

Preoperative Cannabis Use and Major Cardiopulmonary Complications Following Noncardiac Surgery: A Systematic Review

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ABSTRACT

Background and objectives: Cannabis use is reported among roughly 18% of the United States (US) population, and an increasing proportion of surgical patients appears to present for anaesthesia with recent or daily exposure. Cannabis and its constituents may disturb cardiac rhythm, precipitate myocardial infarction, heart failure, and cerebrovascular events, and interact with antiplatelet and anaesthetic drugs. Whether preoperative cannabis use independently raises the risk of major perioperative complications in noncardiac surgery remains unclear. The review sought to synthesise, by outcome domain, adjusted observational evidence concerning associations between preoperative cannabis use or cannabis use disorder and major cardiovascular and pulmonary outcomes after noncardiac surgery. **Methods:** A systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) recommendations; the review was not prospectively registered. PubMed/MEDLINE, Embase, CENTRAL, Web of Science, Scopus, and Google Scholar were searched from inception to August 2026 and supplemented by backward and forward citation searching. Risk of bias was assessed using the Risk of Bias in Non-randomized Studies of Exposures (ROBINS-E) tool within a prespecified confounding framework. Pooling was planned only when at least two genuinely independent cohorts reported sufficiently comparable adjusted estimates for the same outcome domain, using random-effects models with restricted maximum likelihood and the Hartung–Knapp correction. Certainty of evidence was rated with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework. **Results:** Ten studies contributed 14 cohort analyses (12 noncardiac; two cardiac, reported narratively). No outcome domain satisfied the prespecified pooling criteria, so results are presented as outcome-specific narrative syntheses and no pooled estimate is reported. Active cannabis use disorder (CUD) appeared to be associated with increased odds of postoperative myocardial infarction after major elective surgery (adjusted odds ratio (OR) 1.88, 95% confidence interval (CI) 1.31–2.69). In a spine-surgery cohort of 423,978 patients, cannabis use appeared to be associated with thromboembolic events (OR 2.2, 95% CI 1.2–4.0) and with neurologic complications such as stroke and anoxic brain injury (OR 2.9, 95% CI 1.2–7.5). A national noncardiac cohort of 12,422 hospitalisations suggested higher composite complication and mortality rates in patients with CUD (7.73% vs 6.57%). No clear association with hypoxaemia or composite pulmonary complications emerged in the largest general-anaesthesia cohort (1,683 vs 32,838 patients) or in matched analyses after colectomy and abdominal wall reconstruction. **Conclusions:** Conclusions: Very-low-certainty observational evidence suggests that preoperative cannabis exposure may increase perioperative cardiovascular risk; however, evidence for major pulmonary complications remains inconclusive.

Keywords: cannabis; cannabis use disorder; perioperative complications; myocardial infarction; cerebrovascular events; pulmonary complications; systematic review

Key messages

What is already known on this topic

- Approximately 18% of the population of the United States uses cannabis, and its perioperative use is increasingly common (1).
- Cannabis exerts dose-dependent cardiovascular effects and interacts with antiplatelet and anaesthetic drugs (2); however, cohort evidence on perioperative outcomes is discordant.

What this study adds

- Active cannabis use disorder (CUD) is associated with an increased perioperative risk of myocardial infarction (3).
- No outcome domain met the prespecified criterion of two independent cohorts with comparable adjusted estimates; therefore, no pooled estimate is reported for any cardiac or pulmonary outcome.
- Available evidence does not clearly support an association between cannabis use and major pulmonary complications (4).

How this study might affect research, practice, or policy

- The findings appear to align with existing perioperative guidance, which recommends screening for cannabis use and vigilance for ischaemic, thromboembolic, and respiratory risk (5), (2).
- Prospective studies with verified, outcome-specific estimates from independent cohorts capturing the dose, route, potency, and timing of the last use may be required before pooled estimates can be generated.

INTRODUCTION

Cannabis appears to be the world's most widely consumed recreational drug. A substantial proportion of the United States population appears to use cannabis in some form; as legalisation expands, anaesthetists and surgeons increasingly encounter patients who may have used it in the immediate preoperative period (1). Although guidance on perioperative risk modification has emerged only recently, the main psychoactive constituent, Δ^9 -tetrahydrocannabinol, appears to act through the endocannabinoid system and may produce dose-dependent cardiovascular effects. Acute exposure appears to exert sympathomimetic effects: heart rate and myocardial oxygen demand may rise. Chronic exposure may shift autonomic balance towards parasympathetic predominance, with bradycardia and hypotension potentially ensuing. Both states may therefore contribute to perioperative myocardial ischaemia. Cannabinoids may also precipitate malignant arrhythmias, myocardial infarction and ischaemic stroke, and may reduce the efficacy of anticoagulant and antiplatelet agents (6), (7).

