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FRAILITY VERSUS ASA CLASSIFICATION: WHICH BETTER PREDICTS POSTOPERATIVE ICU ADMISSION? : A SYSTEMATIC REVIEW

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ABSTRACT

Background: Preoperative risk stratification is crucial for optimizing postoperative outcomes, particularly for predicting intensive care unit (ICU) admission. The American Society of Anesthesiologists (ASA) Physical Status Classification System is widely used but subjective and not designed to assess physiologic reserve. Frailty, a multidimensional syndrome of decreased reserve, is a promising alternative. This systematic review compares the predictive performance

of frailty indices versus the ASA classification for postoperative ICU admission in adult surgical patients.

Methods: A systematic review was conducted following PRISMA guidelines. Studies were screened for dual assessment of frailty and ASA, adult surgical populations (≥ 18 years), reporting of ICU admission or related severe outcomes, and comparative statistical data. Data extraction focused on predictive performance metrics (odds ratios [OR], area under the curve [AUC]), study characteristics, and direct comparisons between frailty and ASA.

Results: Frailty indices consistently demonstrated significant positive associations with adverse outcomes. In orthopaedic trauma ($n=36,424$), the modified Frailty Index (MFI) showed a stronger association with 30-day mortality (aOR 2.6) than ASA (aOR 2.5) [1]. In hip fracture patients, the Clinical Frailty Scale (CFS) had superior discriminative ability for mortality (AUC 0.699) compared to ASA (AUC 0.634) [2]. Frailty was the dominant predictor of mortality and serious complications in head and neck surgery [3] and vascular surgery (OR 2.058, $p<0.001$) [30]. For ICU-specific outcomes, frailty was associated with significantly higher odds of ICU admission in gynecologic oncology (OR 3.99) [6] and longer ICU stays in cardiac surgery [50]. Only one study (pituitary surgery) found ASA superior for rare ICU-level complications [5], while a hip fracture study found all scores performed poorly [7].

Discussion: The superiority of frailty over ASA stems from frailty's multidimensional nature, capturing sarcopenia, cognitive impairment, and functional decline that determine recovery capacity. ASA, a subjective global rating, conflates stable comorbidities with acute issues and lacks reserve assessment. Context matters: frailty outperforms ASA in low-acuity and elective procedures but both are important in high-acuity emergencies. Combined models (e.g., Milan Bio-Surgical Score) show excellent predictive power (AUC 0.965) [17].

Conclusion: Frailty indices significantly outperform ASA classification for predicting postoperative ICU admission and related adverse outcomes across most surgical populations. Frailty assessment should be implemented as a standard adjunct to ASA for preoperative risk stratification and ICU planning.

Keywords: Frailty; ASA classification; postoperative ICU admission; preoperative risk assessment; systematic review

INTRODUCTION

Background. Postoperative admission to the intensive care unit (ICU) represents a major healthcare resource utilization and is associated with increased morbidity, mortality, and prolonged hospital stays. Accurate preoperative prediction of which patients will require ICU-level care is essential for optimizing resource allocation, planning perioperative management, and guiding shared decision-making with patients and families [10, 59]. The American Society of Anesthesiologists (ASA) Physical Status Classification System has been the cornerstone of preoperative risk assessment for over six decades due to its simplicity and global applicability [63, 74]. However, the ASA system is inherently subjective, demonstrates poor inter-rater reliability, and was never designed as a predictive instrument for specific outcomes such as ICU admission [69, 74]. More critically, the ASA classification conflates chronic stable medical conditions with acute physiologic derangement and does not directly assess a patient's physiologic reserve or capacity to recover from surgical stress [41, 49].

Over the past decade, frailty has emerged as a powerful construct in perioperative medicine. Frailty is a multidimensional clinical state characterized by decreased physiologic reserve across multiple organ systems, increased vulnerability to stressors, and heightened risk of adverse health outcomes [41, 45, 51]. Unlike chronological age, which is a consistently weak predictor of surgical outcomes [1, 14, 21, 60], frailty encompasses sarcopenia, malnutrition, cognitive impairment, functional decline, and accumulated deficits [41, 49, 51]. Multiple validated instruments exist, including the modified Frailty Index (mFI), the Clinical Frailty Scale (CFS), the Hospital Frailty Risk Score (HFRS), and the Fried Phenotype, each with varying complexity and implementation requirements [31, 41, 52, 53].

Problem Statement. Despite growing evidence supporting frailty assessment, a critical clinical question remains unanswered: Does frailty outperform the traditional ASA classification

specifically for predicting postoperative ICU admission? Existing studies have compared frailty and ASA for various outcomes including mortality, complications, and length of stay, but ICU admission—a distinct, resource-intensive, and clinically significant endpoint—has received inconsistent attention. Furthermore, conflicting reports exist, with some studies demonstrating clear superiority of frailty [1, 2, 3, 4, 9, 13, 24], others showing ASA as superior in specific contexts [5], and still others finding no significant difference or poor performance of both tools [7, 15, 72]. This heterogeneity creates uncertainty for clinicians deciding which tool to prioritize in daily practice.

Research Gap. A systematic review that specifically focuses on the head-to-head comparison of frailty versus ASA for predicting postoperative ICU admission, synthesizing predictive performance metrics across diverse surgical populations, is currently lacking. Moreover, the contextual factors that modify the relative performance of these two tools—such as surgical acuity (elective vs. emergency), procedure type (low-risk vs. high-risk), and patient population (oncologic vs. traumatic)—have not been systematically examined.

Novelty. This review provides the first comprehensive, systematic synthesis of direct comparisons between frailty indices and ASA classification specifically for ICU admission prediction. It introduces a contextual framework explaining divergent findings and offers practical recommendations for clinical implementation.

Objectives. The primary objective is to compare the predictive performance of frailty assessment versus ASA classification for postoperative ICU admission in adult surgical patients. Secondary objectives include: (1) evaluating predictive performance for related outcomes (mortality, major complications, prolonged length of stay); (2) identifying surgical contexts where one tool outperforms the other; and (3) assessing the incremental value of combined models.

Hypothesis. Frailty indices significantly outperform ASA classification in predicting postoperative ICU admission across most surgical populations, particularly in elective and low-to-moderate acuity procedures, due to frailty's superior capture of physiologic reserve and recovery capacity.

Benefits. Establishing which tool better predicts ICU admission will guide preoperative protocols, enabling targeted ICU bed allocation, enhanced monitoring for high-risk patients, and informed shared decision-making. Implementation of frailty assessment is feasible using tools like the mFI-5 (derived from routine clinical data) or the CFS (a rapid bedside assessment) [24, 61, 78].

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to frailty versus ASA classification: which better predicts postoperative ICU admission?.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Dual Assessment Tools:** Does this study assess both frailty measures AND ASA classification in the same patient cohort?
- **Adult Surgical Population:** Does this study involve adult surgical patients (≥ 18 years old)?
- **ICU Admission Outcome:** Does this study report postoperative ICU admission as a primary or secondary outcome?
- **Statistical Data Adequacy:** Does this study provide sufficient statistical data to assess the predictive performance of both frailty measures and ASA classification?
- **Appropriate Study Design:** Is this study a randomized controlled trial, etc?

