

Is Sarcopenia Associated with Worse Postoperative Outcomes following Emergency Laparotomy? A Systematic Review and Meta-analysis

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Abstract

Introduction: The association between sarcopenia and many postoperative outcomes is not well-established. **Aims:** This meta-analysis aims to clarify the potential of sarcopenia to predict these postoperative outcomes. **Methods:** A search of PubMed, EMBASE, and Cochrane CENTRAK databases was performed until November 2023 in accordance with Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines. Studies that met the inclusion criteria were extracted and their quality assessment was done using the Newcastle–Ottawa Scale. The pooled analysis was done using a random-effects model with dichotomous outcomes expressed as odds ratio (OR) and continuous as weighted mean differences with 95% confidence intervals (CIs). **Results:** Seventeen studies met the inclusion criteria with a total of 5879 patients, with 1690 diagnosed with sarcopenia. Sarcopenia was shown to be significantly associated with increased risk of inpatient mortality (OR = 5.18, 95% CI: 1.04–25.68; $P = 0.04$), 30-day mortality (OR = 3.32, 95% CI: 2.02–5.46; $P < 0.00001$), 90-day mortality (OR = 4.24, 95% CI: 1.19–15.12; $P = 0.03$) and 1-year mortality (OR = 2.53, 95% CI: 1.25–5.12; $P = 0.01$). Sarcopenic was also associated with an increased risk of severe complications, cardiac complications, pulmonary complications, renal complications, postoperative infections, intensive care unit and hospital length of stay and the risk of unfavorable discharge. There was no significant association between sarcopenia and risk of leakage. **Conclusion:** Our meta-analysis provided insights into sarcopenia and postoperative outcomes of emergency surgeries. We demonstrated the significant association between the presence of sarcopenia and the presentation of postoperative adverse outcomes and markers of worsened quality of recovery.

Keywords: Emergency laparotomy, meta-analysis, mortality, sarcopenia

INTRODUCTION

Sarcopenia indicates mortality and morbidity. While primarily affecting the elderly, it can arise from endocrine changes, chronic diseases, inflammation, insulin resistance, and nutritional deficiencies.^[1–4]

Studies show sarcopenia negatively impacts postoperative outcomes, extended hospital stays, and increased mortality rates, particularly after emergency laparotomy (EL).^[5–12]

Preoperative assessments utilize computed tomography (CT) imaging to evaluate skeletal muscle status.^[13] However, limited research poses challenges, necessitating further meta-analyses

to enhance understanding, as previous studies had constrained results.^[14–16]

We aim to conduct a meta-analysis to explore the entire body of current literature and incorporate a broader range of outcomes than evaluated previously.

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METHODS

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines.^[17] Two independent researchers (AF and UA) performed a comprehensive literature search by electronically searching PubMed, EMBASE, and the Cochrane CENTRAL databases up to November 2023 using keywords such as “sarcopenia,” “laparotomy,” and “emergency surgery,” along with their synonyms and relevant MeSH terms where appropriate. The detailed search strategy for each database is provided in Supplementary Table 1. We also screened the reference lists of relevant reviews identified during the search to identify additional published observational studies. The search was conducted without any language or regional restrictions.

Articles retrieved from the literature search were first exported to EndNote Reference Library software, where duplicate records were removed. Two reviewers (AF and UA) worked independently to screen the remaining records, and any disagreements were resolved by consulting a third reviewer (MTM). The screening process involved assessing titles and abstracts of studies for relevance, followed by a full-text review of all articles that made it past the initial title and abstract screening. The inclusion of the articles was based on the predetermined eligibility criteria mentioned below.

We included all studies in our meta-analysis, which were comparing sarcopenia patients with nonsarcopenia patients, and were also meeting the following inclusion criteria: (1) Adult populations (>18 years of age); (2) Patients undergoing EL; (3) Studies grouping patients as sarcopenic and nonsarcopenic based on physician established cutoffs; (4) relevant CT scan data available. The exclusion criteria for this study were: (1) Pediatric population (<18 years of age); (2) Patients undergoing elective surgery; (3) Studies without distinct sarcopenia and nonsarcopenia cohorts with separate data for each; and (4) Studies not reporting the outcome data in a manner that can be used for analysis.

