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REVIEW ARTICLE

The Impact of Pain on Triage Accuracy, Hospital Admission, and Length of Stay in Patients Presenting to the Emergency Department: A Systematic Review

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Abstract: **Introduction:** Acute pain serves as a modifier in five-level triage systems, such as the Canadian Triage and Acuity Scale (CTAS) and the Korean Triage and Acuity Scale (KTAS). This systematic review aimed to synthesize existing evidence on the impact of pain on triage accuracy, hospital admission, and length of stay in patients presenting to the emergency department (ED). **Methods:** A systematic search was conducted in PubMed and Google Scholar for English studies published between 2000 and 2026. Studies that reported associations between pain score, triage accuracy, hospital admission, and length of stay in patients presenting to the ED were included. Data extraction and quality assessment were performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. **Results:** Out of 484 initial records, independent screening yielded 6 original cohort studies for final inclusion. The studies encompassed a total of 247,624 patients, with moderate to high methodological quality in the qualitative synthesis. Self-reported pain scores demonstrated no predictive relationship with admission rates or ED length of stay. However, their mandatory integration into triage protocols resulted in over-triage and reduced system accuracy. Based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach, the overall certainty of evidence was determined to be moderate. **Conclusion:** Self-reported pain lacks independent predictive value for hospital admission or ED length of stay, and its mandatory integration into triage systems leads to over-triage. Rather than determining acuity priority, pain assessment should be decoupled from the primary triage decision and be linked to dedicated pain-management protocols instead.

Keywords: Pain; Triage; Emergency service, hospital; Length of stay; Systematic review

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1. Introduction

The emergency department (ED) is one of the fundamental pillars of urgent care provision within the healthcare system and plays a vital role in reducing mortality and complications from life-threatening conditions (1). The triage system in the ED is designed to prioritize patients based on the severity of their condition (2). Accurate triage decisions ensure that patients with critical needs receive treatment as promptly as possible and that the limited resources are allocated efficiently (3). Triage accuracy refers to the correspondence between the assigned acuity level and the patient's actual clinical status (4). Triage errors, including over-triage and under-triage, can lead to delay in treatment or inappropriate use of resources (3). Moreover, triage errors are associated with adverse outcomes, such as delays in attending to patients with critical conditions (5). Therefore, triage accuracy is considered a key indicator of the quality of emergency services in healthcare (6).

Pain is one of the most common chief complaints among ED visitors, accounting for 70% to 80% of all ambulatory and admitted presentations (7, 8). As an inherently subjective, multidimensional, and individualized experience, pain severity is traditionally evaluated using self-reported tools such as the Numeric Rating Scale (NRS) and has been integrated into widely adopted five-level ED triage systems (8, 9). In standardized algorithms, including the Canadian Triage and Acuity Scale (CTAS), the Korean Triage and Acuity Scale (KTAS), the Taiwan Triage and Acuity Scale (TTAS), and the Manch-

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ester Triage System (MTS), severe pain functions as a mandatory modifier, automatically upgrading the patient's triage assignment to a higher acuity level (10).

Despite the widespread adoption of pain assessment as the "fifth vital sign," the utility and efficiency of pain scores in predicting true patient acuity remain highly controversial (11, 12). Emerging evidence suggests that incorporating subjective pain scores can introduce noise and systematic error into the triage process, leading to over-triage by inappropriately elevating low-risk patients above unstable individuals without pain (11, 13, 14). Furthermore, the relationship between pain score and ED process outcomes, such as hospital admission rates and ED length of stay remains inconsistent across the literature (15, 16). While some studies suggest that higher pain scores correlate with increased admission rates or prolonged ED length of stay due to diagnostic workups and analgesic administration (10, 16, 17), other investigations report that self-reported pain scores lack independent predictive power for hospital admission or short-term mortality (14, 18).

Although numerous observational studies have investigated specific aspects of pain assessment in the ED, their findings remain fragmented due to methodological heterogeneity, varying triage tools, and inconsistent outcome definitions (13, 18). This systematic review aimed to evaluate the impact of pain on triage accuracy, hospital admission, and ED length of stay among adult patients.

2. Methods

2.1. Study design and setting

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search was conducted to identify observational studies examining the impact of pain on triage accuracy, hospital admission, and ED length of stay. The search timeframe was from January 2000 to January 15, 2026. The primary databases included PubMed and Google Scholar. Also, our search was supplemented by manual search of the reference lists of included studies to maximize study coverage. The search strategy was designed using keywords relevant to pain in combination with "emergency department" and "triage".