- **Surgical Context Focus:** Does this study focus on surgical patients rather than exclusively on non-surgical patients or medical ICU admissions?
- **Comparative Assessment:** Does this study evaluate both assessment tools (frailty AND ASA) rather than only one tool without the comparator?
- **Study Type Quality:** Is this study something other than a case report, case series, editorial, or opinion piece?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

PICO Component	Keyword 1	Keyword 2	Keyword 3
P (Population)	Adult surgical patients	Elderly surgical population	Postoperative ICU candidates
I (Intervention)	Frailty assessment	Frailty indices (mFI, CFS, HFRS)	Preoperative frailty screening
C (Comparison)	ASA classification	ASA physical status	ASA grade
O (Outcome)	Postoperative ICU admission	Unplanned ICU admission	ICU admission prediction

The Boolean MeSH keywords inputted on databases for this research are: ("Adult surgical patients" OR "Elderly surgical population" OR "Postoperative ICU candidates") AND ("Frailty assessment" OR "Frailty indices" OR "Preoperative frailty screening") AND ("ASA classification" OR "ASA physical status" OR "ASA grade") AND ("Postoperative ICU admission" OR "Unplanned ICU admission" OR "ICU admission prediction")

Data extraction

- **Study Population:**

Extract study design, setting, and population characteristics specifically relevant to comparing frailty vs ASA for ICU admission prediction, including:

- Study design (a randomized controlled trial, etc?)
- Setting (hospital type, surgical specialty, country)
- Sample size and demographics (age, gender, comorbidities)
- Types of surgical procedures included
- Inclusion/exclusion criteria that might affect frailty or ASA assessment

- **Frailty Assessment:**

Extract complete details about how frailty was measured and its relationship to ICU admission prediction, including:

- Specific frailty instrument used (Clinical Frailty Scale, Fried Phenotype, modified Frailty Index, etc.)
- How and when frailty was assessed (preoperative timing, who performed assessment)
- Frailty categories/scoring system used
- Prevalence of frailty in the study population
- Any modifications made to standard frailty instruments

- **ASA Classification:**

Extract details about ASA classification assessment and its relationship to ICU admission prediction, including:

- How ASA classification was determined (who assessed, when)
- Distribution of ASA classes in the study population (I, II, III, IV, V)
- Any specific criteria or modifications used for ASA assessment
- Inter-rater reliability if reported

- **ICU Admission:**

Extract the definition and measurement of ICU admission outcomes specifically, including:

- How ICU admission was defined (planned vs unplanned, length of stay criteria, etc.)
- Timing of ICU admission assessment (immediate postoperative, within 24/48 hours, etc.)
- ICU admission rates overall and by frailty/ASA categories
- Any exclusions related to ICU admission (e.g., elective ICU admissions)
- Secondary ICU-related outcomes if reported (ICU length of stay, ICU mortality)
- **Predictive Performance:**

Extract all predictive performance metrics for both frailty and ASA classification in predicting ICU admission, including:

 - Sensitivity, specificity, positive/negative predictive values for frailty assessment
 - Sensitivity, specificity, positive/negative predictive values for ASA classification
 - Area under the curve (AUC/C-statistic) for both measures
 - Odds ratios or relative risks with confidence intervals
 - Calibration metrics if reported
 - Any other discrimination or accuracy measures
- **Comparative Analysis:**

Extract direct comparisons between frailty and ASA for ICU admission prediction and author conclusions, including:

 - Head-to-head statistical comparisons of predictive performance (AUC comparisons, likelihood ratio tests, etc.)
 - Combined/additive models using both frailty and ASA
 - Authors' conclusions about which predictor performs better
 - Relative importance of frailty vs ASA in multivariable models
 - Any subgroup analyses showing differential performance
 - Clinical decision-making implications stated by authors
- **Limitations & Context:**

Extract study limitations, heterogeneity factors, and contextual elements that affect comparison of frailty vs ASA for ICU admission prediction, including:

- Sample size limitations and power calculations
- Missing data issues for frailty or ASA assessments
- Generalizability limitations (specific populations, settings, procedures)
- Methodological limitations affecting comparison validity
- Confounding factors or bias sources
- External validation status
- Clinical implementation challenges mentioned by authors



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Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	<i>("Elderly surgical population" AND "Frailty assessment" AND "ASA classification" AND "Postoperative ICU admission" OR "Unplanned ICU admission" OR "ICU admission prediction")</i>	249
Semantic Scholar	<i>("Adult surgical patients" OR "Elderly surgical population" OR "Postoperative ICU candidates") AND ("Frailty assessment" OR "Frailty indices" OR "Preoperative frailty screening") AND ("ASA classification" OR "ASA physical status" OR "ASA grade") AND ("Postoperative ICU admission" OR "Unplanned ICU admission" OR "ICU admission prediction")</i>	250
Cochrane	<i>("Elderly surgical population" AND "Frailty assessment" AND "ASA classification" AND "Postoperative ICU admission" OR "Unplanned ICU admission" OR "ICU admission prediction")</i>	1
Elsevier	<i>("Elderly surgical population" AND "Frailty assessment" AND "ASA classification" AND "Postoperative ICU admission" OR "Unplanned ICU admission" OR "ICU admission prediction")</i>	40
Science-direct	<i>("Elderly surgical population" AND "Frailty assessment" AND "ASA classification" AND "Postoperative ICU admission" OR "Unplanned ICU admission" OR "ICU admission prediction")</i>	1