Two researchers (AF and UA) performed data extraction and quality assessment of the included studies independently, and any disagreements were resolved by consulting a third researcher (MTM). Initially, baseline information was retrieved from the studies, including the author name, year of study, study period, study design, country, hospital setting, number of patients, number of patients with sarcopenia, male/female ratio, age of patients, imaging method, and parameters used to diagnosed sarcopenia, as well as the most common indication for surgery. Following this, outcome data were extracted. The main outcomes of interest were inpatient mortality, 30-day mortality, 90-day mortality, and 1-year mortality. Secondary outcomes included severe complications (defined as >3 Clavien–Dindo classification), cardiac complications, pulmonary complications, renal complications, postoperative infection, leakage, length of stay (LOS) in intensive care

unit (ICU), LOS in hospital and unfavorable discharge (defined as discharge to home with a caretaker, discharge to a nursing home, discharge to a rehabilitation facility or discharge to another hospital).

The quality assessment of the included studies was done using the Newcastle–Ottawa Scale (NOS).^[18] The NOS evaluated the quality of each study based on key domains such as selection, comparability, and outcomes reported.

Data was analyzed using Review Manager Software (RevMan) version 5.4.1 using a random-effects model. Data were presented as odds ratios (ORs) and weighted mean differences (MDs) with 95% confidence intervals (CIs). Higgins’ I^2 statistics was used to evaluate heterogeneity across pooled studies, with $I^2 = 25\%$ – 50% considered low, $I^2 = 50\%$ – 75% moderate, and $I^2 > 75\%$ being considered high heterogeneity. A value $< I^2 = 25$ was considered to have no significant heterogeneity between studies. Publication bias was evaluated using Begg’s test and a visual inspection of the funnel plot. Statistical significance was determined at a $P < 0.05$ in all cases.

RESULTS

Following the removal of 111 duplicate records, 173 studies remained for title and abstract screening. Of these, 127 records were excluded based on irrelevance, leaving 46 articles for full-text assessment.

After full-text review, 29 studies were excluded for the following reasons: inclusion of elective surgical populations rather than EL ($n = 10$); absence of clearly defined sarcopenic and nonsarcopenic cohorts or inability to extract separate data ($n = 8$); lack of relevant or usable CT-based body composition data ($n = 6$); and inclusion of pediatric or mixed-age populations without separable adult data ($n = 5$).

Ultimately, 17 studies met all inclusion criteria and were included in the final meta-analysis.

A PRISMA flow chart summarizing our search process has been provided in Figure 1.

All included studies were retrospective in nature except for one,^[7] which was prospective. The individual study sample sizes varied from 89 to 967, encompassing a total of 5879 patients, of which 1690 had sarcopenia. 49.5% of the participants were male and 50.5% were female. The baseline characteristics of included studies is outlined in Table 1.

The risk of bias assessment is presented in Tables 2 and 3. All included studies were of a reasonably high methodological quality. Symmetry in the funnel plot [Supplementary Figure 1] indicates the absence of small study and publication bias.

Forest plots summarizing the results of the meta-analysis can be found in Figures 2–5 and Supplementary Figures 2–10.

Inpatient mortality

Five of the 17 included studies reported inpatient mortality, with a total of 1896 participants. The pooled analysis showed