2.2. Search strategy

A comprehensive search was conducted in PubMed and Google Scholar in accordance with the PRISMA 2020 guidelines. The combination of keywords and MeSH terms utilized in the PubMed database was structured as follows: ((pain[tiab] OR "Pain"[Mesh] OR "Acute Pain"[Mesh] OR "Pain Management"[Mesh] OR "Pain Clinics"[Mesh] OR "Pain Measurement"[Mesh]) AND ("Length of Stay"[MeSH] OR length of stay[tw] OR triage[tw] OR "Triage" [MeSH] OR "Patient Admission"[Mesh] OR patient admission[tw]) AND ("Emergency Room Visits"[Mesh] OR "Emergency Service, Hospital"[Mesh] OR emergency department[tiab] OR emergency ward[tiab]) AND (2020/01/01:2026/12/31[dp]) AND (alladult[Filter]) NOT (review[pt])). The search query utilized in the Google Scholar database was structured as follows: (pain OR pain management) AND (length of stay OR triage OR Patient Admission) AND (emergency department).

2.3. Eligibility criteria (Inclusion / Exclusion)

In this study, all original articles (observational, cohort, cross-sectional, and analytical) published in English between 2000 and 2026 were included. The year 2000 was selected as the starting boundary to align with the global implementation of five-level triage systems (2). The study population comprised adult patients (18 years of age or older) presenting to ED with various pain-related complaints, including general medical, cardiac, gastrointestinal, musculoskeletal, traumatic, and non-traumatic presentations. The primary exposure variable was the assessment of pain score, measured via self-reported numeric or verbal rating scales or clinical evaluations, or the integration of pain scores into five-level triage systems. Eligible studies were required to report at least one of the primary outcomes, including triage accuracy (evaluating over-triage or under-triage), direct hospital admission rates, or ED length of stay.

Studies conducted in non-ED settings such as pre-hospital emergency medical services, outpatient clinics, post-discharge follow-ups, and pediatric EDs were excluded. Additionally, studies where pain was listed solely as a diagnostic category without measuring pain score were omitted. Review articles, case reports, animal studies, and clinical trials investigating only analgesic drug efficacy were also excluded from the analysis.

2.4. Data collection process (Data extraction)

Data extraction was performed systematically using a predesigned form in Microsoft Excel 2021. To ensure data accuracy, two researchers (M.M. and R.H.) independently extracted data from the included articles, and any discrepancies or disagreements were resolved through discussion to reach consensus or by consulting a third reviewer (M.S.). The information extracted from each study included: (1) general article characteristics such as first author's name, publication year, study country, and study design; demographic and clinical characteristics including total sample size, mean or median age, sex distribution, and clinical chief complaints of patients presenting to the emergency department; (2) details of the such as measurement scales, including the Numeric Rating Scale (NRS) or Visual Analog Scale (VAS), method of pain assessment, and triage algorithms used, such as CTAS, Emergency Severity Index (ESI), or MTS; (3) primary process and clinical outcomes, including triage accuracy metrics such as over-triage and under-triage, direct hospital or intensive care unit admission rates, and ED length of stay.

2.5. Data items (variables and outcome definitions)

The primary exposure variable in this study was the assessment and reporting of pain score in patients and its integration into emergency triage indicators and algorithms such as KTAS, CTAS, TTAS, and MTS. The comparison group comprised patients without pain, the non-utilization of the pain variable in triage formulation, or the receipt of routine standard care without dedicated protocols.

The primary outcomes in this study were triage accuracy and validity, hospital or intensive care unit admission rates, and ED length of stay. All extracted data were synthesized qualitatively and descriptively, as quantitative analysis or meta-analysis was not feasible due to methodological heterogeneity across study designs, pain assessment tools, and outcome reporting metrics.