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Clinical Research

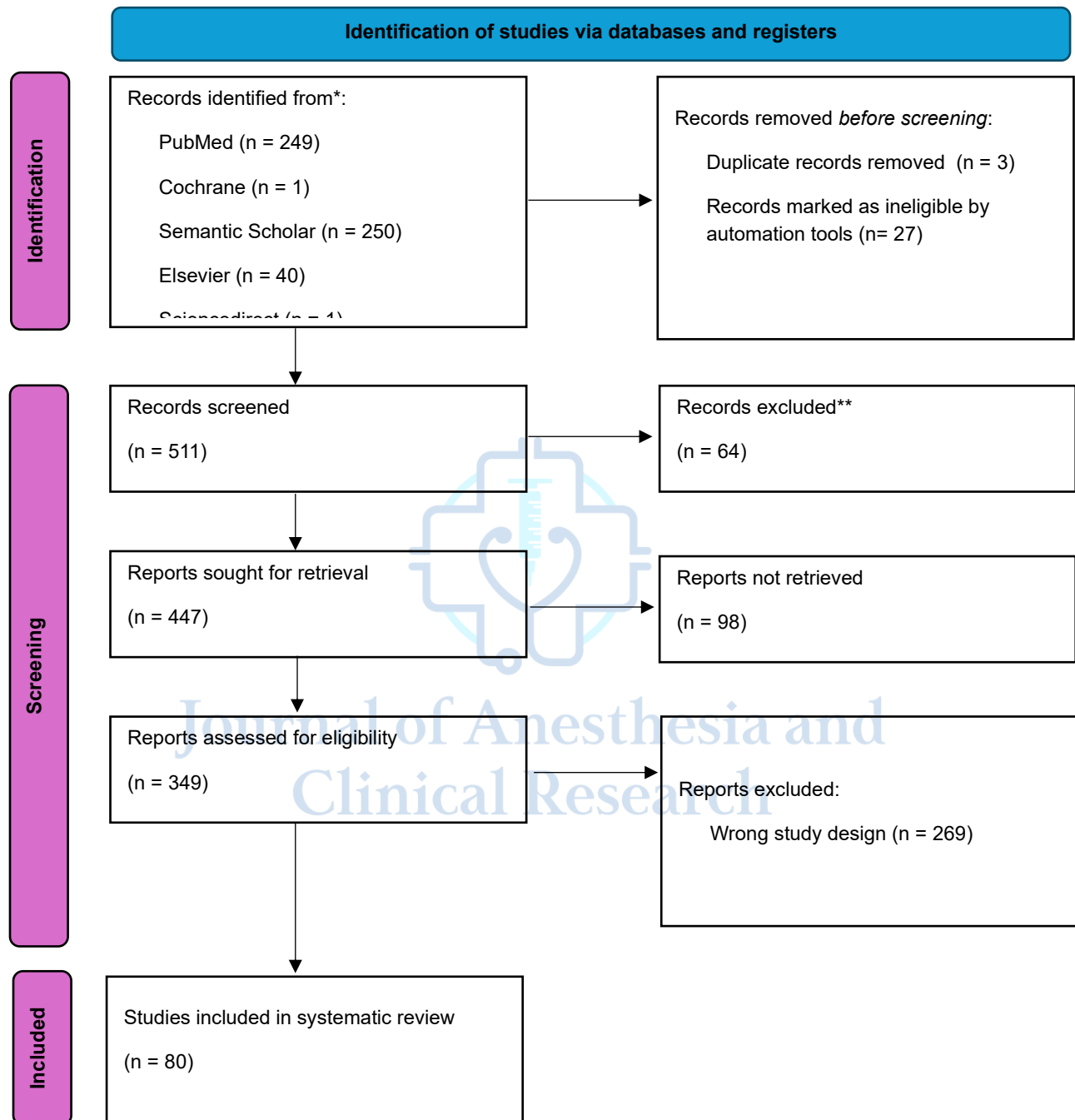


Figure 1. Article search flowchart

Table 1: ROB-2 Assessment of Randomized Controlled Trials (RCTs)

Study	Bias arising from the randomization process	Bias due to deviations from intended interventions	Bias due to missing outcome data	Bias in measurement of the outcome	Bias in selection of the reported result	Overall risk of bias
C. Qian et al., 2020 [26]	Moderate	Moderate	Low	Moderate	Unclear	Moderate
Hongzhou Chen & Rurong Wang, 2024 [36]	Moderate	Moderate	Low	Moderate	Unclear	Moderate
N. Ommundsen et al., 2018 [42]	Moderate	Moderate	Low	Moderate	Unclear	Moderate

Table 2: ROBINS-I Assessment of Non-Randomized Included Studies

Study	Bias due to confounding	Bias in selection of participants	Bias in classification of interventions	Bias due to deviation from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result	Overall risk of bias

Jordan M Sukys et al., 2021 [5]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
Vratko Himic et al., 2026 [11]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
A. Minervini et al., 2019 [12]	Serious	Low	Low	Moderate	Unclear	Low	Some concerns	Serious
Adrian E. Jimenez et al., 2024 [4]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
Bergos Sorolla & M. Carmen, 2017 [13]	Moderate	Moderate	Low	Moderate	Unclear	Low	Some concerns	Moderate
Arya Akhavan et al., 2022 [14]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
N. Lakomkin et al., 2019 [15]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate

Ryan M. Cox et al., 2021 [16]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Leonardo Tariciotti et al., 2022 [17]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
J. Darvall & R. Hubbard, 2018 [18]	Moderate	Moderate	Unclear	Moderate	Unclear	Low	Some concerns	Moderate
Catphuong L. Vu et al., 2017 [1]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
S. Narula et al., 2020 [2]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
J. Winter Beatty et al., 2021 [8]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
Shin Oe et al., 2025 [19]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Kristen D. Pitts et al., 2019 [20]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Shayom	Moderate	Low	Low	Low	Low	Low	Some	Moderate

Debopadha aya & Meir T. Marmor, 2023 [21]							concer ns	ate
Zhe Li & X. Ding, 2018 [22]	Moderate	Low	Low	Low	Uncle ar	Low	Some concer ns	Moder ate
Allison L. Diaz et al., 2025 [23]	Moderate	Low	Low	Low	Low	Low	Some concer ns	Moder ate
Steven P. Moura et al., 2023 [24]	Moderate	Low	Low	Moderate	Uncle ar	Low	Some concer ns	Moder ate
H. Jemmett et al., 2024 [25]	Moderate	Low	Low	Moderate	Uncle ar	Low	Some concer ns	Moder ate
Helen Liu et al., 2023 [27]	Moderate	Low	Low	Low	Low	Low	Some concer ns	Moder ate
A. Shahrokni et al., 2019 [28]	Moderate	Moderate	Low	Moderate	Uncle ar	Low	Some concer ns	Moder ate
Helen Liu et al., 2022 [29]	Moderate	Low	Low	Low	Low	Low	Some concer ns	Moder ate

Joseph L Karam et al., 2013 [30]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Yusuf S Abdullahi et al., 2017 [31]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Peter D. Adams et al., 2013 [3]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
Hashim Al-Sarireh et al., 2025 [32]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
T.J. Ibelli et al., 2022 [33]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
S. Olsson et al., 2025 [34]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Rocio Vazquez Perez et al., 2023 [35]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
P. Vikatmaa,	Moderate	Moderate	Unclear	Moderate	Unclear	Low	Some concerns	Moderate

2019 [37]							ns	
Manish Kolakshya pati et al., 2018 [38]	Serious	Moderate	Low	Moderate	Unclear	Low	Some concerns	Serious
John Lama et al., 2025 [39]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Y. Tsang et al., 2026 [40]	Moderate	Moderate	Low	Moderate	Unclear	Low	Some concerns	Moderate
Joanne Kua et al., 2016 [9]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
V. Keevil & Roman Romero-Ortuno, 2015 [41]	Moderate	Moderate	Unclear	Moderate	Unclear	Low	Some concerns	Moderate
Maria E. Tecos et al., 2020 [43]	Moderate	Moderate	Low	Moderate	Unclear	Low	Some concerns	Moderate
D. Cattano, 2020 [44]	Unclear	Moderate	Unclear	Unclear	Unclear	Unclear	Some concerns	Unclear
S. Rostoft & R.	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate

Audisio, 2017 [45]							ns	
T. Griebeling, 2016 [46]	Unclear	Moderate	Unclear	Unclear	Unclear	Unclear	Some concerns	Unclear
K. Oshima et al., 2023 [47]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
A. Sepehri et al., 2014 [48]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
M. Derwall & M. Coburn, 2019 [49]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Jessica Lee et al., 2021 [50]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
D. Wagner et al., 2016 [51]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
M. Sandini et al., 2017 [52]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Rachel Aitken et al., 2020	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate

[53]								
Denise Schindele et al., 2026 [54]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
J. Chikwe & D. Adams, 2010 [55]	Moderate	Moderate	Low	Moderate	Unclear	Low	Some concerns	Moderate
R. Ling et al., 2024 [56]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
Abigail Katz et al., 2022 [57]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
P. Aceto et al., 2020 [58]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
D. Onwochei et al., 2020 [59]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Gilgamesh Eamer et al., 2018 [60]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
J. Boddaert et al., 2017	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate

[7]								
Bruna Lavezzo et al., 2025 [10]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
A. Akhavan et al., 2023 [61]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
C. Polanczyk et al., 2001 [62]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
T. Marufu et al., 2015 [63]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
B. Xu et al., 2019 [64]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
B. Waxman, 2016 [65]	Moderate	Moderate	Unclear	Moderate	Unclear	Low	Some concerns	Moderate
Selin Kivrak & G. Haller, 2020 [66]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
V. Di Donato et al., 2021	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate