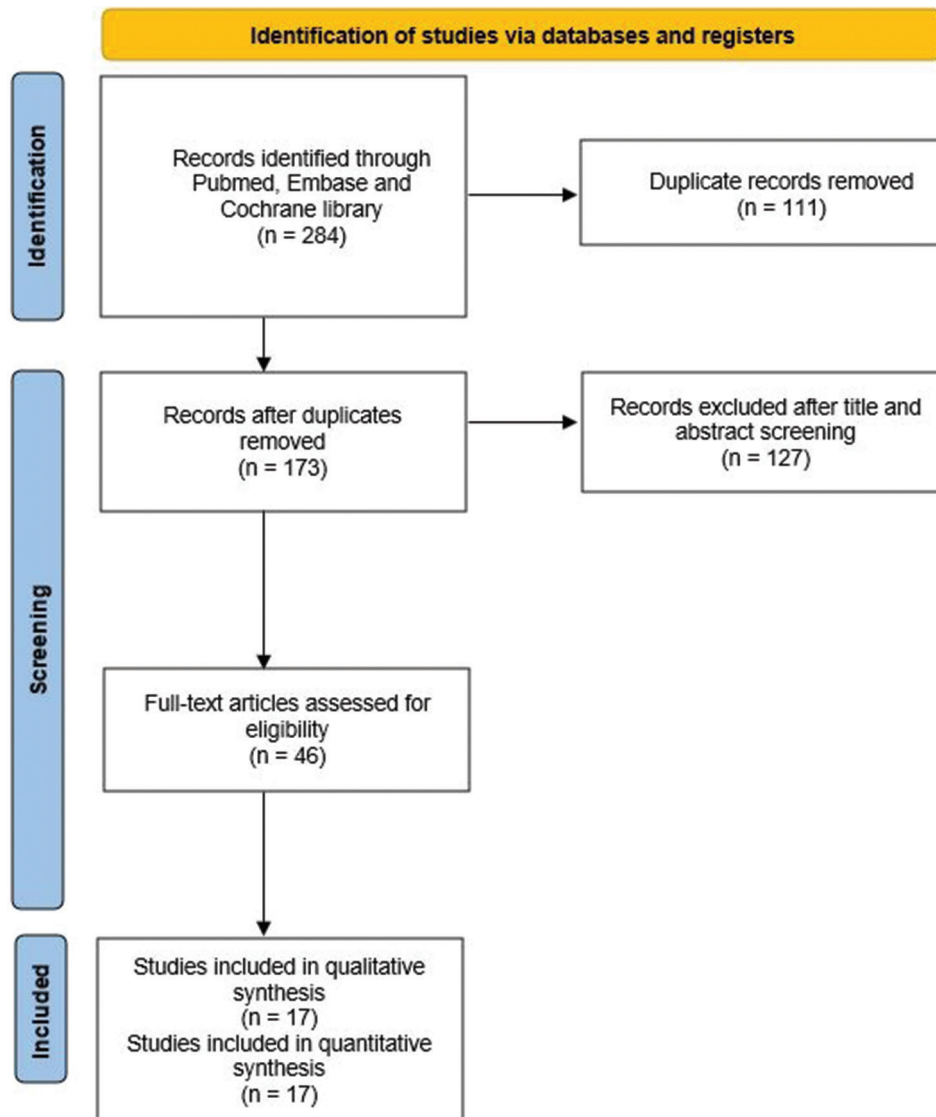


Figure 1: Preferred Reporting Items for Systematic Review and Meta-Analyses flow chart summarizing literature search results

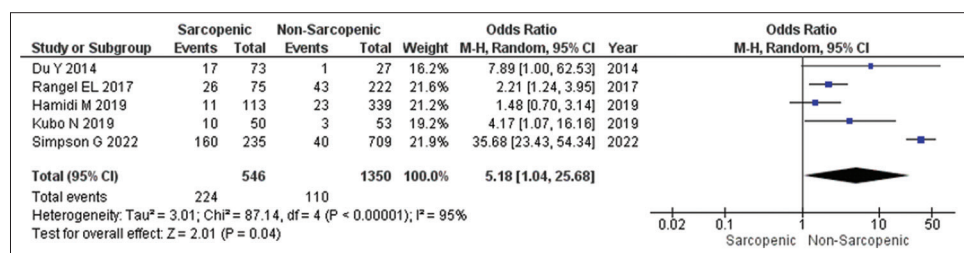


Figure 2: Forest plot of inpatient mortality

that sarcopenia was associated with a significantly higher risk of inpatient mortality [OR = 5.18, 95% CI: 1.04–25.68; $P = 0.04$; Figure 2]. There was high heterogeneity between studies ($I^2 = 95\%$).