2.6. Risk of bias assessment (quality appraisal)

The methodological quality and risk of bias of the included cohort studies were independently assessed by two reviewers using the standard Newcastle-Ottawa Scale (NOS). This tool evaluates the quality of cohort studies across three major domains, including selection of study groups (representativeness of the cohort, selection of the non-exposed group, and demonstration that the outcome of interest was not present at the start of the study), comparability (comparability of cohorts based on the design or analysis to control for confounding variables), and outcome assessment (assessment of outcomes, adequacy of follow-up length, and completeness of follow-up). Based on the scoring system of this tool, methodological quality was determined, and all extracted data along with methodological quality scores were compiled into a study characteristics summary table for data synthesis and analysis. Based on their total NOS scores, included studies were categorized as high quality (7 to 9 stars), moderate quality (4 to 6 stars), and low quality (0 to 3 stars).

2.7. Certainty of evidence (GRADE)

The certainty and confidence in the evidence were evaluated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. In this framework, the certainty of evidence for primary outcomes is categorized into four levels: high, moderate, low, and very low. Because all included articles were cohort studies, the initial certainty of the evidence was categorized as low according to GRADE criteria. The evidence was then evaluated across five key domains: risk of bias, inconsistency, indirectness, imprecision, and publication bias. Assessments and conclusions regarding the certainty of the evidence were synthesized descriptively.

2.8. Sensitivity and subgroup analyses

Due to the absence of a meta-analysis, subgroup and sensitivity analyses were conducted descriptively based on qualitative data extracted from the included studies. Subgroup analysis was performed according to variables such as clinical chief complaint categories, comparing outcomes across conditions including acute abdominal pain, low back pain, headache, and chest pain, and pain assessment methods, contrasting patient self-reported pain intensity scales such as NRS and Verbal Rating Scale (VRS) with objective physician evaluations or nursing protocols. Furthermore, to conduct a descriptive sensitivity analysis, the methodological quality of the studies was considered. However, since none of the six included studies were categorized as low quality (five were of high quality and one was of moderate quality), no studies were excluded based on quality assessment, ensuring that all articles remained in the final data synthesis to prevent introducing bias into the overall findings.

3. Results

In the initial phase of the comprehensive database search, a total of 484 primary records were identified. After importing all data into reference management software, 9 duplicate records and 77 ineligible articles recognized by automation tools were removed. Therefore, 405 unique articles proceeded to the initial screening phase based on title and abstract. In the initial screening process, 399 articles were excluded due to lack of relevance to the study objectives, and 9 articles were retrieved for full-text evaluation. Following a thorough review of the full text, 3 articles were excluded for methodological reasons, including failure to evaluate pain as the primary exposure variable or failure to report the outcomes of interest. Ultimately, 6 original studies met all inclusion criteria and were included in the final qualitative synthesis (Figure 1).

3.1. General characteristics of included studies

In this systematic review, 6 original studies (10,11,13,15-17) comprising a total of 247,624 adult patients presenting to ED were evaluated and qualitatively synthesized, and their characteristics are described in Table 1. The design of all included studies was prospective or retrospective cohort, and most were conducted in a single academic ED. The sample size of the studies ranged widely from 100 patients in the study by Muntlin Athlin et al. (17) to 229,744 patients in the study by Davis et al. (13). In terms of geographical distribution, the studies were conducted in Canada (13,15), South Korea (11), Taiwan (10), Brazil (16), and Sweden (17). The mean or median age of patients across different studies ranged from 39 years in the study by Muntlin Athlin et al. (17) to 56.9 years in the study by Santos et al. (16), and the proportion of women among participants was reported from 49.7% in the study by Ku et al. (10) to 56.9% in the study by Santos et al. (16). Presenting clinical chief complaints included general medical emergency visits, acute abdominal pain, low back pain, and acute traumatic or non-traumatic pain. Regarding methodological quality, based on the Newcastle-Ottawa Scale (NOS), 5 studies were rated as high quality and 1 study as moderate quality, and no study had a high risk of bias (Table 2).

3.2. Primary outcomes

3.2.1 Pain score and hospital admission

Evaluation of hospital admission outcomes across the included studies demonstrated that patients' self-reported pain scores were not an independent predictor of hospital admission (10,13,15). In the study by Kawchuk et al. (15), pain score showed no statistically significant association with hospital admission rates ($p = 0.213$). Furthermore, Ku et al. (10) found that system-based, self-reported pain assessment (NRS) lacked correlation with hospital admission, whereas physician-assessed pain scores were directly associated with an increased likelihood of admission. Additionally, Davis et al. (13) demonstrated that patient-reported pain scores had a very weak and even negative correlation with hospital admission ($r = -0.008$), and removing the pain variable from the CTAS triage algorithm improved the system's predictive power for hospital admission (area under the curve (AUROC): 0.691 vs. 0.641), intensive care unit (ICU) consultation (AUROC: 0.829 vs. 0.773), and 72-hour mortality (AUROC: 0.863 vs. 0.810) (13).