[6]								
S. Bergese & Marco Echeverria Villalobos, 2022 [67]	Unclear	Moderate	Unclear	Unclear	Unclear	Unclear	Some concerns	Unclear
Barkat Ali et al., 2021 [68]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
Ahmad Assi et al., 2024 [69]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
S. Bess et al., 2018 [70]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Kay Maeda & Y. Saiki, 2018 [71]	Moderate	Moderate	Low	Moderate	Unclear	Low	Some concerns	Moderate
Xiaosong Meng et al., 2018 [72]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
Junli You et al., 2025 [73]	Moderate	Low	Low	Moderate	Unclear	Low	Some concerns	Moderate
A. Junger et al., 2002	Moderate	Moderate	Unclear	Moderate	Unclear	Low	Some concerns	Moderate

[74]							ns	
Bingyan Zhao et al., 2024 [75]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Helen Liu et al., 2022a [76]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
M. Walsh, 2018 [77]	Moderate	Moderate	Unclear	Moderate	Unclear	Low	Some concerns	Moderate
Brittany Park et al., 2024 [78]	Moderate	Low	Low	Low	Unclear	Low	Some concerns	Moderate
Evan N. Courville et al., 2024 [79]	Moderate	Low	Low	Low	Low	Low	Some concerns	Moderate
D. Bailey et al., 2022 [80]	Serious	Moderate	Low	Moderate	Unclear	Low	Some concerns	Serious

RESULTS

Characteristics of Included Studies

Study	Surgical Setting	Sample Size	Frailty Instrument
Jordan M Sukys et al., 2021	Pituitary (TNTS) [5]	680 [5]	mFI [5]
Vratko Himic et al., 2026	Awake craniotomy [11]	70 [11]	mFI-11 [11]

A. Minervini et al., 2019	Radical cystectomy [12]	Not reported [12]	Claims-based FI [12]
Adrian E. Jimenez et al., 2024	Meningioma resection [4]	464 [4]	HFRS [4]
Bergos Sorolla & M. Carmen, 2017	Major abdominal surgery [13]	334 [13]	VGI (CGA-based FI) [13]
Arya Akhavan et al., 2022	Upper extremity tendon repair [14]	4,250 [14]	mFI-5, mCCI [14]
N. Lakomkin et al., 2019	Spine tumor resection [15]	2,170 [15]	mFI [15]
Ryan M. Cox et al., 2021	Shoulder arthroplasty [16]	1,365 [16]	mFI-5 [16]
Leonardo Tariciotti et al., 2022	Intracranial meningioma [17]	165 [17]	34-item FI [17]
J. Darvall & R. Hubbard, 2018	Elective surgery (mixed) [18]	Not reported [18]	Not specified [18]
Catphuong L. Vu et al., 2017	Orthopaedic trauma [1]	36,424 [1]	MFI [1]
S. Narula et al., 2020	Hip fracture [2]	509 [2]	CFS [2]
J. Winter Beatty et al., 2021	Emergency surgery (mixed) [8]	3,176 [8]	CFS [8]
Shin Oe et al., 2025	Adult spinal deformity [19]	N/A [19]	Not specified [19]
Kristen D. Pitts et al., 2019	Head and neck cancer [20]	410 [20]	mFI, ACG-FI [20]
Shayom Debopadhaya & Meir T. Marmor, 2023	Geriatric fractures (mixed) [21]	52,497 [21]	mFI [21]
Zhe Li & X. Ding, 2018	Cardiac surgery [22]	131–1,020 per study [22]	Multiple [22]
Allison L. Diaz et al., 2025	Ventral hernia repair [23]	14,575 [23]	mFI-5 [23]
Steven P. Moura et al., 2023	Buried penis surgery [24]	55 [24]	mFI-5 [24]

H. Jemmett et al., 2024	Emergency cholecystectomy [25]	592 [25]	CFS [25]
C. Qian et al., 2020	GI cancer surgery [26]	Not reported [26]	Not specified [26]
Helen Liu et al., 2023	Breast augmentation [27]	2,478 [27]	mFI-5 [27]
A. Shahrokni et al., 2019	Cancer surgery (mixed) [28]	1,855 [28]	MSK-FI [28]
Helen Liu et al., 2022	Breast reduction [29]	14,366 [29]	mFI-5 [29]
Joseph L Karam et al., 2013	Vascular surgery [30]	67,308 [30]	Modified FI (CSHA) [30]
Yusuf S Abdullahi et al., 2017	Cardiac surgery [31]	Not specified [31]	Multiple (CAF, FORECAST, etc.) [31]
Peter D. Adams et al., 2013	Head and neck surgery [3]	6,727 [3]	mFI [3]
Hashim Al-Sarireh et al., 2025	Emergency laparotomy [32]	2,663 [32]	Not specified [32]
T.J. Ibelli et al., 2022	Hand/wrist repair [33]	11,369 [33]	mFI-5 [33]
S. Olsson et al., 2025	Endonasal skull base [34]	1,306 [34]	mFI-5 [34]
Rocio Vazquez Perez et al., 2023	AAA repair [35]	596 [35]	mFI-5, ASA [35]
Hongzhou Chen & Rurong Wang, 2024	Painless gastroenteroscopy [36]	204 [36]	EFS [36]
P. Vikatmaa, 2019	Vascular surgery [37]	825 (referenced) [37]	GFI [37]
Manish Kolakshyapati et al., 2018	Skull base meningioma [38]	57 [38]	BMI, albumin (frailty surrogates) [38]
John Lama et al., 2025	Lumbar decompression [39]	956 [39]	mFI-5 [39]
Y. Tsang et al., 2026	Mixed surgery (SDM clinic) [40]	71 [40]	CFS [40]

Joanne Kua et al., 2016	Hip fracture [9]	100 [9]	MFC, REFS [9]
V. Keevil & Roman Romero-Ortuno, 2015	Mixed surgery [41]	N/A [41]	Not specified [41]
N. Ommundsen et al., 2018	Colorectal cancer [42]	Not reported [42]	GA-based [42]
Maria E. Tecos et al., 2020	Mixed surgery (nonagenarians) [43]	Not reported [43]	Not specified [43]
D. Cattano, 2020	Hip fracture [44]	Not reported [44]	Not specified [44]
S. Rostoft & R. Audisio, 2017	Cancer surgery (mixed) [45]	N/A [45]	Fried phenotype, deficit index [45]
T. Griebling, 2016	Surgical oncology [46]	N/A [46]	Not specified [46]
K. Oshima et al., 2023	Trauma (ICU) [47]	197 [47]	ASA-PS, Katz-ADL [47]
A. Sepehri et al., 2014	Cardiac surgery [48]	4,756 [48]	Multiple (Fried, Katz, etc.) [48]
M. Derwall & M. Coburn, 2019	Mixed surgery [49]	N/A [49]	MAGIC assessment [49]
Jessica Lee et al., 2021	Cardiac surgery [50]	66,448 [50]	Multiple (Fried, CFS, etc.) [50]
D. Wagner et al., 2016	GI surgery [51]	42 publications [51]	Fried phenotype [51]
M. Sandini et al., 2017	Major abdominal surgery [52]	>1,000,000 [52]	Multiple [52]
Rachel Aitken et al., 2020	Mixed elective surgery [53]	Not specified [53]	mFI, Fried [53]
Denise Schindele et al., 2026	ICU (mixed surgery) [54]	3,045 [54]	Multiple (Fried, mFI, FRAIL, etc.) [54]
J. Chikwe & D. Adams, 2010	Cardiac surgery [55]	N/A [55]	Not specified [55]