30-day mortality

Fifteen of the 17 included studies reported 30-day mortality, with a total of 5614 participants. The pooled analysis showed

that sarcopenia was associated with a significantly higher risk of 30-day mortality [OR = 3.32, 95% CI: 2.02–5.46; $P < 0.00001$; Figure 3]. There was high heterogeneity between studies ($I^2 = 86\%$).

90-day mortality

Five of the 17 included studies reported 90-day mortality, with a total of 2179 participants. The pooled analysis showed that

Table 1: Baseline characteristics of the included studies

Baseline characteristics									
Included studies	Study period	Study design	Country	Number of patients	Number of sarcopenic patients	Sex (Male/Female)	Age (years)	Imaging method	Surgery indication
Wang <i>et al.</i> , 2023 ^[19]	2011–2016	Case Control	Taiwan	146	80	75/71	77.9±7.0	L3 SMG	Perforated peptic ulcers
Tan <i>et al.</i> , 2022 ^[5]	2016–2019	Case Control	Singapore	289	49	167/122	75.5±6.9	L3 SMI	Bowel obstruction, perforation, bowel ischemia
Wu <i>et al.</i> , 2022 ^[6]	2019–2021	Cohort	China	228	56	138/90	57.7±15.8	Psoas muscle to L3 vertebral body ratio (PML3)	Small bowel resection, perforation repair, appendectomy, others
Barazanchi <i>et al.</i> , 2022 ^[20]	2012–2017	Cohort	New Zealand	167	84	85/82	75.6±7.2	L3 SMI	Adhesiolysis, small bowel resection, right hemicolectomy and left hemicolectomy
Body <i>et al.</i> , 2022 ^[7]	2017–2018	Cohort	England	609	179	283/326	71 (57–79)	L3 SMI	Small bowel obstruction
Simpson <i>et al.</i> , 2022 ^[21]	2014–2018	Cohort	United Kingdom	944	235	442/502	76 (70–82)	Psoas muscle to L3 vertebral body ratio (PML3)	Abdominal hernia, small bowel resection
Salem <i>et al.</i> , 2021 ^[22]	2006–2011	Cohort	Jerusalem	283	73	122/161	77.9±7.7	Lower psoas muscle attenuation	Ischemia, perforation, peritonitis, hernia, obstruction
Kubo <i>et al.</i> , 2019 ^[23]	2008–2016	Cohort	Japan	103	50	48/55	68.1±16.5	L3 SMI	Perforation panperitonitis
Hamidi <i>et al.</i> , 2019 ^[8]	2012–2015	Case Control	United States	452	113	271/181	58±8.7	TPI	Cholecystectomy, hernia repair, appendectomy
Brandt <i>et al.</i> , 2019 ^[9]	2014–2015	Cohort	Denmark	150	38	59/91	81.5 (78–86)	L3 TPA	Intestinal obstruction, perforation
Francomacaro <i>et al.</i> , 2018 ^[10]	2010–2014	Cohort	United States	967	241	469/498	63.5±16.8	TPA	Small bowel resection, lysis of adhesions
Trotter <i>et al.</i> , 2018 ^[11]	2014–2015	Cohort	United Kingdom	259	64	125/134	69.7±15.9	Psoas Density	Obstruction, perforation, ischemia, hemorrhage, colitis
Rangel <i>et al.</i> , 2017 ^[12]	2006–2011	Case control	United States	297	75	127/170	78 (74–84)	TPI	GIT resection, cholecystectomy, Hernia repair
Dirks <i>et al.</i> , 2017 ^[24]	2008–2013	Cohort	United States	593	197	289/304	Mean: 61	L4 TPA	Colon resection, small bowel resection, hernia repair
Matsushima <i>et al.</i> , 2017 ^[25]	2007–2014	Case Control	United States	89	32	61/28	49 (23–92)	Cross sectional area and transverse diameter of Psoas muscle	Acute diverticulitis
Witherspoon <i>et al.</i> , 2017	2013	Cohort	United Kingdom	203	51	101/102	72 (22–92)	L3 TPA	Intestinal obstruction, perforation
Du <i>et al.</i> , 2014 ^[26]	2008–2010	Cohort	Canada	100	73	51/49	84.1 (3.6)	L3 SMI	Colon resection, small bowel resection, laparotomy