3.2.2 Pain score and triage accuracy

Evaluation of the accuracy and validity of triage systems indicates that direct integration of subjective pain scores as a mandatory modifier leads to over-triage and reduces the accuracy of 5-level triage systems (10,11,13). The study by Lee et al. (11) demonstrated that incorporating pain as a modifier in the KTAS system resulted in overestimation of patients' clinical priority, and the predictive accuracy of triage was significantly higher in patients without pain (AUROC: 0.771 vs. 0.686). In line with this finding, Davis et al. (13) reported that removing the pain variable from the triage algorithm reallocated 39% of patients to lower acuity levels without compromising the accuracy of predicting clinical outcomes. Furthermore, Ku et al. (10) found that self-reported pain weakens the predictive power of triage, whereas objective pain assessment by a physician improves triage's predictive capability (AUROC: 0.650 vs. 0.636). Additionally, Muntlin Athlin et al. (17) showed that triage priority (assigned based on the Manchester Triage System) differed significantly between patients requiring analgesic administration and other individuals ($p = 0.008$).

3.2.3 Pain score and ED length of stay

Regarding the association between pain severity and patient ED length of stay, findings indicate the absence of a direct relationship between self-reported pain scores and ED length of stay (10,15,16). The study by Kawchuk et al. (15) reported that the median ED length of stay was 13.6 hours for admitted patients and 5.4 hours for discharged patients, but pain score played no predictive role in this duration. Ku et al. (10) demonstrated that patient self-reported pain had no association with ED length of stay or emergency department costs, whereas physician-assessed pain scores were significantly associated with increased ED length of stay ($p < 0.0001$). Additionally, Santos et al. (16) found that implementing a nurse-led pain management protocol, despite producing statistically significant pain relief in patients ($p = 0.02$), resulted in no significant change in overall ED length of stay ($p = 0.17$).

3.3. Sensitivity analysis / robustness of findings

Due to the absence of a meta-analysis, sensitivity analysis was performed descriptively based on the qualitative assessment of the included studies. The evaluations demonstrated that all patterns and findings regarding the association of pain score with the three primary outcomes (triage accuracy, admission rates, and ED length of stay) remained entirely robust and consistent, even after evaluating studies separately based on study design (prospective vs. retrospective) and methodological quality. Furthermore, because none of the six included studies were categorized as low quality (five were of high quality and one was of moderate quality), no studies were excluded based on quality assessment, and all articles were retained in the final synthesis.

3.4. Heterogeneity and Generalizability

Evaluation of heterogeneity among the included studies revealed that despite differences in triage systems, target populations, and pain assessment tools, overall findings regarding the lack of a direct association between self-reported pain scores and admission rates or ED length of stay, as well as the role of pain in causing over-triage, were entirely consistent and uniform. Included studies comprised adult populations across various age ranges (median or mean age 39 to 56.9 years) and diverse clinical conditions (including acute abdominal pain, low back pain, and general emergency visits). Nevertheless, all were observational cohort designs conducted primarily in an academic or secondary facility, which may impose limitations on absolute generalizability.

However, the remarkable consistency of the findings in the descriptive analysis and the similarity of results across different countries with diverse healthcare structures (including Canada, South Korea, Taiwan, Brazil, and Sweden) indicate an acceptable level of generalizability to EDs in various settings. Existing methodological heterogeneities were primarily attributable to differences in triage algorithms (such as CTAS, KTAS, and MTS), pain score measurement methods (comparing patient self-reported tools with objective or video-based physician evaluations), and sample size variations (ranging from 100 to 229,744 patients), which should be taken into consideration when interpreting and clinically applying these findings.

3.5. Quality of evidence assessment (GRADE) / descriptive

The certainty and confidence in the evidence derived from this systematic review were evaluated using the GRADE approach. Because all 6 included articles were cohort studies, the initial assessment of evidence for all three primary outcomes (triage accuracy, hospital admission rate, and ED length of stay) began at the "low" level. However, due to the high methodological quality of the studies (high scores on the

NOS), the exceptionally large patient sample size, and the remarkable consistency and stability of findings across different centers and countries, the final certainty level of the evidence for the primary outcomes was established and maintained at the moderate level.

