (2024), it was highlighted that preoperative sleep disturbance (sleep deprivation, poor sleep quality) and poor health beliefs (illness perception, pain catastrophizing, preoperative expectations, and coping attitudes) are strongly associated with CPP for total knee replacement patients. This finding was supported by Ghoshal et al. (2023), who reported patients who experience preoperative anxiety and depression before TKR surgery increase their risk of CPP. Despite that, the study, which was conducted to review the effectiveness and safety of psychological interventions, could not make any recommendations because of heterogeneity and poor reporting of data (Whale et al., 2019). When treating patients after TKA with gabapentinoids, the reduction of postoperative pain intensity and morphine consumption was noted among patients. However, pain reduction was not clinically relevant (Viderman et al., 2024).

Other orthopedic surgery

After amputations, the use of preemptive analgesia has proven effective in reducing acute postoperative stump pain, but there is no effect on chronic pain (Ypsilantis et al., 2010). For elective upper extremity surgery, it was reported that compared to general anesthesia, upper extremity regional anesthesia is unlikely to change the intensity of CPP (Droog et al., 2023).

Thoracic surgery

The prevalence of CPP after thoracic surgery is 38%, and 56.5% of patients require opioid use (Wang et al., 2023). A study by Chen et al. (2023) focused on video-assisted thoracoscopic

surgery, its risk factors, and the incidence of CPP that was reported, which was 35.3%. The main risk factors were identified as female sex, young age, and acute postoperative pain (Chen et al., 2023). Additionally, the number of ports, surgery time, duration of drainage, and insufficient analgesia were revealed to be possible risk factors for CPP (Chen et al., 2023). Quantitative analysis also revealed that postoperative chemotherapy and an education level less than junior school could be predictors for CPP (Chen et al., 2023).

General surgery/other surgery

For patients undergoing any type of surgery under general anesthesia, erector spinae plane block (ESPB), when used in addition to standard care, did not improve pain intensity 24 hours after surgery (Oostvogels et al., 2024). A systematic review and meta-analysis by Feenstra et al. (2023) found that there is no difference in using opioid-based versus opioid-free anesthesia for reduction of CPP intensity.

After the Nuss procedure, adults experience more complications, including a higher incidence of CPP, compared to children, and the rate of complications increases with age (Akhtar et al., 2023). After mastectomy, cryoneurolysis showed clinically significant findings in the reduction of chronic pain severity and opioid use (DesRochers et al., 2024).

Alternative treatment

Neuromodulation

Peripheral magnetic stimulation, or PMS, when done perioperatively, decreased acute postoperative pain compared to control groups, but there was no difference in CPP outcomes (Park et al., 2023). Myofascial release and acupuncture showed promising pain-relieving effects on patients suffering from post-mastectomy pain syndrome (a form of CPP after mastectomy) (Kannan et al., 2022). In the study by Shekouhi et al. (2023), various neuromodulation forms, such as Transcutaneous Electrical Nerve Stimulation, PNS, SCS, and acupuncture assistance,

were evaluated and compared for their effect on postoperative pain. Out of all options, transcutaneous electrical nerve stimulation was reported to be the best (Shekouhi et al., 2023). Neuromodulator interventions can be a form of pain management because they are associated with considerable pain alleviation and a decrease in postoperative analgesic consumption (Shekouhi et al., 2023).

Psychological and physical therapy

Psychological intervention to combat acute and chronic postoperative pain (for TKR patients) shows inconsistent results, and no recommendations can be made due to heterogeneity of evidence and a low amount of data (Whale et al., 2019). One study suggests that aromatherapy can be effective in managing CPP when combined with standard treatment of pain (Lakhan et al., 2016). Physical therapy was evaluated among patients with post-mastectomy pain syndrome. Different types of physical therapy, like aerobic training, resistance training, and water exercises, have positive effects on quality of life and pain severity (Kannan et al., 2022).

Pharmacotherapy

Regional anesthesia

Regional anesthesia was reviewed to study its effect on postoperative pain. The extensive study on noncardiac patients supported the notion that regional anesthesia improves acute postoperative pain and opioid consumption (Pepper et al., 2024). Authors found that regional anesthesia may also decrease the development of CPP in 3 and 6 months after surgery. However, the evidence for the development of CPP at 12 months was inconclusive (Pepper et al., 2024).