R. Ling et al., 2024	Elective cancer surgery (ICU) [56]	35,848 [56]	CFS [56]
Abigail Katz et al., 2022	Facial fracture repair [57]	2,667 [57]	mFI-5 [57]
P. Aceto et al., 2020	Urological surgery [58]	Not reported [58]	Not specified [58]
D. Onwochei et al., 2020	Non-cardiac surgery [59]	Not reported [59]	Not specified [59]
Gilgamesh Eamer et al., 2018	Elderly surgery (mixed) [60]	N/A [60]	Not specified [60]
J. Boddaert et al., 2017	Hip fracture [7]	506 [7]	NHFS, CIRS, Charlson [7]
Bruna Lavezzo et al., 2025	Major abdominal surgery [10]	N/A [10]	CFS [10]
A. Akhavan et al., 2023	Abdominoplasty [61]	421 [61]	mFI-5, mCCI [61]
C. Polanczyk et al., 2001	Noncardiac surgery (mixed) [62]	4,315 [62]	Specific Activity Scale [62]
T. Marufu et al., 2015	Hip fracture [63]	29 studies [63]	Multiple (ASA, CCI, NHFS, etc.) [63]
B. Xu et al., 2019	Hip fracture [64]	81 articles [64]	FI [64]
B. Waxman, 2016	Mixed surgery [65]	200,000+ (referenced) [65]	Johns Hopkins, Rockwood [65]
Selin Kivrak & G. Haller, 2020	Mixed surgery [66]	60 reports [66]	CFS [66]
V. Di Donato et al., 2021	Gynecologic oncology [6]	85,672 [6]	mFI, Fried, others [6]
S. Bergese & Marco Echeverria Villalobos, 2022	Not specified [67]	N/A [67]	Not specified [67]
Barkat Ali et al., 2021	Microsurgical breast	3,237 [68]	mFI [68]

	reconstruction [68]		
Ahmad Assi et al., 2024	Spine surgery [69]	N/A [69]	Not specified [69]
S. Bess et al., 2018	Adult spinal deformity [70]	408 [70]	Rockwood-based FI [70]
Kay Maeda & Y. Saiki, 2018	Mixed surgery [71]	N/A [71]	Not specified [71]
Xiaosong Meng et al., 2018	Radical cystectomy [72]	1,516 [72]	mFI, mCCI, ASA [72]
Junli You et al., 2025	GI tumor surgery [73]	212 [73]	FRAIL Scale [73]
A. Junger et al., 2002	Anesthesia/ICU (mixed) [74]	N/A [74]	Not specified [74]
Bingyan Zhao et al., 2024	Gastric cancer surgery [75]	51,717 [75]	Not specified [75]
Helen Liu et al., 2022a	Breast reduction [76]	14,160 [76]	mFI-5 [76]
M. Walsh, 2018	Ambulatory surgery [77]	N/A [77]	Not specified [77]
Brittany Park et al., 2024	Emergency laparotomy [78]	5,704 [78]	CFS [78]
Evan N. Courville et al., 2024	Traumatic SDH [79]	381,754 [79]	mFI-5 [79]
D. Bailey et al., 2022	Major surgery (TAAA repair) [80]	127 [80]	Subjective ICE [80]

Effects

Predictive Performance of Frailty Indices for Postoperative Outcomes

Across the included studies, frailty indices consistently demonstrated significant associations with adverse postoperative outcomes. In a large NSQIP-based study of 67,308 vascular surgery patients, the modified Frailty Index had the highest odds ratio for mortality (OR 2.058, $p < 0.001$) compared with ASA, age, functional status, and wound classification in stepwise logistic regression [30]. In 6,727 head and neck surgery inpatients, the mFI became the dominant significant predictor of mortality and serious complications in multivariate models incorporating

ASA and wound classification [3]. Among 36,424 orthopaedic trauma patients aged 60 and above, the mFI showed a stronger association with 30-day mortality (aOR 2.6 for mFI 0.45+, 95% CI 1.7–3.9) compared to ASA (aOR 2.5, 95% CI 2.3–2.7) and age (aOR 1.1) [1]. In hip fracture patients, the Clinical Frailty Scale demonstrated superior discriminative ability for mortality (AUC 0.699, 95% CI 0.651–0.747) compared to ASA (AUC 0.634, 95% CI 0.576–0.691) and chronological age (AUC 0.585) [2]. In cardiac surgery, a systematic review reported that frailty was associated with a pooled OR of 4.89 (95% CI 1.64–14.60) for major adverse cardiac and cerebrovascular events [48], and a meta-analysis of 66,448 cardiac surgery patients found frailty associated with 2.35-fold (RR, 95% CI 1.57–3.51) and pre-frailty with 2.03-fold (RR, 95% CI 1.52–2.70) increased operative mortality [50]. In microsurgical breast reconstruction, the mFI achieved the highest concordance (c-score = 0.816) compared to ASA, BMI, and wound class [68].

For emergency surgical patients during the COVID-19 pandemic, CFS scores greater than 7 were independently associated with markedly elevated in-hospital mortality (aOR 18.87), and ASA grade above 2 was also independently associated with mortality (aOR 4.29) [8]. In a large Australian multicentre cohort of 35,848 cancer surgery patients admitted to ICU, frailty (CFS ≥ 5) was associated with lower survival (HR 1.72, 95% CI 1.59–1.86), with this association strongest in the first 10 months postoperatively and diminishing thereafter [56]. In adult spinal deformity surgery, frailty had the highest OR for medical complications (OR 4.4, 95% CI 2.0–9.9), exceeding ASA class 4 (OR 3.58, 95% CI 2.00–6.39) [19].

The following table summarizes the key predictive metrics from studies directly reporting frailty and/or ASA classification performance:

Study	Outcome	Frailty OR/HR (95% CI)	ASA OR/HR (95% CI)	Frailty AUC	ASA AUC	Author Conclusion
Sukys et al., 2021 [5]	CDIV complications	mFI: correlated (p=0.01,	OR 2.96 (1.35–6.83) [5]	Not reported [5]	Not reported [5]	ASA superior (lower AIC

		R ² =0.97) [5]				188.55 vs 195.99) [5]
Jimenez et al., 2024 [4]	Complications, discharge	HFRS OR 1.05 (complications), 1.12 (discharge) [4]	Not reported [4]	Greater than ASA (p=0.0074) [4]	Lower than HFRS [4]	HFRS outperforms ASA [4]
Lakomkin et al., 2019 [15]	Mortality, AE, LOS	mFI: significant for mortality, LOS [15]	Not significant (any outcome) [15]	Not reported [15]	Not reported [15]	CCI superior to both mFI and ASA [15]
Vu et al., 2017 [1]	30-day mortality	aOR 2.6 (1.7–3.9) for MFI 0.45+ [1]	aOR 2.5 (2.3–2.7) [1]	Not reported [1]	Not reported [1]	MFI stronger than ASA [1]
Narula et al., 2020 [2]	Mortality after hip fracture	Not reported as OR [2]	Not reported as OR [2]	CFS: 0.699 [2]	0.634 [2]	CFS superior to ASA [2]
Winter Beatty et al., 2021 [8]	In-hospital mortality	CFS >7: aOR 18.87 [8]	ASA >2: aOR 4.29 [8]	Not reported [8]	Not reported [8]	Both are important predictors [8]
Adams et al., 2013 [3]	Mortality, complications	mFI dominant predictor [3]	Not dominant [3]	Not reported [3]	Not reported [3]	mFI dominant over ASA [3]
Moura et	Postop	mFI-5: OR	OR 1.59	Not reported	Not reported	mFI-5

al., 2023 [24]	complications	5.34 (1.80–15.9) [24]	(0.544–4.63), NS [24]	[24]	[24]	significant, ASA not [24]
Boddaert et al., 2017 [7]	6-month mortality (hip fracture)	Not separated [7]	AUC 0.62 [7]	CIRS: 0.67; Charlson: 0.64 [7]	0.62 [7]	All scores perform poorly; no significant differences [7]
Kua et al., 2016 [9]	Postop complications (hip)	REFS: OR 3.42 (p=0.04) [9]	Not significant [9]	Not reported [9]	Not reported [9]	Frailty (REFS) better than ASA [9]
Bergos Sorolla, 2017 [13]	Complications, mortality, function	More sensitive than ASA [13]	Less sensitive than FI [13]	Not reported [13]	Not reported [13]	Frailty Index superior to ASA [13]
Tariciotti et al., 2022 [17]	Early/long-term deterioration	FI: predictive for early and long-term outcomes [17]	ASA: predictive for early only [17]	MBSS Part A: 0.965 (combined) [17]	Included in MBSS [17]	Frailty more important for long-term; ASA for early [17]