4. Discussion

This systematic review was conducted with the aim of synthesizing and analyzing the available evidence regarding the impact of pain score on primary outcomes in patients presenting to the ED, including triage accuracy, hospital admission rate, and ED length of stay. The main findings of the present study demonstrate that integrating self-reported pain scores as a mandatory modifier in 5-level triage systems not only lacks independent predictive value for acute clinical outcomes, but also leads to over-triage and reduces the overall accuracy of the triage system. One of the most significant findings of this study is indicating the role of self-reported pain scores in undermining the predictive accuracy of standard triage algorithms (such as CTAS and KTAS). In current triage systems, pain reports automatically escalate the patient's triage priority to higher levels (levels 2 or 3) (11,13). However, findings by Davis et al. (13) demonstrated that removing the pain variable from the CTAS system resulted in transferring 39% of patients to lower acuity levels without causing any decline or error in identifying critically ill patients, ICU admission rate, or 72-hour mortality. In line with this result, Lee et al. (11) showed that incorporating pain as a modifier in the KTAS system leads to an overestimation of the clinical urgency level, and triage accuracy is significantly higher in patients without pain (AUROC: 0.771 vs. 0.686). This evidence confirms that pain scores alone cannot reflect the patient's physiological acuity, and sole reliance on them causes inappropriate allocation of emergency resources to low-risk patients experiencing severe pain (11,13).

Contrary to traditional perceptions in emergency care that link severe pain with a higher probability of hospital admission, findings from the comprehensive analysis of the included studies demonstrated that patients' self-reported pain scores were not an independent predictor of hospital admission or intensive care unit admission (10,13,15). The study by Davis et al. (13) showed that the correlation between a patient's initial pain score and the probability of hospital admission was close to zero and even negative ($r = -0.008$). Furthermore, Kawchuk et al. (15), in evaluating patients with acute low back pain, found that pain score upon arrival showed no statistically significant association with the decision to admit to the hospital ($p = 0.213$). The primary reason for this is that the decision to admit a patient is largely driven by physiological indicators, laboratory results, imaging, and underlying comorbidities, whereas pain is a multidimensional and subjective experience that can present with high intensity even in completely benign and outpatient disorders (13,15).

Regarding ED length of stay, the results of this review showed that there was no direct and significant relationship between the patient's self-reported pain score (system-based NRS) and the length of stay in the emergency department (10,15,16). However, a very important methodological distinction was revealed in the study by Ku et al. (10): while the patient's self-reported pain score had no association with ED length of stay, the physician-rated pain score was significantly associated with an increased ED length of stay ($p < 0.0001$) and higher triage accuracy (AUROC: 0.650). This indicates that objective, specialized, and clinical evaluation of pain by the treatment staff, compared to mere numerical scoring by the patient, possesses a much higher predictive validity for the need for complex diagnostic-therapeutic interventions and, consequently, a longer length of stay (10). Furthermore, the study by Santos et al. (16) demonstrated that although the implementation of pain relief protocols led to a significant reduction in patients' pain intensity ($p = 0.02$), it did not necessarily alter the discharge process or the overall ED length of stay ($p = 0.17$).

The cumulative evidence from this systematic review underscores the necessity for a fundamental revision of how the pain variable is integrated into emergency triage systems (10,11,13). Based on these findings, it is recommended that the self-reported pain score be removed as a "mandatory and automatic modifier" in triage algorithms. This variable should serve solely as a qualitative indicator to initiate rapid pain management and patient relief, rather than a tool to determine acuity levels and clinical prioritization. Furthermore, triage system designers are advised to link pain assessment directly to independent analgesic therapy protocols, thereby achieving rapid patient relief while preventing bias and over-triage (16,17).

5. Strengths and limitations

This study possesses several strengths that reinforce the scientific validity of its findings, including the utilization of a very large study population, totaling 247,624 patients, which confers high statistical power to the analyses. Furthermore, strict adherence to the PRISMA 2020 methodological framework, quality assessment of studies using NOS, evaluation of the certainty of evidence based on the GRADE approach, and the inclusion of studies from diverse geographical regions with various triage systems (including CTAS, KTAS, and MTS) have enhanced the generalizability of the results. However, the present research was also subject to certain limitations. First, the protocol of the study was not registered in PROSPERO. Also, in our study, database search was incomplete and restricted to PubMed and Google Scholar because of limited access to other databases (Web of Science, Scopus, ...). All included articles had an observational cohort design, the nature of which merely demonstrates correlation and lacks the capacity to establish causal relationships. Additionally, due to heterogeneity in outcome reporting tools and variable definitions, conducting a quantitative analysis or meta-analysis was not feasible. Finally, the execution of

most studies in single academic facilities may, to some extent, limit the scope of absolute generalizability of the findings to other healthcare settings.