SMI: Skeletal muscle index, TPA: Total psoas area, TPI: Total psoas index, SMG: Skeletal muscle gauge, GIT: Gastrointestinal

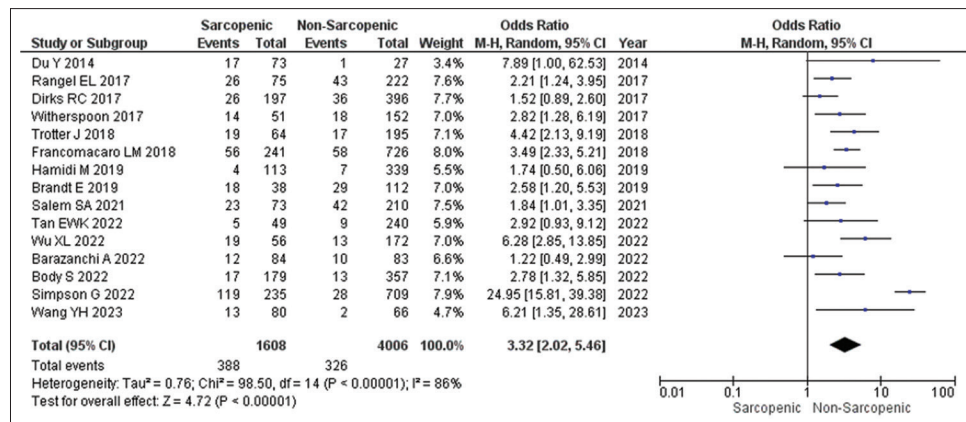


Figure 3: Forest plot of 30-day mortality

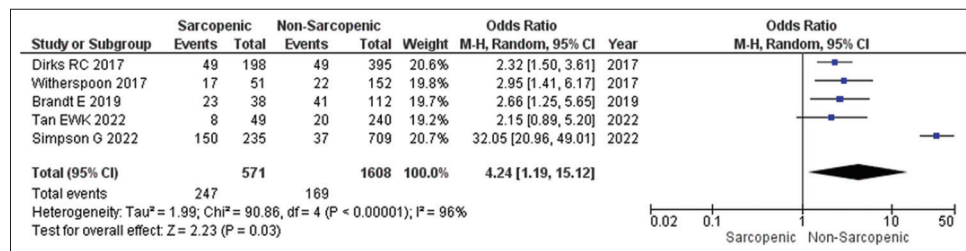


Figure 4: Forest plot of 90-day mortality

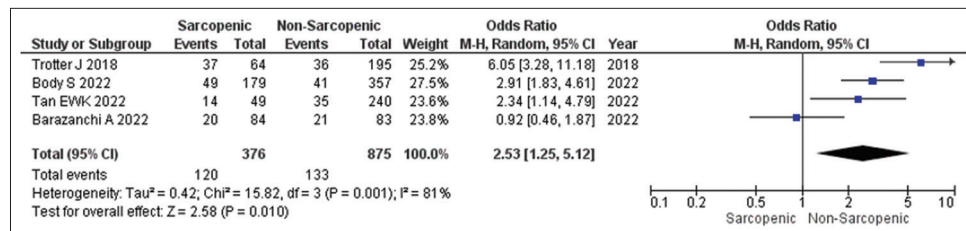


Figure 5: Forest plot of 1-year mortality

sarcopenia was associated with a significantly higher risk of 90-day mortality [OR = 4.24, 95% CI: 1.19–15.12; $P = 0.03$; Figure 4]. There was high heterogeneity between studies ($I^2 = 96\%$).