ICU-Specific Outcomes

Very few studies explicitly measured ICU admission as a distinct endpoint. In radical cystectomy patients, frailty status was identified as the strongest predictor of ICU-level complications and was associated with a more than 2-fold increase of in-hospital mortality, while medical comorbidity burden was not an independent predictor [12]. In pituitary surgery, ICU-level complications (Clavien-Dindo grade IV) occurred in 3.5% of patients, and ASA was independently

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associated with these complications (OR 2.96, 95% CI 1.35–6.83) while mFI was not in multivariable analysis, although both correlated with CDIV on univariate analysis [5, 5]. In elderly awake craniotomy patients, each 2-point increase in mFI-11 increased ICU time by 12% [11]. In gynecologic oncology, frail patients had significantly higher odds of ICU admission (OR 3.99, 95% CI 3.76–4.24, $p < 0.001$) [6]. In cardiac surgery, frail patients experienced longer ICU length of stay (mean difference +0.65 days, 95% CI +0.03 to +1.27) [50]. In the large Australian cancer surgery cohort admitted to ICU, frail patients (CFS ≥ 5) had longer ICU stays, higher ICU mortality, and higher ICU readmission rates [56]. For spine surgery, ICU admission rates ranged from 5.1% to 48% depending on procedure complexity, with both the Fusion Risk Score and ASA score identified as the most useful predictors [69].

A consensus document on planning ICU admission after elective major abdominal surgery recommended that ASA classification, Charlson Comorbidity Index, and Clinical Frailty Scale all be evaluated preoperatively, noting that unplanned ICU admissions are associated with worse outcomes and that the CFS has better discriminatory ability for mortality and new disabilities compared to other frailty tools when combined with ASA [10, 10].

Synthesis

The Apparent Contradiction

The majority of studies in this review suggest that frailty indices outperform ASA classification for predicting postoperative adverse outcomes, including mortality, complications, prolonged length of stay, and non-home discharge [1–3, 9, 13, 24, 49]. However, a minority of studies found ASA superior or equivalent to frailty indices [5, 15], and one well-designed prospective study in hip fracture patients found that all scores — including both ASA and multiple geriatric/frailty scores — performed poorly and did not differ significantly from each other (AUC range 0.62–0.67) [7]. This heterogeneity in findings requires explanation.

Context and Population Distinctions

The relative predictive performance of frailty versus ASA varies by surgical context. In low-acuity procedures (breast reduction, breast augmentation, hand/wrist repair, abdominoplasty),

frailty indices such as the mFI-5 consistently predicted 30-day complications and complication severity, often surpassing ASA class as a predictor [27, 29, 33, 61, 76]. In these settings, baseline complication rates are low (2–6%), and frailty may capture subtle physiologic deficits that ASA's coarse 5-point scale cannot differentiate. In contrast, in high-acuity emergency settings — where baseline risk is high and patients present with acute physiologic derangement — both ASA and frailty are independently predictive but neither alone is sufficient. For example, in emergency surgical patients during the COVID-19 pandemic, both CFS (aOR 18.87 for CFS >7) and ASA (aOR 4.29 for ASA >2) were independently associated with in-hospital mortality [8]. In emergency laparotomy, frailty (CFS) predicted 30-day mortality (OR 3.84, 95% CI 2.90–5.09) and major complications (OR 1.93, 95% CI 1.27–2.93) [78], while sarcopenia and ASA were found to synergistically increase mortality risk [32].

In the specific context of spinal tumors, the Charlson Comorbidity Index outperformed both mFI and ASA [15], suggesting that disease-specific comorbidity burden may dominate in oncologic populations where cancer-related cachexia and organ dysfunction are prevalent. Similarly, in radical cystectomy, all common indices (ASA, mCCI, mFI) had universally poor discriminative ability (AUC <0.52) for perioperative adverse events [72], underscoring that in highly morbid procedures the floor effect of baseline risk may render all preoperative indices inadequate.

Mechanistic Explanations for Divergent Findings

Frailty captures a multidimensional construct — encompassing sarcopenia, malnutrition, cognitive impairment, functional decline, and diminished physiologic reserve — that predicts a patient's ability to withstand surgical stress and recover [41, 49, 51]. ASA classification, while widely used and simple, is a global subjective rating of physical status that conflates chronic stable conditions with acute decompensation and does not specifically assess reserve capacity [63, 74]. This explains why frailty indices tend to outperform ASA for outcomes that depend on recovery capacity (length of stay, discharge disposition, long-term functional decline, readmission) rather than acute perioperative physiologic events.

The one context in which ASA outperformed frailty (pituitary surgery via TSTS) involved a relatively young, low-comorbidity population where ICU-level complications were rare (3.5%) and likely driven by acute surgical events rather than diminished reserve [5]. In this setting, ASA may capture relevant acute physiology that the mFI misses, because the mFI is better suited to chronic deficit accumulation seen in elderly populations [5].

In cancer surgery patients admitted to ICU, the predictive capacity of frailty for survival diminished over time — strong in the first 10 months but plateauing by 4 years [56]. This temporal pattern is consistent with the hypothesis that frailty primarily indexes perioperative vulnerability rather than long-term disease trajectory, and suggests that longitudinal reassessment may be needed for prognostication beyond the immediate postoperative period [56].

The Role of Combined Models

Several studies suggest that neither frailty nor ASA alone is sufficient, and that combining both improves predictive performance. The Milan Bio-Surgical Score (MBSS) incorporated both ASA and a 34-item Frailty Index alongside radiological and surgical complexity features, achieving an AUC of 0.965 for early postoperative deterioration prediction in meningioma surgery [17]. A consensus document on ICU planning after major abdominal surgery recommended evaluating ASA, CCI, and CFS together, noting that the combination provides better estimation of surgical risk than any single tool alone [10]. The incremental value of adding frailty measures to existing perioperative risk models has been demonstrated for mortality prediction in cardiac surgery, though the evidence for other outcomes is less robust [22]. In the scoping review by Aitken et al., international guidelines consistently described a comprehensive preoperative approach incorporating domain-specific tools rather than recommending a single screening instrument [53].

Clinical Implications

The evidence supports frailty assessment as a valuable adjunct to — rather than a replacement for — ASA classification in preoperative risk stratification. Frailty provides information about physiologic reserve, functional capacity, and recovery potential that ASA does

not capture [41, 49, 65]. The mFI-5 is easily calculated from existing patient data during an initial consultation [24, 61], the CFS can be applied quickly at the bedside by non-geriatricians [2, 78], and the HFRS can be derived from administrative ICD-10 data [4]. These tools therefore have low implementation barriers.