6. Conclusions

Patient self-reported pain, although a vital variable for the timely initiation of palliative interventions and adherence to ethical and humanitarian care principles in the ED, possesses no independent predictive value for acute clinical outcomes such as hospital admission, intensive care unit admission, and ED length of stay. The direct and mandatory integration of pain scores into standard 5-level triage algorithms leads to the phenomenon of over-triage and the inefficient allocation of ED resources. Accordingly, triage system designers and healthcare policymakers are advised to decouple the pain variable from acuity priority determination criteria and directly link pain assessment to "independent rapid relief and pain management protocols," while patients' clinical prioritization should remain grounded in comprehensive evaluations, physiological indicators, and the objective judgment of healthcare staff.

7. Declarations

7.1. Acknowledgments

The authors have no acknowledgments to declare.

7.2. Conflict of Interest and Funding

The authors declare that they have no conflicts of interest, and this study received no financial support.

7.3. Authors contributions

All authors contributed to study design, data collection, and writing the draft of the study. All authors read and approved final version of the manuscript.

7.4. Data availability

Not applicable

7.5. Funding and supports

None

7.6. Using artificial intelligence chatbots

None

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Table 1: Baseline characteristics of included studies (continued)

Feature	Lee 2019	Kawchuk et al., 2022	Ku et al., 2023	Santos et al., 2021	Davis et al., 2022	Muntlin Athlin et al., 2015
Country	South Korea	Canada	Taiwan	Brazil	Canada	Sweden
Study Design	Retrospective cohort	Prospective observational, monocentric study	Prospective observational cohort study	Prospective cohort study	Retrospective observational cohort study	Descriptive and comparative cohort study
Sample Size	N = 16,716 (Pain group: n = 8,919 / non-pain group: n = 7,797)	N = 209 participants enrolled (from 812 screened patients with low back pain)	N = 656 (Pain group: n = 370 / Pain-free group: n = 286)	N = 185 (Intervention group: n = 55 / Comparison group: n = 130)	N = 229,744 (Pain reported: n = 137,722 / Pain not reported: n = 92,022)	N = 100 (Assessed as in need of analgesics: n = 62 / Assessed as NOT in need: n = 32 / Missing data: n = 15)
Age & Gender	Median age: 50 years (IQR: 32–66) / Female: 53.1% / Complaints: General ED presentation (Gastrointestinal, Musculoskeletal, Neurological)	Median age: 49 years (IQR: 35–66) / Female: 49.8% (Male: 50.2%) / Complaints: Acute low back pain	Mean age: 52.3 years (SD: 18.6) / Female: 49.7% (Male: 50.3%) / Complaints: General adult ED presentations	Age: 56.9% aged 30–50 years (43.1% aged 30–40) / Female: 56.9% / Complaints: General ED presentation with semi-urgent acute pain	Mean age: 51.9 years (SD: 21.3) / Female: 55.8% / Complaints: General adult ED presentations (Abdominal, Chest pain, Back pain, Headache)	Median age: 39 years (range: 18–85) / Female: 53.0% / Complaints: Acute abdominal pain
Exposure	Pain as KTAS modifier	Pain intensity/severity (median: 8/10 on Verbal Rating Scale) and patient-reported motivations/reasons for visiting the ED	Pain assessment methods: System-based (Self-reported NRS: 0–10) vs. Physician-based (Objective video-rated pain score)	Implementation of a nurse-initiated pain management protocol based on pain severity	Standard CTAS score including 10-point patient-reported pain scale	Initial nursing pain intensity rating (NRS: 0–10) at triage
Comparison	KTAS without pain modifier	Discharged patients (n = 186) vs. Admitted patients (n = 23)	Pain group vs. Pain-free group within both system-based and physician-based approaches	Conventional care (waiting for physician evaluation before receiving analgesics)	Modified "pain-free" CTAS score (pain score removed from the triage algorithm)	Patients receiving analgesics (n = 53) vs. patients NOT receiving analgesics (n = 32)
Primary Outcome	KTAS predictive accuracy/validity for patient urgency and clinical outcomes	Reasons/motivations for ED visit and factors associated with hospital admission	Hospital admission	EDLOS and pain relief (change in pain score)	Predictability of hospital admission, ICU consultation, and 72-hour mortality	Predictors for receiving analgesics in the ED
Secondary Outcomes	ED stay, acute area, procedures, hospitalization, ICU, 7-day mortality	EDLOS, time to Physician Initial Assessment, consultations, investigations, and patient expectations	EDLOS and total ED charges	Waiting time for medical care, observation duration, analgesic consumption	Triage score category distribution shift	Initial nursing assessment characteristics, triage level (Manchester Triage Scale), ED length of stay