1-year mortality

Four of the 17 included studies reported 1-year mortality, with a total of 1251 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher risk of 1-year mortality [OR = 2.53, 95% CI: 1.25–5.12; $P = 0.01$; Figure 5]. There was high heterogeneity between studies ($I^2 = 81\%$).

Severe complications (>3 Clavien–Dindo classification)

Nine of the 17 included studies reported severe complications, with a total of 2977 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher risk of severe complications [OR = 1.84, 95% CI: 1.40–2.41; $P < 0.0001$; Supplementary Figure 2]. There was low heterogeneity between studies ($I^2 = 37\%$).

Cardiac complications

Four of the 17 included studies reported cardiac complications, with a total of 1668 participants. The pooled analysis

showed that sarcopenia was associated with a significantly higher risk of cardiac complications [OR = 1.93, 95% CI: 1.45–2.56; $P < 0.00001$; Supplementary Figure 3]. There was no significant heterogeneity between studies ($I^2 = 0\%$).

Pulmonary complications

Five of the 17 included studies reported pulmonary complications, with a total of 1896 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher risk of pulmonary complications (OR = 2.06, 95% CI: 1.61–2.64; $P < 0.00001$; Supplementary Figure 4). There was no significant heterogeneity between studies ($I^2 = 0\%$).

Renal complications

Four of the 17 included studies reported renal complications, with a total of 1668 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher risk of renal complications [OR = 1.50, 95% CI: 1.06–2.12; $P = 0.02$; Supplementary Figure 5]. There was no significant heterogeneity between studies ($I^2 = 0\%$).

Table 2: Quality assessment of the included cohort studies using the Newcastle-Ottawa scale

Cohort studies	Selection			Comparability		Outcomes			Total (Max. 9)
	Representativeness of exposed cohort (Max.★)	Selection of the nonexposed cohort (Max.★)	Ascertainment of exposure (Max.★)	Outcome was not present at start of study (Max.★)	Comparability of cohorts on the basis of the design or analysis (Max.★★)	Assessment of outcomes (Max.★)	Sufficient follow-up time (Max.★)	Adequacy of follow-up (Max.★)	
Wu XL, 2022	-	★	★	★	★★	★	★	★	8
Barazanchi A, 2022	★	★	★	★	★★	★	★	★	9
Body S, 2022	★	★	★	★	★★	★	-	-	7
Simpson G, 2022	★	★	★	★	★★	★	★	★	9
Salem SA, 2021	★	★	★	★	★	★	★	★	8
Kubo N, 2019	-	★	★	★	★	-	★	★	6
Brandt E, 2019	★	★	★	★	★	★	-	-	6
Francomacaro LM, 2018	★	★	-	★	★★	★	★	★	7
Trotter J, 2018	★	★	★	★	★★	★	★	-	8
Dirks RC, 2017	★	★	★	★	★	★	★	★	8
Witherspoon, 2017	★	★	★	★	★	★	★	★	8
Du Y, 2014	-	★	★	★	★★	★	★	★	8

A star (*) indicates that the study met the criteria for the corresponding quality domain. Studies can receive a maximum of nine stars across three domains: selection (maximum four stars), comparability (maximum two stars), and outcome/exposure assessment (maximum three stars)

Table 3: Quality assessment of the included case-control studies using the Newcastle-Ottawa scale

Case control studies	Selection			Comparability		Outcomes			Total (Max. 9)
	Case definition adequate (Max.★)	Selection Representativeness (Max.★)	Control selection (Max.★)	Control definition (Max.★)	Comparability of the cases and controls on the basis of the design or analysis (Max.★★)	Ascertainment of exposure (Max.★)	Method of ascertainment for cases and controls same (Max.★)	Response rate (Max.★)	
Wang YH, 2023	★	-	★	★	★	★	★	★	7
Tan EWK, 2022	★	-	★	★	★★	★	★	★	8
Hamidi M, 2019	★	★	★	★	★	★	★	★	8
Rangel EL, 2017	★	★	★	★	★	★	★	★	8
Matsushima K, 2017	★	-	★	★	★	-	★	★	6