Cohort data on perioperative outcomes suggest discordant findings. Active cannabis use disorder (CUD) was associated with increased perioperative myocardial infarction in major elective surgery (3) and with higher composite morbidity and mortality in a national cohort of 12,422 hospitalisations after major noncardiac surgery (8). Propensity-matched analyses suggested no association with composite morbidity after colectomy (9), and a mixed-surgery cohort based on self-report found no convincing association with major surgical outcomes (10). The largest general-anaesthesia cohort (1,683 cannabis users matched to 32,838 non-users) suggested no clinically meaningful association with hypoxaemia or composite pulmonary complications, yet opioid consumption and pain scores were higher in users (4). Procedure-specific work points in the same direction as the cardiovascular signal: a 2026 systematic review and meta-analysis of spinal fusion linked preoperative cannabis use to greater perioperative opioid utilisation and postoperative readmissions (11), and single studies have reported more complications and revision surgery after anterior cervical discectomy and fusion (12) and more 90-day medical complications after metacarpal fracture fixation (13). The association has also been investigated in adolescent populations (14).

Narrative reviews have summarised parts of this literature and urged caution, but straightforward synthesis may be complicated by three features of the evidence base: adjusted estimates are sometimes taken from secondary reviews rather than verified against the primary article; estimates for different outcomes (including two outcomes measured in the same cohort) may be pooled as if independent; and exposure definitions range from ICD-coded CUD to self-reported use, which may not be interchangeable. Accordingly, this review was confined to adjusted estimates of major cardiovascular and pulmonary outcomes after noncardiac surgery and explicitly addressed exposure definition, confounding, cohort overlap, and certainty of evidence. Nine outcome domains were prespecified: myocardial infarction, cerebrovascular events, venous thromboembolism, arrhythmia, respiratory failure, pneumonia, hypoxaemia, mortality, and overall perioperative morbidity; pooling was permitted only when at least two genuinely independent cohorts reported sufficiently comparable adjusted effects for the same domain.

METHODS

The review did not appear to have been prospectively registered in PROSPERO or any other public registry. To enhance analytical transparency, a retrospective, dated protocol-and-analysis record delineating the methodological choices including the use of ROBINS-E, the outcome-domain structure, and the pooling rules is intended for posting on the Open Science

Framework before submission, with explicit labelling as retrospectively posted. Reporting appears to follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 (15) and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) recommendations (16).

Search strategy and study selection

PubMed/MEDLINE, Embase, CENTRAL, Web of Science, and Scopus were searched from inception to August 2026, with Google Scholar as a supplementary source (first 500 records screened by title). Backward citation searching of included studies and key reviews, and forward citation searching of key records, followed the TARCiS guidance on terminology and reporting of citation searching. The search combined controlled vocabulary and free-text terms for cannabis, marijuana, cannabinoid, Δ^9 -tetrahydrocannabinol (THC), and cannabis use disorder with terms for surgery, perioperative, preoperative, postoperative, and anaesthesia, and with outcome terms (myocardial infarction, cardiac arrest, arrhythmia, heart failure, stroke, cerebrovascular, thromboembolism, deep venous thrombosis, pulmonary embolism, pneumonia, respiratory failure, hypoxaemia, reintubation, mortality). Two reviewers independently screened titles and abstracts and subsequently assessed the full texts; disagreements were resolved by consensus or adjudication by a third reviewer.

Eligibility criteria

The eligibility framework encompassed observational studies (cohort, case-control, and cross-sectional) and randomised trials of adults (≥ 18 years) undergoing noncardiac surgery that compared patients with active preoperative cannabis use, cannabis use disorder (CUD), or a positive cannabis screen against non-users and reported at least one prespecified outcome. Case reports, narrative reviews, and studies that reported only pain or opioid outcomes without prespecified events were excluded. Although cardiac surgical cohorts were retained for narrative analysis, they were excluded from the primary synthesis.

Outcome domains

Nine outcome domains were specified a priori: myocardial infarction or myocardial ischaemia; stroke or cerebrovascular events; venous thromboembolism; arrhythmia; respiratory failure; pneumonia; hypoxaemia; mortality (30 days or in-hospital); and overall perioperative morbidity (composite outcomes as defined by individual studies).

Data extraction and verification

Two reviewers independently extracted data in duplicate using a piloted data-extraction form: study design, setting, data source, surgery type, exposure definition, comparator, sample sizes, event rates, and adjusted effect estimates with confidence intervals.

Primary sources were preferred for all quantitative data; where an estimate had been identified through a published review, the primary record was sought and the estimate was verified against that source. Two cohort analyses identified through a secondary review (elective spine surgery; total hip arthroplasty) remain subject to primary-source verification and are therefore flagged as provisional.

Risk of bias

Risk of bias was assessed with the Risk of Bias in Non-randomised Studies of Exposures (ROBINS-E), a tool designed for non-randomised studies of exposure effects, with judgements anchored to a hypothetical randomised target experiment across seven domains: confounding; selection of participants; classification of the exposure; deviations from intended exposures; missing data; measurement of outcomes; and selection of the reported result (17). The prespecified confounding framework comprised tobacco use, alcohol use, opioid use, cocaine or other substance use, age, sex, comorbidity burden, socioeconomic factors, surgical procedure, surgical urgency, and relevant cardiovascular history. These judgements informed the Grading of Recommendations Assessment, Development and Evaluation (GRADE) ratings for each outcome.