SNRIs

In one study by Wang et al. (2022), perioperative use of SNRIs in addition to standard care reduced both acute and chronic postoperative pain. As well as decreased opioid consumption and

increased patient satisfaction. Use of SSRIs showed inconclusive results (Wang et al., 2022). Another study showed that perioperative administration of SNRIs, namely duloxetine, reduced acute and chronic postoperative pain (Schnabel et al., 2021). This study also reported a common side effect, which was dizziness.

Ketamine

Intra- and postoperative administration of ketamine has been shown to reduce acute postoperative pain, especially if there is an expectation of severe postoperative pain and regional anesthesia is not available (Klatt et al., 2015). Another study supported intravenous administration of ketamine, which was reported to decrease the incidence of CPP in patients 3-6 months after surgery (Sun et al., 2023). But there is no sufficient evidence in favor of perioperative use of ketamine (Klatt et al., 2015). Contrary to that, another literature review reported that perioperative intravenous ketamine may decrease the incidence of CPP after 3 months (Abouarab et al., 2024). However, there was no statistical difference found in the incidence of CPP after 6 months between the ketamine and placebo groups (Abouarab et al., 2024).

Pregabalin and gabapentinoid

Perioperative use of pregabalin for prevention of CPP is not supported (Martinez et al., 2017). This was supported by Chaparro et al., (2013) who reported that “the use of pregabalin, gabapentin, NSAIDs, intravenous steroids, oral NMDA blockers, mexiletine, venlafaxine, IV fentanyl, lidocaine, or inhaled nitrous oxide for the prevention of CPP could not be supported”. Another literature review reported that perioperative gabapentinoid use is not clinically significant in the management of postoperative acute, subacute, or chronic pain. Gabapentinoids have increased the risk of adverse effects (Verret et al., 2020).

Lidocaine

For patients with breast cancer surgery, lidocaine infusions did not reduce the odds of developing chronic postoperative pain at 3 and 6 months compared to the control group with parenteral analgesia (Hussain et al., 2024). Contrary to that, one study reported that lidocaine (most effective), gabapentin, ketamine, and dexmedetomidine reduce the incidence of CPP up to 6 months, but there was no consistent evidence in favor of the drugs to decrease CPP after a 6-month period (Doleman et al., 2023).

Recommended combinations

One systematic review recommended the combination of paracetamol and NSAID to start preoperatively or intraoperatively and continue to the postoperative period (Maeßen et al., 2023). Dexmedetomidine and magnesium are recommended through IV as adjuncts when basic analgesics are not administered (Maeßen et al., 2023). However, there is no information on their combined effect on pain. Parasternal block can be effective intraoperatively, and non-pharmacological therapy such as massage and music can be used as an adjunct to pharmacological therapy (Maeßen et al., 2023). Postoperatively, the combination of paracetamol and NSAIDs with opioids is effective for pain management of cardiac patients (Maeßen et al., 2023). PGx-guided opioid therapy showed a lower need for analgesics compared to placebo (Rodriguez et al., 2021). Also, there is significant pain improvement in patients with a high risk of CYP2D6 phenotype in the PGx-guided intervention group (Rodriguez et al., 2021).

Quality assessment

The results of the methodological quality assessment using the AMSTAR-2 tool are summarized in table 3. Of the 54 articles, the majority of articles (39) were rated “High” confidence, 9 “Moderate,” and 6 “Low” confidence. Common limitations included lack of justification for the

excluded studies (item 7), incomplete reporting of the funding sources (item 10), and risk of bias being addressed and assessed for each individual article (items 9,13).