A star (*) indicates that the study met the criteria for the corresponding quality domain. Studies can receive a maximum of nine stars across three domains: selection (maximum four stars), comparability (maximum two stars), and outcome/exposure assessment (maximum three stars)

Postoperative infections

Four of the 17 included studies reported postoperative infections, with a total of 872 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher risk of postoperative infections [OR = 1.97, 95% CI: 1.19–3.25; $P = 0.008$; Supplementary Figure 6]. There was low heterogeneity between studies ($I^2 = 38\%$).

Leakage

Three of the 17 included studies reported leakage, with a total of 477 participants. The pooled analysis showed that sarcopenia was not significantly associated with a higher risk of leakage (OR = 1.57, 95% CI: 0.78–3.16; $P = 0.20$; Supplementary Figure 7). There was no heterogeneity between studies ($I^2 = 0\%$).

Unfavorable discharge

Seven of the 17 included studies reported unfavorable discharge, with a total of 2860 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher risk of unfavorable discharge (OR = 1.94, 95% CI: 1.39–2.71, $P < 0.0001$; Supplementary Figure 8). There was moderate heterogeneity between studies ($I^2 = 60\%$).

Length of stay in intensive care unit

Six of the 17 included studies reported LOS in ICU, with a total of 1676 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher LOS in ICU [MD = 0.64, 95% CI: 0.14–1.14, $P = 0.01$; Supplementary Figure 9]. There was low heterogeneity between studies ($I^2 = 38\%$).

Length of stay in hospital

Thirteen of the 17 included studies reported LOS in hospital, with a total of 4281 participants. The pooled analysis showed that sarcopenia was associated with a significantly higher LOS in the Hospital [MD = 2.53, 95% CI: 1.60–3.46; $P < 0.00001$; Supplementary Figure 10]. There was low heterogeneity between studies ($I^2 = 47\%$).

DISCUSSION

Our meta-analysis evaluated the association between sarcopenia and postoperative outcomes following EL in almost 6000 patients. Our results demonstrate a significant association between sarcopenia and the risk of inpatient mortality, 30-day mortality, 90-day mortality, 1-year mortality, severe complications, cardiac complications, pulmonary complications, renal complications, postoperative infections, ICU and hospital LOS and the risk of unfavorable discharge. There was no significant association between sarcopenia and the risk of leakage.

While our findings were largely similar to those presented in recent meta-analyses to this end by Humphry *et al.*,^[16] our study demonstrated several novel characteristics. First and foremost, the analysis presented by Humphry *et al.* was severely limited in both scope and the number of explored

outcomes. As only 9 studies were included in their pooled analysis, and several important outcomes were not evaluated, this previous meta-analysis was due for an update. Our pooled analysis evaluates data from 17 studies and explores several outcomes not previously explored to this end. These additional outcomes provide important clinical data and can help guide clinical decision-making. As such, our analysis represents the largest and most exhaustive such analysis to date. In addition, our analysis also demonstrated the significant association between sarcopenia and severe complications reported as >3 by the Clavien–Dindo classification. This is contradictory to this previous meta-analysis and serves to clarify potential ambiguity and inaccuracies to this end.

The factors contributing to the unfavorable prognosis of individuals with sarcopenia following EL are diverse and multifaceted. These encompass aging-related changes such as preoperative frailty, prior malnutrition, and intricate comorbidities. Due to the disparities in the manifestations and progression of these changes in different patients an objective metric for preoperative risk assessment is needed. Evaluation of sarcopenia has the potential to fulfill this role by acting as a marker of frailty and progression of associated physiological changes.