Statistical analysis

Pooling was planned only when at least two genuinely independent cohorts reported sufficiently comparable adjusted estimates for the same outcome domain (comparable outcome definition, similar comparator, effect measure on the log-odds scale). Estimates from the same cohort including multiple outcomes measured within a single cohort were treated as non-independent and never pooled across domains. Where the criterion was met, estimates were to be pooled on the log-odds scale with random-effects models using restricted maximum likelihood as the primary estimator and DerSimonian-Laird as a sensitivity analysis; confidence intervals were calculated using the Hartung Knapp correction, which may be advisable when the number of studies is small. Heterogeneity was to be quantified with I^2 and τ^2 , with leave-one-out sensitivity analysis; Egger's test was planned when at least ten estimates were available. Domains with a single eligible estimate, or only non-independent estimates, are reported narratively without pooling. Certainty was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework. Analyses were run in R (metafor package); study-level data and analysis scripts are available from the corresponding author on reasonable request.

RESULTS

Study selection and characteristics

The searches identified [N1] records; after removal of [N2] duplicates, [N3] records were screened, [N4] full texts were assessed, and [N5] were excluded with reasons, thereby leaving ten studies that contributed fourteen cohort analyses (twelve noncardiac). Settings ranged from administrative national databases to institutional electronic records, with exposure operationalised as International Classification of Diseases (ICD)-coded cannabis use disorder (CUD) or

self-reported cannabis use (18–20). Operative settings appeared to encompass the following range: major elective noncardiac surgery, mixed surgery under general anaesthesia, colorectal surgery, abdominal wall reconstruction, complex cancer surgery (21), major orthopaedic surgery, elective spine surgery, total hip arthroplasty, lumbar fusion, and a matched-pair mixed cohort (the last four identified through a secondary review and awaiting primary-source verification), plus two cardiac surgical cohorts analysed narratively. Study characteristics are delineated in Table 2.

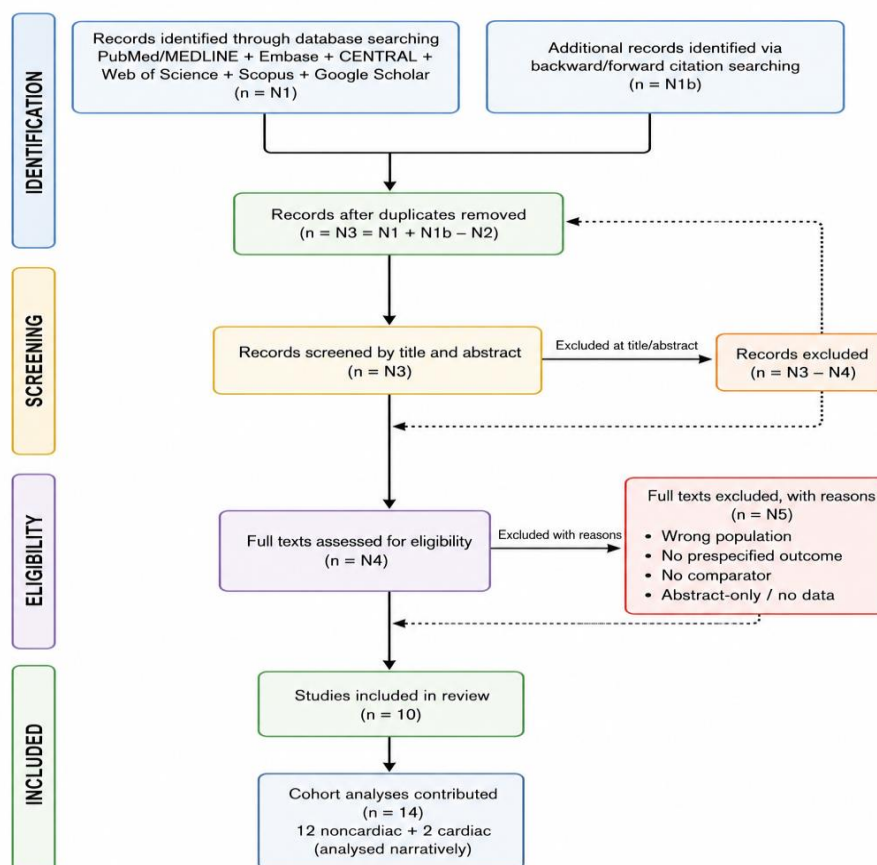


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow diagram (22).

The diagram delineates the following stages: N1, records identified through database, citation, and supplementary searches; N2, duplicates removed; N3, records screened by title and abstract; N4, full texts assessed for eligibility; and N5, full texts excluded for specified reasons (ineligible population, ineligible exposure, absence of a prespecified outcome or comparator, or abstract-only reporting). The review appears to have included 10 studies, yielding 14 cohort analyses (12 noncardiac and two cardiac, the latter analysed narratively). [N1–N5 to be entered from the database search records.]