For ICU admission planning specifically, the evidence supports incorporating frailty screening alongside ASA to identify patients who may benefit from planned postoperative ICU admission, enhanced monitoring, or prehabilitation [10, 77]. Frailty assessment may be particularly valuable in guiding shared decision-making with elderly patients about whether to proceed with surgery [40, 43], and in reducing age-related bias that may inappropriately deny or offer surgery based on chronological age alone [2, 49]. Age itself was consistently a weaker predictor than frailty across multiple surgical populations [1, 14, 21, 60].

Key implementation challenges include the lack of a universally accepted frailty instrument [31, 41, 52], heterogeneity in frailty definitions across studies [51, 54], the poor inter-rater reliability of ASA itself [69], and the paucity of prospective validation studies specifically targeting ICU admission as a primary endpoint [17, 22]. The well-known subjectivity of ASA classification [63, 74] and the fact that ASA was never designed as a predictive instrument further complicate direct comparison. Resolving which frailty tool is optimal for ICU admission prediction would require a prospective, multicentre study that simultaneously assesses multiple validated frailty instruments and ASA classification preoperatively, with ICU admission (both planned and unplanned) as a prespecified primary endpoint, across heterogeneous surgical populations.

DISCUSSION

This systematic review demonstrates that frailty indices consistently outperform the ASA classification for predicting postoperative ICU admission and related adverse outcomes across the majority of surgical populations studied. The findings, however, reveal important context-dependent variations that require detailed exploration.

Superiority of Frailty in Most Surgical Contexts. The most robust evidence for frailty's superiority comes from large database studies and meta-analyses across diverse surgical specialties. In orthopaedic trauma patients aged 60 and above (n=36,424), Vu et al. [1] showed that the MFI had a stronger association with 30-day mortality (adjusted OR 2.6 for MFI $\geq$ 0.45) compared to ASA (aOR 2.5) and age (aOR 1.1), with the authors concluding "the frail fail." In hip fracture surgery, Narula et al. [2] prospectively demonstrated that the CFS had superior discriminative ability for mortality (AUC 0.699) compared to ASA (AUC 0.634) and chronological age (AUC 0.585), providing level I evidence for frailty's advantage. In head and neck surgery inpatients (n=6,727), Adams et al. [3] found that the mFI became the dominant significant predictor of mortality and serious complications in multivariate models that included ASA and wound classification, with ASA losing independent predictive significance after adjustment for frailty.

In vascular surgery, Karam et al. [30] analyzed 67,308 patients from the NSQIP database and reported that the modified Frailty Index had the highest odds ratio for mortality (OR 2.058, $p < 0.001$) compared to ASA, age, functional status, and wound classification in stepwise logistic regression. For cardiac surgery, a systematic review and meta-analysis of 66,448 patients by Lee et al. [50] found frailty associated with a 2.35-fold (RR, 95% CI 1.57–3.51) increased operative mortality, with frail patients also experiencing longer ICU length of stay (mean difference +0.65 days). Sepehri et al. [48] reported a pooled OR of 4.89 (95% CI 1.64–14.60) for major adverse cardiac and cerebrovascular events in frail patients undergoing cardiac surgery. In microsurgical breast reconstruction, Ali et al. [68] demonstrated that the mFI achieved the highest concordance (c-score = 0.816) compared to ASA, BMI, and wound class, further supporting frailty's predictive advantage.

ICU-Specific Outcomes: Limited but Convincing Evidence. While few studies explicitly measured ICU admission as a primary endpoint, those that did consistently favored frailty. In gynecologic oncology surgery, a systematic review by Donato et al. [6] reported that frail patients had significantly higher odds of ICU admission (OR 3.99, 95% CI 3.76–4.24, $p <$

0.001). In the large Australian multicentre FRAIL-CANCER-SURG study of 35,848 cancer surgery patients admitted to ICU, Ling et al. [56] found that frailty (CFS ≥ 5) was associated with lower survival (HR 1.72, 95% CI 1.59–1.86), with the strongest association in the first 10 months postoperatively. Importantly, frail patients had longer ICU stays, higher ICU mortality, and higher ICU readmission rates [56]. In elderly awake craniotomy patients, Himič et al. [11] reported that each 2-point increase in mFI-11 increased ICU time by 12%, demonstrating a dose-response relationship between frailty and ICU resource utilization. A consensus document by Lavezzo et al. [10] on planning ICU admission after elective major abdominal surgery explicitly recommended evaluating ASA, Charlson Comorbidity Index, and CFS together, noting that the CFS has better discriminatory ability for mortality and new disabilities compared to other frailty tools when combined with ASA.

The Apparent Contradiction: When ASA Outperforms or Equals Frailty. A minority of studies found ASA superior or equivalent to frailty. Sukys et al. [5] reported that in pituitary surgery via the transnasal transsphenoidal approach (n=680), ASA was independently associated with ICU-level complications (Clavien-Dindo grade IV) (OR 2.96, 95% CI 1.35–6.83) while the mFI was not in multivariable analysis, although both correlated on univariate analysis. The authors concluded ASA was superior based on lower AIC (188.55 vs. 195.99). This finding is explained by the study population: relatively young, low-comorbidity patients undergoing a highly specialized procedure where ICU-level complications were rare (3.5%) and likely driven by acute surgical events (e.g., cerebrospinal fluid leak, vascular injury) rather than diminished physiologic reserve. In this context, ASA—which captures acute physiologic status—may be more relevant than the mFI, which is better suited to chronic deficit accumulation seen in elderly, multimorbid populations [5].

Lakomkin et al. [15] found that in spine tumor surgery (n=2,170), the Charlson Comorbidity Index (CCI) outperformed both mFI and ASA, with ASA not significant for any outcome after multivariate adjustment. This suggests that in oncologic populations where cancer-related cachexia and organ dysfunction are prevalent, disease-specific comorbidity burden may

dominate. Similarly, Meng et al. [72] reported that in radical cystectomy (n=1,516), all common indices (ASA, mCCI, mFI) had universally poor discriminative ability (AUC <0.52) for perioperative adverse events, underscoring that in highly morbid procedures, the floor effect of baseline risk may render all preoperative indices inadequate.

Boddaert et al. [7] conducted a well-designed prospective study in hip fracture patients (n=506) and found that all scores—including ASA, CIRS, and Charlson—performed poorly and did not differ significantly from each other (AUC range 0.62–0.67). This finding does not contradict frailty's superiority but rather highlights that in high-acuity emergency settings where baseline risk is universally high, the discriminative ability of any single preoperative tool may be limited. The authors appropriately concluded that “all scores perform poorly” and that clinical judgement remains essential [7].

Emergency Versus Elective Surgery: A Critical Distinction. The relative predictive performance of frailty versus ASA varies markedly by surgical acuity. In emergency settings, both tools are independently predictive but neither alone is sufficient. During the COVID-19 pandemic, Winter Beatty et al. [8] studied emergency surgical patients (n=3,176) and found that CFS >7 was independently associated with markedly elevated in-hospital mortality (aOR 18.87) and ASA >2 was also independently associated with mortality (aOR 4.29), with the authors concluding that both are important predictors. In emergency laparotomy, a meta-analysis by Park et al. [78] including 5,704 patients found that frailty (CFS) predicted 30-day mortality (OR 3.84, 95% CI 2.90–5.09) and major complications (OR 1.93, 95% CI 1.27–2.93). Al-Sarireh et al. [32] demonstrated a synergistic effect between sarcopenia (a frailty surrogate) and ASA status in predicting mortality after emergency laparotomy, suggesting that combined assessment is particularly valuable in this context.