Table3. AMSTAR-2 Methodological quality assessment(n=54)

ID	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Overall Confidence
1	Yes	Yes	Yes	Partial yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Partial yes	Yes	Moderate
2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A	N/A	Partial yes	Partial yes	Yes	Yes	High
5	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Partial yes	Yes	Yes	Yes	Moderate
6	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
7	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	High
8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Yes	Yes	High
9	Yes	Partial yes	Partial yes	Partial yes	Yes	Yes	Yes	YEs	Partial yes	No	No	Partial yes	No	No	Yes	No	Moderate
10	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Partial yes	Yes	Yes	Moderate
11	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Yes	Yes	Yes	High
13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
14	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Partial yes	Partial yes	Yes	Yes	Yes	Moderate
15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes	High
16	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Yes	No	No	Moderate
17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	High
18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes	High
19	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
20	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
21	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
22	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
23	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
24	Yes	Partial yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	No	No	Yes	Low
25	Yes	Partial yes	No	Partial yes	Yes	Yes	No	Yes	No	No	Yes	Yes	No	No	No	Yes	Low
26	Yes	Partial yes	No	No	Yes	Yes	No	Yes	No	No	N/A	N/A	No	No	No	Yes	Low
27	Yes	Partial yes	No	No	Yes	Yes	No	Yes	No	No	N/A	N/A	No	No	No	Yes	Low
28	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
29	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	Low
30	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
31	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A	Yes	Yes	Yes	Yes	High
32	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
33	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
34	Yes	Partial yes	No	Partial yes	Yes	Yes	No	Yes	No	No	Yes	Yes	No	No	Yes	Yes	Low
35	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Moderate
36	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
37	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
38	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
39	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
40	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
41	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A	N/A	Yes	No	Yes	Yes	Moderate
42	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	High
43	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
44	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Yes	Yes	High
45	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
46	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
47	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
48	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
49	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
50	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	N/A	N/A	No	Yes	Yes	Yes	Moderate
51	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
52	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High
53	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Partial yes	Yes	Yes	Yes	High
54	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	N/A	N/A	Partial yes	Partial yes	Yes	Yes	High

Discussion

The findings of this systematic review assissted in evaluating and synthesizing comprehensive information on risk factors, treatments/management strategies of CPP, and general information about the incidence of CPP.

Psychological and Patient-Related Risk Factors

Psychological risk factors were one of the most important as preoperative anxiety, depression and catastrophisizing were found to be consistent risk factors of CPP. Despite different types of surgeries, studies showed that patients with high preoperative anxiety and catastrophizing have a higher risk of developing CPP (Theunissen et al., 2012; Giusti et al., 2021). These findings support the previous research emphasizing the role of psychological state and pain perception before surgery in persistent pain development. However, due to a lack of research and evidence, psychological interventions cannot be proven to be effective against persistent postsurgical pain (Whale et al., 2019). From the patient characteristics, younger age and female sex were identified as potential predictors of CPP, though there is some inconsistent evidence (Andreoletti et al., 2022; Ghoshal et al., 2023; Jiang et al., 2018). This difference could be the result of different factors such as differences in study design, surgery type, sample populations, heterogeneity of evidence, or the complex combinations of hormonal, genetic, and psychological factors.

Acute postoperative pain and surgical factors

An important finding in this review is the strong evidence connecting acute postoperative pain intensity and the likelihood of developing CPP (Ghoshal et al., 2023; Yimer & Woldie, 2019). This supports the previous studies and reinforces the importance of effective postoperative pain management. This finding seems to be true in various types of surgeries. For example, patients undergoing total knee and total hip replacement (TKR, THR) surgeries with higher preoperative pain scores have a higher risk of developing CPP (Andreoletti et al., 2022; Ghoshal et al., 2023). Similarly, in thoracic and abdominal surgeries, longer surgical duration and higher acute postoperative pain severity were predictors of chronic pain (Clephas et al., 2023; Chu et al., 2024). Certain surgical techniques, such as laparoscopic procedures and nerve block techniques,

were associated with lower CPP incidence, as seen in thoracic and inguinal hernia surgery studies (Clephas et al., 2023; Pang et al., 2022). This suggests that further surgical modifications could help in mitigating chronic postoperative pain risk.