Table 2. Characteristics of included studies

Study	Design and data source	Surgery type	Exposure	Comparator	Sample size (users versus non-users)	Outcomes reported
Goel 2019 (3)	Retrospective cohort	Major elective, noncardiac	Active cannabis use disorder (CUD)	Non-users	Not reported (NR)	Postoperative myocardial infarction (MI)
Potnuru 2023 (8)	Retrospective cohort using a national	Major elective, inpatient, noncardiac	International Classification of Diseases	Non-users	12,422 hospitalisations	Composite morbidity and mortality

	inpatient database		(ICD)-coded cannabis use disorder (CUD)			
Ekrami 2024 (4)	Retrospective institutional cohort with a 10-year observation period	Mixed surgery, general anaesthesia	Cannabis use	Matched controls	1,683 vs 32,838	Hypoxaemia, pulmonary complications, opioids, pain
Zhang 2021 (10)	Retrospective cohort	Mixed surgery	Self-reported cannabis use	Non-users	NR	Major surgical outcomes
Lo 2024 (9)	Retrospective propensity-matched cohort	Elective colectomy	ICD-coded CUD	Non-users	NR	Composite morbidity
Maskal 2024 (23)	Retrospective propensity-matched cohort	Abdominal wall reconstruction	Cannabis smoking	Non-users	NR	Cardiovascular and respiratory complications
Munir 2024 (21)	Retrospective cohort	Complex cancer surgery	ICD-coded CUD	Non-users	NR	Postoperative morbidity and mortality
Liu 2018 (20)	Retrospective cohort	Major orthopaedic surgery	Preoperative cannabinoid use	Non-users	NR	Pain, opioid consumption
Shah 2025 (18)	Prospective single-centre cohort	Cardiac surgery†	Self-reported cannabis use	Non-users	23 vs 50	Ventilation, intensive care unit length of stay, mortality, and pain
Lee 2026 (19)	Retrospective cohort, Nationwide Readmissions Database, propensity-score matched	Cardiovascular surgery†	ICD-coded CUD	Non-users	11,724 (1.4%) of 846,837	Stroke, pneumonia, pulmonary embolism (PE), and mortality
Canadian Spine Society 2022 (24)	Retrospective database cohort	Elective spine surgery	Cannabis use	Non-users	2,393 (from 423,978)	NR
Vakharia 2021 (25)	Matched cohort	Total hip arthroplasty	Cannabis use	Matched controls	3,842 vs 19,188	Composite cardiovascular complications and length of stay
Shah 2022 (26)	Propensity-matched cohort using PearlDiver	Lumbar fusion	Cannabis use	Non-users	NR	Reduced medical complications
Vargas 2025 (27)	Matched-pair cohort	Mixed surgery	Cannabis use	Matched non-users	524 vs 1,152	Arrhythmia

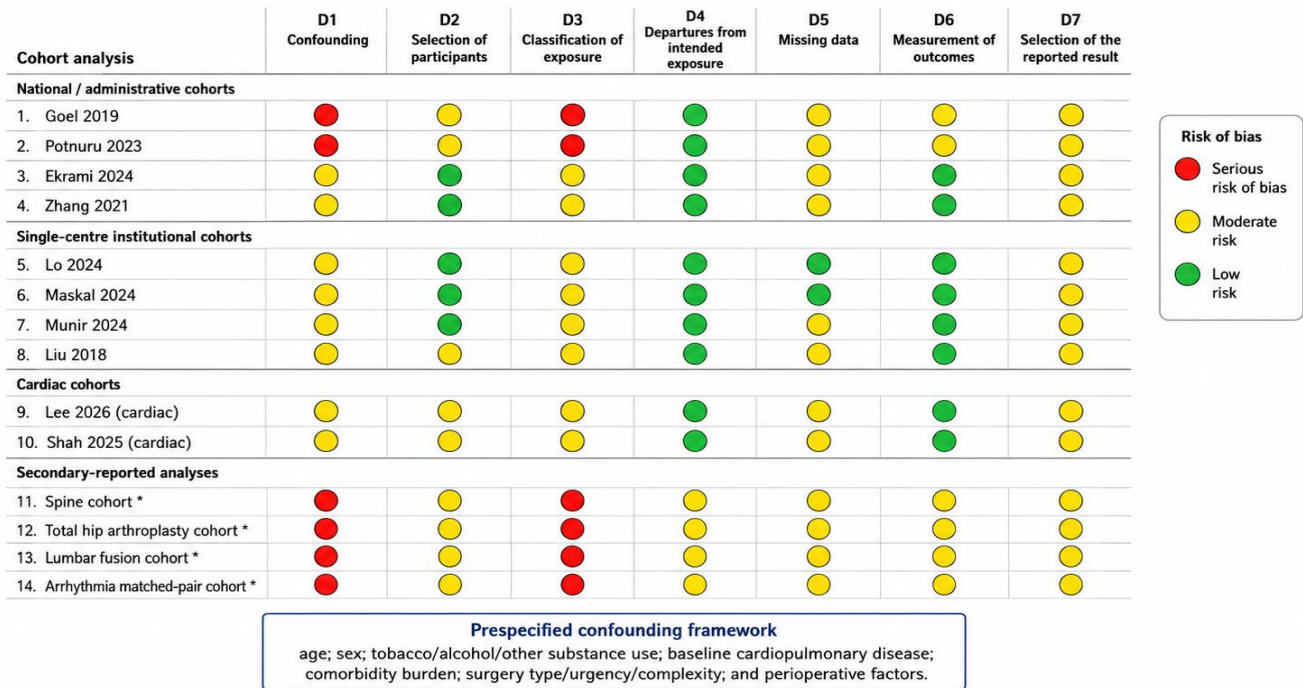
CUD, cannabis use disorder; MI, myocardial infarction; DVT, deep venous thrombosis; PE, pulmonary embolism; ICU, intensive care unit; LOS, length of stay; NR, not reported in the available record. †Cardiac analyses reported narratively and excluded from the primary synthesis. *Secondary reports within a published review; estimates require verification against primary articles before quantitative use.