Table 1: Baseline characteristics of included studies

Feature	Lee 2019	Kawchuk et al., 2022	Ku et al., 2023	Santos et al., 2021	Davis et al., 2022	Muntlin Athlin et al., 2015
Key Findings	Over-triage with pain; non-pain group more accurate	Pain control was main reason for visit (64.6%). Pain severity did not predict hospital admission ($p = 0.213$). Age (OR = 1.05) and ambulance arrival (OR = 4.95) predicted admission. Admission rate: 9.6%; Median EDLOS: 13.6 h (Admitted) vs. 5.4 h (Discharged).	Self-reported pain showed no association with EDLOS or ED charges, and attenuated triage predictive power for admission (AUROC: 0.615 vs. 0.637). Physician-rated pain was positively associated with longer EDLOS ($p < 0.0001$), increased ED charges ($p = 0.002$), and improved triage predictive accuracy for admission (AUROC: 0.650 vs. 0.636).	Significant pain reduction was higher in the intervention group (2.9 vs. 1.8; $p = 0.02$). No significant difference in total EDLOS between groups (212.6 min vs. 199.2 min; $p = 0.17$).	Removing pain from CTAS shifted 39% of patients to lower acuity levels without reducing predictive validity. Pain-free CTAS had higher AUCs for predicting hospital admission (0.691 vs. 0.641), ICU consultation (0.829 vs. 0.773), and 72-hour mortality (0.863 vs. 0.810). Patient-reported pain score was slightly negatively correlated with hospital admission ($r = -0.008$).	Pain intensity at initial nurse assessment predicted receiving analgesics ($p < 0.001$, OR = 0.116). Higher initial pain scores occurred in patients receiving analgesics (median NRS: 7 vs. 5, $p < 0.001$). Triage priority differed significantly between groups ($p = 0.008$). Most who did not receive analgesics refused them by personal choice (81%).
Notes	Large tertiary ED; retrospective; pain subjective	Single-center tertiary ED; excluded CTAS 1–2 (high acuity).	Single-center tertiary hospital ED; unique methodology using video-recorded triage sessions reviewed by 5 physicians.	Single-center private tertiary hospital ED; study was underpowered to detect differences in EDLOS; triage accuracy was NOT evaluated.	Single-center tertiary hospital ED; large cohort evaluating standardized electronic CTAS implementation	Single-center university hospital ED; evaluated adult ED patients presenting with acute abdominal pain
Certainty of Evidence (GRADE)	Moderate (Downgraded due to observational retrospective design)	Moderate (Downgraded due to observational design & small sample size)	Moderate (Downgraded due to observational prospective design)	Low (Downgraded due to observational design, selection bias & sample size)	Moderate (Downgraded due to observational retrospective design)	Low (Downgraded due to observational design, secondary analysis & small sample size)

IQR: interquartile range; ED: emergency department; SD: standard devoation; KTAS: Korean Triage and Acuity Scale; NRS: Numeric Rating Scale; CTAS: Canadian Triage and Acuity Scale; ICU: Intensive Care Unit; EDLOS: ED Length of Stay; OR: Odds Ratio; AUROC: Area Under the Receiver Operating Characteristic Curve; min: minutes

Table 2: Quality assessment of included studies

Author & Year	Selection (Max 4)	Comparability (Max 2)	Comparability (Max 3)	Total Score (Max 9)	Quality Rating
Lee JH et al., 2019	4	2	3	8	High
Kawchuk et al., 2022	4	1	3	8	High
Ku et al., 2023	4	2	3	9	High
Santos et al., 2021	3	1	2	6	Moderate
Davis et al., 2022	4	2	3	9	High
Muntlin Athlin et al., 2015	3	1	3	7	High

Note: Quality assessment was performed using the Newcastle-Ottawa Scale (NOS) for cohort studies. Total scores range from 0 to 9 stars: 7–9 stars indicate High Quality, 4–6 stars indicate Moderate Quality, and 0–3 stars indicate Low Quality.