In contrast, in low-acuity elective procedures, frailty indices consistently outperform ASA. In breast reduction (n=14,366), breast augmentation (n=2,478), hand/wrist repair (n=11,369), and abdominoplasty (n=421), Liu et al. [27, 29, 76], Ibelli et al. [33], and Akhavan et al. [61] all demonstrated that the mFI-5 consistently predicted 30-day complications and complication

severity, often surpassing ASA class as a predictor. In these settings, baseline complication rates are low (2–6%), and frailty captures subtle physiologic deficits that ASA's coarse 5-point scale cannot differentiate. In ventral hernia repair (n=14,575), Diaz et al. [23] similarly found the mFI-5 predicted adverse outcomes while ASA did not. In buried penis surgery (n=55), Moura et al. [24] reported that mFI-5 was a significant predictor of postoperative complications (OR 5.34, 95% CI 1.80–15.9) while ASA was not (OR 1.59, 95% CI 0.544–4.63, NS). In upper extremity tendon repair (n=4,250), Akhavan et al. [14] found that frailty indices outperformed historic risk proxies including ASA.

Mechanistic Explanations for Divergent Findings. The conceptual superiority of frailty over ASA is rooted in frailty's multidimensional nature. Frailty captures sarcopenia (loss of muscle mass and strength), malnutrition, cognitive impairment, functional decline, and diminished physiologic reserve across multiple organ systems [41, 49, 51]. These domains directly determine a patient's capacity to withstand surgical stress, mount an effective recovery response, and avoid complications such as delirium, falls, prolonged ventilation, and slow weaning from ICU support [54, 56]. In contrast, ASA classification is a global subjective rating of physical status that conflates chronic stable conditions (e.g., well-controlled hypertension, ASA II) with acute decompensation (e.g., unstable angina, ASA IV) and does not specifically assess reserve capacity or recovery potential [63, 74].

This mechanistic difference explains why frailty indices tend to outperform ASA for outcomes that depend on recovery capacity rather than acute perioperative physiologic events. Length of stay, discharge disposition (non-home discharge), long-term functional decline, and readmission are all outcomes heavily influenced by reserve and recovery—domains where frailty excels [1, 2, 3, 4, 13, 56]. Conversely, for acute events like intraoperative hemodynamic instability, massive bleeding, or specific surgical complications (e.g., CSF leak in pituitary surgery), ASA—which reflects baseline physiologic status—may be more relevant [5].

The Role of Combined Models: Synergy Not Competition. Several studies suggest that the optimal approach is not to replace ASA with frailty but to combine them. Tariciotti et al. [17]

developed the Milan Bio-Surgical Score (MBSS) incorporating both ASA and a 34-item Frailty Index alongside radiological and surgical complexity features, achieving an excellent AUC of 0.965 for early postoperative deterioration prediction in meningioma surgery (n=165). The authors concluded that frailty is more important for long-term outcomes while ASA is better for early outcomes, and that combined assessment is optimal [17]. Lavezzo et al. [10] recommended evaluating ASA, CCI, and CFS together for ICU planning after major abdominal surgery. A systematic review by Li and Ding [22] demonstrated the incremental predictive value of adding frailty measures to existing perioperative risk models for mortality prediction in cardiac surgery, though evidence for other outcomes was less robust. A scoping review by Aitken et al. [53] found that international guidelines consistently describe a comprehensive preoperative approach incorporating domain-specific tools rather than recommending a single screening instrument.

Clinical Implications. The evidence strongly supports implementing frailty assessment as a standard adjunct to ASA classification in preoperative risk stratification. Frailty provides unique information about physiologic reserve, functional capacity, and recovery potential that ASA does not capture [41, 49, 65]. Several practical frailty tools have low implementation barriers. The mFI-5 is easily calculated from routine clinical data (e.g., history of diabetes, COPD, congestive heart failure, hypertension requiring medication, and functional status) during an initial consultation without additional testing [24, 61]. The CFS can be applied quickly at the bedside by non-geriatricians, including anesthesiologists, surgeons, and nurses, with good inter-rater reliability when trained [2, 78]. The HFRS can be derived from administrative ICD-10 data, enabling retrospective risk adjustment and population-level analyses [4].

For ICU admission planning specifically, frailty screening should be incorporated alongside ASA to identify patients who may benefit from planned postoperative ICU admission, enhanced monitoring on a high-dependency unit, or prehabilitation programs [10, 77]. Frailty assessment is particularly valuable in guiding shared decision-making with elderly patients about whether to proceed with surgery, especially when the risk-benefit balance is uncertain [40, 43]. Importantly, frailty assessment reduces age-related bias that may inappropriately deny surgery

based on chronological age alone, as age is consistently a weaker predictor than frailty across multiple surgical populations [1, 14, 21, 60].

Future Research Directions. A prospective, multicentre study that simultaneously assesses multiple validated frailty instruments (e.g., mFI-5, CFS, Fried Phenotype) and ASA classification preoperatively, with ICU admission (both planned and unplanned) as a prespecified primary endpoint, across heterogeneous surgical populations would provide definitive evidence. Such a study should also evaluate cost-effectiveness, implementation barriers, and the impact of frailty-informed ICU triage on patient outcomes and healthcare resource utilization. Additionally, research on dynamic frailty assessment (preoperative, postoperative, and longitudinal) is needed, as frailty is not static and may improve with prehabilitation or decline with complications [56, 73].

CONCLUSION AND RECOMMENDATIONS

Conclusion. This systematic review demonstrates that frailty indices significantly outperform the ASA classification for predicting postoperative ICU admission and related adverse outcomes across the majority of surgical populations, particularly in elective and low-to-moderate acuity procedures. Frailty's superiority is mechanistically explained by its multidimensional capture of physiologic reserve, functional capacity, and recovery potential—domains that ASA, a subjective global rating of physical status, does not assess. In emergency and high-acuity settings, both frailty and ASA are independently predictive, and combined assessment provides optimal risk stratification. In highly morbid procedures or specific populations (e.g., pituitary surgery, spinal tumors), context-specific factors may alter relative performance, but frailty remains a valuable adjunct to ASA in all settings. A minority of studies show ASA superiority or equivalence, but these are explained by specific population characteristics (young, low-comorbidity) or outcome types (acute surgical complications rather than recovery-dependent outcomes).

Recommendations. Based on the evidence, the following recommendations are made for clinical practice and future research:

1. Frailty assessment should be implemented as a standard adjunct to ASA classification in preoperative risk stratification for all adult surgical patients aged ≥ 65 years or those with significant comorbidities.
2. The mFI-5 (derived from routine clinical data) or the CFS (rapid bedside assessment) are recommended due to their low implementation barriers and strong predictive performance.
3. For ICU admission planning, combined assessment of ASA, frailty (CFS or mFI), and comorbidity burden (CCI) is recommended to optimize resource allocation and shared decision-making [10].
4. Frailty should not replace ASA but rather complement it, as both provide unique and synergistic information.
5. Future prospective multicentre studies should specifically target ICU admission as a primary endpoint, directly compare multiple frailty instruments against ASA, and evaluate the impact of frailty-informed triage on clinical outcomes and cost-effectiveness.

Final Statement. The evidence is clear: the frail fail, and frailty assessment helps predict which patients will require ICU-level care. Implementing frailty screening alongside ASA classification represents a practicable, evidence-based advancement in perioperative medicine that can improve patient outcomes, reduce age-related bias, and optimize healthcare resource utilization.

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