Risk of bias

Risk of bias appears to have ranged from moderate to serious across cohorts, driven mainly by two considerations: confounding, because cannabis users may exhibit higher rates of tobacco, opioid, cocaine, and alcohol co-use (28); and uncertainty in exposure classification and outcome ascertainment. National database cohorts were judged at serious risk because International Classification of Diseases (ICD)-coded CUD may reflect disorder rather than use,

may misclassify the exposure, and may not distinguish route, potency, or timing of last use. Single-centre institutional cohorts were judged at moderate risk. Secondly reported analyses appear to entail additional uncertainty regarding verification. Domain-level judgements appear in Figure 3.

Figure 3. ROBINS-E risk-of-bias summary across included cohort analyses



D1: confounding; D2: selection of participants into the study; D3: classification of the exposure; D4: deviations from intended exposures; D5: missing data; D6: measurement of outcomes; D7: selection of the reported results. Judgements for the analyses reported secondarily are conditioned on retrieval and verification of the primary articles.

Figure 3. ROBINS-E risk-of-bias summary across the seven domains for the included cohort analyses, with the prespecified confounding framework. ● red = serious risk of bias; ○ yellow = moderate risk; ○ green = low risk. The draft ratings may require confirmation against the full-text ROBINS-E forms. National database cohorts appear to be at serious risk in the confounding and exposure-classification domains; single-centre institutional cohorts (self-report/chart-verified exposure) appear to be at moderate risk; secondarily reported analyses appear to entail additional uncertainty regarding verification pending retrieval of the primary articles.

Myocardial infarction

Active cannabis use disorder (CUD) was associated with an increased risk of perioperative myocardial infarction after major elective surgery (adjusted odds ratio (OR) 1.88, 95% confidence interval (CI) 1.31–2.69) (3). A propensity-matched lumbar-fusion cohort likewise suggested a higher frequency of myocardial infarction among cannabis users (p < 0.0001) (6). As only one adjusted estimate with a confidence interval was available, quantitative pooling appeared unwarranted; the result is therefore presented narratively (Figure 2; Table 3).

Stroke and cerebrovascular events

This endpoint cannot be relabelled as isolated ischaemic stroke in the absence of primary-source confirmation. In a nationwide cardiovascular surgery cohort, stroke appeared to be more frequent among patients with CUD before matching (3.4% vs 2.8%; p

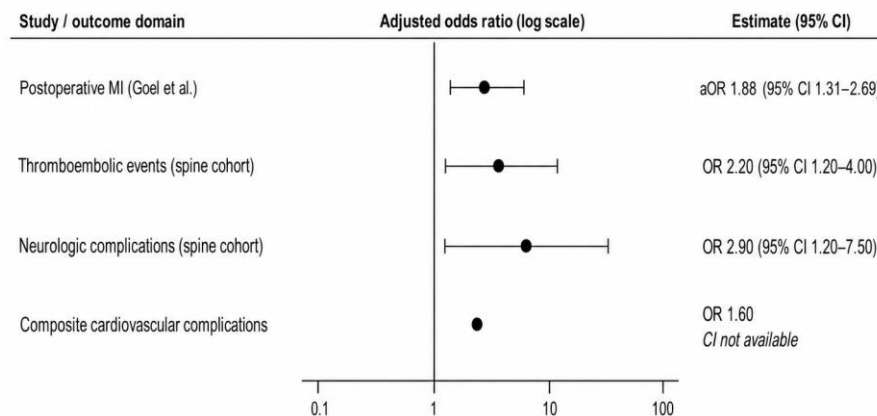
= 0.008) but not after balancing-score matching (19). Given the availability of only one adjusted estimate with a confidence interval, the findings were therefore synthesised narratively (Figure 2; Table 3).

Venous thromboembolism

Cannabis use was associated with thromboembolic events in the spinal cohort (OR 2.2, 95% CI 1.2–4.0; p = 0.005), and the lumbar-fusion cohort reported a higher frequency of deep venous thrombosis among users (p < 0.0001) (6). In the cardiovascular surgery cohort, pulmonary embolism appeared to be more frequent before matching (3.6% vs 1.8%; p < 0.001) but not after matching (19). Because only one adjusted estimate with a confidence interval was available, the findings were synthesised narratively (Figure 2; Table 3).

Figure 2. Adjusted cardiac effect estimates by study and outcome domain

No pooled estimate is shown for any domain (prespecified pooling rule: fewer than two independent cohorts with comparable adjusted estimates per domain).



The thromboembolic and neurologic estimates derive from the same spine cohort and are dependent observations. An exploratory pooled estimate across the four estimates (OR 2.04, 95% CI 1.35–3.08; $P = 0.018$) is discussed in the Discussion only to illustrate why such pooling is inappropriate.

Figure 2. Adjusted cardiac effect estimates by study and outcome domain. Given the prespecified pooling rule which requires at least two independent cohorts with comparable adjusted estimates per domain no pooled estimate is shown for any domain. The thromboembolic and neurologic results appear to derive from the same spine cohort and may therefore constitute dependent observations; an exploratory pooled estimate across the four findings (odds ratio (OR) 2.04, 95% confidence interval (CI) 1.35–3.08; $p = 0.018$) is considered solely in the Discussion to elucidate why such pooling may be inappropriate.