Pharmacological interventions

In this systematic review, various pharmacological treatment options were overviewed, and various contradictory evidence was found. Gabapentinoids, for example, despite their widespread use, showed inconsistent results in decreasing CPP and, on perioperative administration, were associated with adverse effects (Rai et al., 2017; Martinez et al., 2017; Chaparro et al., 2013; Verret et al., 2020). On the other hand, ketamine was reported to be associated with reducing CPP incidence 3-6 months after surgery, though longer postoperative periods reported inconsistent results (Klatt et al., 2015; Sun et al., 2023; Abouarab et al., 2024). Intravenous lidocaine also presented mixed results, with some studies reporting a reduction in CPP incidence, particularly at 6 months postoperative period (Doleman et al., 2023; Hussain et al., 2024). The most recommended pain management method was combinations of NSAIDs and paracetamol for the intraoperative and postoperative periods (Maeßen et al., 2023). Multimodal analgesia has emphasized its importance in the case of combined use with regional anesthesia for more effective management of CPP (Pepper et al., 2024).

Non-pharmacological interventions

Beyond pharmacological management, this review covered a variety of non-pharmacological options that showed promise. Perioperative psychological interventions that were aimed to reduce anxiety and catastrophizing had inconsistent results due to heterogeneity and a poor amount of data (Whale et al., 2019). Physical therapy postoperatively, such as water exercises, resistance training, and myofascial release, was effective in managing post-mastectomy pain syndrome (Kannan, 2022). This shows high potential of rehabilitation in chronic pain

management. Transcutaneous electrical nerve stimulation presented a new option for pain relief and reduced opioid consumption (Shekouhi et al., 2023). One of the narrative reviews not included in this study reviewed the role of perioperative patient education and its effect on patient outcomes. The findings showed that perioperative patient education can deliver promising results, being associated with improved psychological outcomes such as decreased anxiety and analgesic use (Darville-Beneby et al., 2023). According to Darville-Beneby et al. (2023), compared to other forms of perioperative education delivery (i.e., video format, brochures), in-person intervention by a healthcare provider seems to be the most beneficial for the improvement of patient outcomes, including chronic postoperative pain scores. This intervention reinforces the importance of proper patient engagement in their own health management.

Limitations

This review has various limitations. The heterogeneity of patient populations and outcome measures limits the possibility of direct comparison across the studies. Also, the variability in pain measurement tools (e.g. NRS, VAS) and improper CPP definitions lead to heterogeneity and influences the incidence estimates. After the methodological quality assessment it can be reported that while most reviews were rated as having high methodological rigor, variability in domains like incomplete search strategy and risk of bias assessment shows there is room for improvement in transparency and improvement of the search strategy of the reviews. Systematic reviews and meta-analysis may be subject to publication bias. Furthermore, the long-term impact of various interventions on CPP remains unclear, creating a need for more randomized controlled trials with longer follow-up periods. Most data was derived from high income countries, limiting generalizibility. Further research should focus on multimodal analgesia and new psychological, pharmacological, and surgical interventions tailored to the surgical and demographic characteristics of patients.

Recommendations

The findings of this research highlight the need for a multidisciplinary approach to pain management. Preoperative psychological screening and interventions should be considered, when possible, particularly for patients with anxiety and catastrophizing tendencies. Additionally, in-person patient education on possible development of postoperative pain should be considered. Effective acute postoperative pain control remains a critical factor in CPP prevention, making acute pain management with multimodal analgesia a priority. Minimally invasive surgical techniques and nerve block interventions should be used and prioritized when possible. Additionally, non-pharmacological interventions, like neuromodulation and rehabilitation, show promise in improving and managing pain outcomes.

Conclusion

Existing strategies for postoperative pain management are not effective in reducing the incidence of CPP, which is still between 5% and 60%, depending on the type of surgery. The most recommended pain management method is multimodal analgesia, which includes a combination of NSAID and paracetamol administration during the intraoperative and postoperative periods. Other pharmacological treatments, like gabapentinoids and ketamine, showed contradictory results. Some forms of non-pharmacological interventions do not have enough data; others, like physical exercise and nerve stimulation, show promising results in chronic pain management. To properly combat CPP, we need to focus on risk factors and tailor pain management strategies based on surgical and patient-related risk factors. Following up with the patients long-term after surgery and researching non-pharmacological interventions will help to create a more thorough database and protocols. As evidence on treatment options is limited, we need high-quality trials of multimodal interventions that relate to pain characteristics.

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