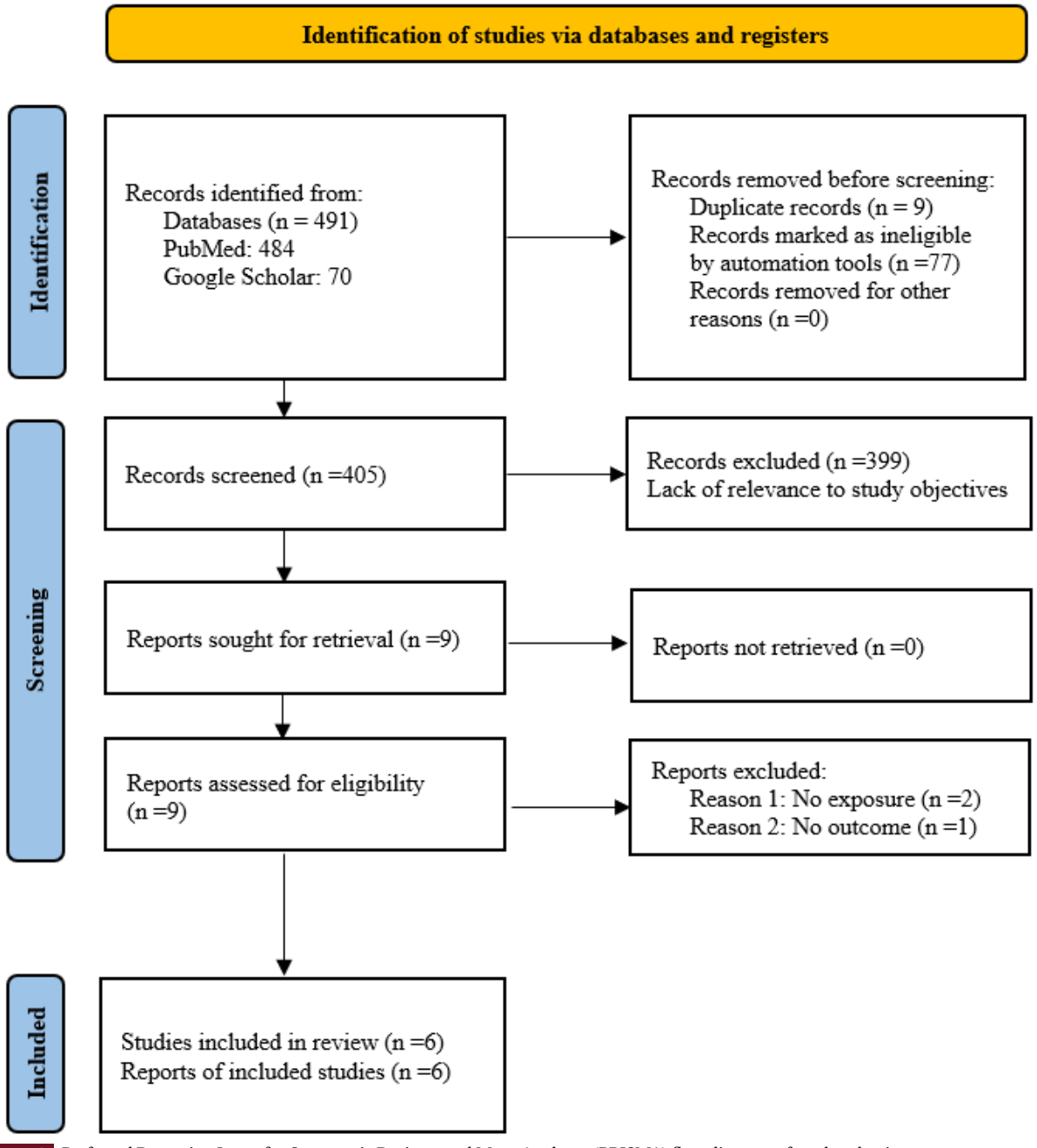

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of study selection.