Outcome domain	Cohort	Adjusted estimate (95% confidence interval [CI])	P-value	Note
Postoperative myocardial infarction (MI)	Major elective noncardiac surgery	Adjusted odds ratio (aOR) 1.88 (1.31–2.69)	<0.001	A single adjusted estimate is reported (3)
Thromboembolic events	Elective spine surgery	Odds ratio (OR) 2.2 (1.2–4.0) (29)	0.005	The estimate may be statistically dependent on the neurologic complications row because both derive from the same cohort.
Neurologic complications (stroke/anoxic brain injury)	Elective spine surgery	Odds ratio (OR) 2.9 (1.2–7.5) (29)	0.007	The estimate may be statistically dependent on the thromboembolic events row because both derive from the same cohort.
Composite cardiovascular complications	Total hip arthroplasty			A single estimate is reported

OR, odds ratio; aOR, adjusted odds ratio. All estimates were obtained from multivariable-adjusted analyses in individual studies; no pooled estimate was calculated. aOR 1.88 ($p < 0.001$) for postoperative myocardial infarction (3); OR 2.2 ($p = 0.005$) and OR 2.9 ($p = 0.007$) for thromboembolic and neurological complications, respectively, both from the same spine cohort (29). Composite cardiovascular complications after THA could not be determined because no adjusted estimates were reported.

Arrhythmia

Hypoxaemia, respiratory failure, and pneumonia

In the largest general-anaesthesia cohort (1,683 cannabis users matched to 32,838 non-users), cannabis use did not appear to be associated with hypoxaemia or composite pulmonary complications (4). Propensity-matched abdominal wall reconstruction suggested no

significant differences in cardiovascular or respiratory complications (23), and a mixed-surgery cohort found no convincing association with major surgical outcomes (10). Pneumonia was more frequent in CUD patients before matching in the cardiovascular surgery cohort (13.0% vs. 9.4%; $p < 0.001$) but not after (19), and a single-centre cardiothoracic cohort suggested no

differences in ventilation outcomes attributable to cannabis (30). A 2024 arthroplasty meta-analysis, by contrast, suggested higher postoperative pneumonia (RR 3.97, 95% CI 3.49–4.51; $I^2 = 18\%$) and respiratory failure (RR 4.10, 95% CI 3.38–4.97; $I^2 = 0\%$) risks (31). Because no pulmonary domain included two independent adjusted estimates, the evidence appeared to remain limited to narrative synthesis.

Mortality

In a nationwide cardiovascular surgery cohort, mortality among patients with CUD was lower in both unmatched (1.8% vs. 3.0%; $p < 0.001$) and matched (1.8% vs. 2.7%; $p < 0.001$) comparisons (19). Noncardiac data were insufficient to support a mortality-specific analysis; consequently, the available evidence may be limited to a narrative synthesis.

Overall perioperative morbidity

A national cohort of 12,422 hospitalisations after major noncardiac surgery suggested higher rates of composite complications and mortality in patients with cannabis use disorder (CUD) (7.73% vs 6.57%) (8). A propensity-matched colectomy cohort found no association between preoperative CUD and composite morbidity (9), and a matched analysis in complex cancer surgery demonstrated no association with postoperative morbidity or mortality (21). For secondary outcomes, cannabis users appeared to have higher postoperative opioid consumption (adjusted ratio of geometric means 1.30, 95% CI 1.22–1.38; $p < 0.0001$) and time-weighted average pain scores (mean difference 0.57, 95% CI 0.46–0.67; $p < 0.0001$) than matched non-users (4), which was consistent with earlier findings in major orthopaedic surgery (20). Because composite definitions differed substantially, pooled estimation was deemed inappropriate; consequently, a narrative synthesis was undertaken.

Table 3. Outcome-domain results (no pooled estimates)

Domain	Evidence (cohorts)	Estimate (95% confidence interval)	P-value	Pooled?
Myocardial infarction	Goel, major elective (3)	adjusted odds ratio 1.88 (1.31–2.69)	<0.001	No — single adjusted estimate
Myocardial infarction	Lumbar fusion, propensity score matching	An elevated event frequency appears to be associated with exposure	<0.0001	—
Stroke/neurologic complications	Spine cohort	odds ratio 2.9 (1.2–7.5)	0.007	No — single adjusted estimate
Stroke	Cardiovascular surgery	3.4% versus 2.8% before matching; no association appears to persist after matching	0.008	—
Venous thromboembolism	Spine cohort	odds ratio 2.2 (1.2–4.0)	0.005	No — single adjusted estimate
Deep vein thrombosis	Lumbar fusion, propensity score matching	An elevated event frequency appears to be associated with exposure	<0.0001	—
Pulmonary embolism	Cardiovascular surgery (19)	3.6% versus 1.8% before matching; no association appears to persist after matching	<0.001	—
Arrhythmia	Matched-pair cohort	2.7% versus 1.6%	—	No — descriptive
Composite cardiovascular	Matched total hip arthroplasty	odds ratio 1.6	<0.0001	No — single estimate
Hypoxaemia/composite pulmonary	General anaesthesia (4)	No association appears to be present	—	No — single estimate
Pneumonia	Cardiovascular surgery (19)	13.0% versus 9.4% before matching; no association appears to persist after matching	<0.001	No — unadjusted estimates
Mortality	Cardiovascular surgery; cardiac surgery	1.8% versus 2.7% (matched); appears to be lower among users	<0.001	No — cardiac only
Composite	12,422 hospitalisations	7.73% versus 6.57%; null;	—	No —

morbidity/mortality	(8); colectomy (9); cancer surgery (21)	null		conflicting composites
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PSM, propensity score-matched; THA, total hip arthroplasty; DVT, deep venous thrombosis; “n” indicates that the information was not reported in the available records. Unannotated rows represent secondary reports identified within a published review and should not be interpreted as independently verified evidence until the corresponding primary sources are confirmed.

Certainty of evidence

The certainty of evidence was very low across all cardiovascular domains, potentially reflecting the risk of bias, sparse evidence exhibiting partial non-independence, and imprecision. Certainty was low for pulmonary domains; the largest cohorts appeared to yield predominantly null estimates, although imprecision and residual confounding may persist.

Table 4. Certainty of evidence Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) summary

Outcome domain	Evidence	Design	Risk of bias	Inconsistency	Imprecision	Certainty
Myocardial infarction	One adjusted estimate, supplemented by one supporting cohort (3)	Observational	Serious	Not assessable	Serious	⊕○○○ Very low
Stroke or cerebrovascular events	One adjusted estimate, supplemented by one supporting cohort (6)	Observational	Serious	Not assessable	Serious	⊕○○○ Very low
Venous thromboembolism	One adjusted estimate, supplemented by two supporting cohorts (31)	Observational	Serious	Not assessable	Serious	⊕○○○ Very low
Arrhythmia	One cohort providing descriptive evidence (32)	Observational	Moderate–serious	Not assessable	Serious	⊕○○○ Very low
Hypoxaemia, respiratory failure, or pneumonia	Four cohorts and one procedure-specific meta-analysis (31)	Observational	Moderate–serious	Conflicting across procedures	Serious	⊕○○○ Low
Mortality	One cohort study (8)	Observational	Serious	Not assessable	Serious	⊕○○○ Very low
Overall perioperative morbidity	Three cohorts; composite outcomes appeared conflicting (8), (9), (21)	Observational	Serious	Serious	Serious	⊕○○○ Very low

CI, confidence interval; GRADE, Grading of Recommendations Assessment, Development and Evaluation; N, total participants; n, participants with events; NR, not reported; OR, odds ratio; RR, risk ratio; SeNPs, selenium nanoparticles. Certainty was rated per GRADE: RCTs started as high and observational studies as low, downgraded for risk of bias, inconsistency, indirectness, imprecision, or publication bias, and upgraded for large effects, dose–response, or residual confounding.

DISCUSSION

Viewed by outcome domain, the adjusted observational evidence suggests that active cannabis use or cannabis use disorder may be associated with higher odds of postoperative myocardial infarction, thromboembolic events, neurologic complications including stroke and anoxic brain injury—and

composite cardiovascular morbidity after noncardiac surgery (3),(29). By contrast, the largest available cohorts suggest no association with hypoxaemia or composite pulmonary complications (4). This divergence strengthens the case for a possible cardiovascular signal but does not establish causality: the cardiovascular estimates are vulnerable to confounding, exposure misclassification, and

differences in outcome definition, and each cardiac domain is supported by only a single adjusted estimate. Moreover, two estimates derive from the same spine cohort and may therefore be statistically dependent. Accordingly, certainty of evidence appears to be very low throughout. Under the prespecified pooling rule, no pooled estimate is reported; the observed cardiovascular signal is best regarded as hypothesis-generating rather than as a quantified summary effect. An exploratory pooled analysis that ignores outcome and cohort structure yields an OR of 2.04 (95% CI 1.35–3.08; $p = 0.018$), but every leave-one-out confidence interval crosses unity. This calculation is therefore presented only to demonstrate the instability and potential inappropriateness of such pooling, not as evidence supporting a definitive overall association.

This pattern appears biologically plausible: acute tetrahydrocannabinol (THC) exposure may increase sympathetic drive and myocardial oxygen demand, whereas chronic exposure may cause bradycardia and hypotension. Cannabinoid–drug interactions may also attenuate antiplatelet and anticoagulant efficacy (6), (7). Ischaemic and thromboembolic events alongside the absence of comparable pulmonary outcomes in general anaesthesia appear consistent with the predominantly cardiovascular pharmacology of cannabinoids, whose respiratory depression appears modest, except when cannabis is smoked with tobacco or combined with opioids.

The results appear concordant with narrative syntheses that describe cannabis as a trigger for perioperative cardiovascular events, and with guidance emphasising postoperative myocardial infarction, pain and opioid requirements, bronchospasm and cannabinoid–anticoagulant interactions (5), (33), (2). They also appear to form part of an expanding body of procedure-specific syntheses. A 2026 systematic review and meta-analysis of spinal fusion suggested an association between preoperative cannabis use and greater perioperative opioid utilisation, as well as more readmissions (11). A 2024 arthroplasty meta-analysis suggested higher cardiovascular (RR 2.49, 95% CI 1.22–5.08; $I^2 = 93\%$), cerebrovascular (RR 3.15, 95% CI 2.54–3.91; $I^2 = 0\%$), pneumonia (RR 3.97, 95% CI 3.49–4.51) and respiratory failure (RR 4.10, 95% CI 3.38–4.97) risks (31). A 2025 analysis associated cannabis use with higher complication and revision rates after anterior cervical discectomy and fusion (12), and a metacarpal-fixation analysis of 80,787 cases suggested an excess of 90-day medical complications, including myocardial infarction (MI), stroke, deep vein thrombosis (DVT), and pneumonia, among users (13). Null results in large matched cohorts (4), (9), (23) coexisting with positive procedure-specific signals may indicate that conclusions are sensitive to exposure definition, comparator, adjustment strategy, and surgical population, a pattern of heterogeneity that may have motivated the outcome- and cohort-specific approach.

Confounding appears to be the principal weakness of this entire evidence base. Cannabis users have substantially higher rates of tobacco, opioid, cocaine, and alcohol co-use (19), each of which may independently worsen perioperative outcomes; tobacco exposure alone may increase postoperative complications, whereas short-term cessation may reduce them (34). Administrative definitions of cannabis use disorder (CUD) capture disorder rather than use, may misclassify exposure, and may not distinguish route, potency, or timing of last use the factors that govern the cardiovascular response. In the largest matched analyses, associations present before matching (pneumonia, stroke, and pulmonary embolism in the cardiovascular cohort) appeared no longer evident after balancing-score adjustment, and propensity-matched studies in colectomy (9) and complex cancer surgery (21) reported no residual association. Unmeasured confounding and the higher baseline comorbidity burden of cannabis users probably account for part of the observed signal; this may explain why estimates are reported without pooled precision and at very low certainty.

The review appears to have substantive strengths: outcome-specific, cohort-specific structure; risk-of-bias assessment with a tool built for exposure effects and a prespecified confounding framework (17); and pooling confined to genuinely independent studies. Its limitations nevertheless warrant explicit qualification. The review was not prospectively registered; a retrospective Open Science Framework (OSF) analysis record may partially address that gap. The adjusted estimates within each cardiac domain are single and partly non-independent (two arise from one spine cohort); pooling therefore appears not to have been feasible and precision is inherently limited. Two outcome-specific estimates were identified through a secondary review and still await primary-source verification; in particular, the spine endpoint (odds ratio [OR] 2.9) is described in the source literature as neurologic complications such as stroke and anoxic brain injury rather than isolated ischaemic stroke, and that distinction may be consequential if verification changes these estimates, the results may require updating. Exposure definitions were heterogeneous and could not distinguish route, potency, or timing of last use. Certainty of evidence was very low for cardiovascular and composite outcomes and low for pulmonary outcomes, and the conclusions are tempered accordingly.

For clinicians, these findings may be interpreted as follows: they appear broadly consistent with the recommendations and do not appear materially to extend those of the American Society of Regional Anesthesia and Pain Medicine (ASRA) consensus guidelines and later reviews: screening for cannabis and cannabinoid use; attention to postoperative myocardial infarction, pain, opioid requirements, and respiratory events such as bronchospasm; and

assessment of interactions between cannabinoids and anticoagulants (2). Higher-certainty data are needed before abstinence can be recommended with confidence; the required duration of any preoperative hold remains unknown (8). In patients with active cannabis use disorder (CUD) — a group with heavy polysubstance comorbidity (6) — heightened vigilance for ischaemic, thromboembolic, and neurologic events, and careful review of antiplatelet and anticoagulant therapy may be prudent.

CONCLUSION

Very-low-certainty evidence from observational studies suggests that preoperative cannabis exposure may raise perioperative cardiovascular risk; evidence for major pulmonary complications is inconclusive. Outcome-specific, independent adjusted estimates are too sparse for valid pooling, and the production of meta-analytic summary effects may not yet be warranted for any domain. Prospective cohorts reporting verified, outcome-specific estimates from independent studies with dose, route, potency, and timing of last use, and explicit adjustment for polysubstance use would be required before the at-risk population could be defined and cessation recommendations based on firm evidence.

Author Contributions:

Conception and design: Shalini Y; methodology and protocol: Shalini Y and Rashmi H R; literature search and screening: Rashmi H R and Akshay B; data extraction and verification: Rashmi H R and Akshay B; statistical analysis and visualisation: Akshay B; manuscript drafting: Shalini Y; critical revision for important intellectual content: Shalini Y, Rashmi H R, and Akshay B. All authors approved the final version and agree to be accountable for all aspects of the work.

Competing Interests

No conflicts of interest have been declared.

Data Availability

Study-level data and analysis scripts are available from the corresponding author on reasonable request. Outcome data are derived from the cited publications; estimates identified through a secondary review are flagged and subject to primary-source verification.

Registration

This review appears not to have been prospectively registered in PROSPERO or any other public registry. A retrospective, dated protocol-and-analysis record is intended to be posted on the Open Science Framework prior to submission, with the retrospective posting clearly labelled as such.

Reporting

The reporting appears to accord with Preferred Reporting Items for Systematic Reviews and Meta-

Analyses (PRISMA) 2020 (15) and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) recommendations (16)

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