Furthermore, the exigency of EL procedures often leaves patients insufficiently prepared, as the surgeries are necessitated by rapid and, at times, life-threatening disease progression. In the postoperative phase, the cumulative impact of surgical trauma, pain, respiratory challenges, circulatory compromise, sepsis, and the onset of multiple organ dysfunction collectively elevate the likelihood of complications and mortality.^[14] Sarcopenia, diagnosed on cross-sectional imaging during the perioperative period, can serve as an objective identifier for those susceptible to unfavorable postoperative trajectories.^[27] The opportunistic assessment of the psoas muscle area using CT images from routine preoperative workups emerges as an uncomplicated, rapid, and reliable gauge of physiologic reserve crucial for surgical endurance.

The integration of sarcopenia as a diagnostic tool not only pinpoints vulnerable patients but also functions as a compass for surgeons. It facilitates tailored preoperative counseling, aligning patient expectations, prompting contemplation of less invasive approaches, and enabling the implementation of specialized care processes, all geared toward enhancing outcomes for the highest-risk groups.

The integration of sarcopenia as a diagnostic tool not only identifies vulnerable patients but also serves as a guide for surgeons to optimize care. For instance, engaging multidisciplinary teams of different specialties pre-emptively could significantly improve outcomes. Specialists such as nutritionists and dietitians could develop targeted nutritional interventions, whereas physical therapists could design rehabilitation programs to enhance muscle strength and function. In addition, geriatricians can offer comprehensive evaluations and management of comorbidities, whereas

anesthesiologists can contribute to risk stratification and planning for less invasive anesthetic techniques. Incorporating these tailored approaches not only facilitates preoperative counseling and aligns patient and family expectations but also enhances the overall quality of care for high-risk patient groups, potentially mitigating adverse outcomes.

Furthermore, assessment of sarcopenia could significantly influence surgical decision-making by identifying high-risk patients who may benefit from tailored interventions such as prehabilitation, nutritional optimization, or modified surgical approaches. Unlike general frailty measures, sarcopenia specifically focuses on muscle mass and strength. Combining both could provide a more comprehensive risk stratification, guiding decisions on surgical feasibility and the need for less invasive treatments.

With the exception of leakage, all other outcomes exhibit a significant association with sarcopenia. The diminished muscle mass attributed to sarcopenia correlates with poorer recovery outcomes, encompassing prolonged hospital stays, heightened operative complication rates, and an increased likelihood of discharge to nursing or care homes.^[10,11,28] These findings align with those reported by various subspecialties investigating pre-operative sarcopenia, including surgical oncology, transplant, and trauma surgery.^[22,29-41]

Despite its strengths, our study faced certain limitations. Firstly, there was considerably high heterogeneity in our findings, likely stemming from divergent study designs and disparate cutoff values. This divergence arises from the use of varied imaging methods as the standard for diagnosing sarcopenia in each study, compounded by differing physician cut-offs to diagnose sarcopenia. Furthermore, PROSPERO registration was not undertaken as this review evaluates sarcopenia as a prognostic imaging-derived variable rather than an intervention, and includes exclusively observational studies without a predefined intervention-comparator framework. At the time of study initiation, such reviews were not consistently eligible for PROSPERO registration. To mitigate potential bias, the review protocol and eligibility criteria were predefined, and the study was conducted in accordance with PRISMA recommendations. Another limitation which must be acknowledged is that several of our outcomes were quite low-powered with some, such as pulmonary complications, real complications, and risk of leakages being limited to fewer than 5 included studies. This severe paucity of data may potentially impact the accuracy of results to this end. As such, more high-powered studies are required to report these outcomes in order to verify the veracity of our results in this capacity. In addition, given the variability in the metrics used to diagnose sarcopenia across the imaging techniques, a guideline-mandated standardization of cutoff values and diagnostic gold standards is essential.

CONCLUSION

By expanding the scope of outcomes considered, our meta-analysis provided valuable insights into the complex

interplay between sarcopenia and postoperative outcomes of emergency surgeries. We demonstrated the significant association between the presence of sarcopenia and the presentation of postoperative adverse outcomes and markers of worsened quality of recovery.

Research quality and ethics statement

The authors followed applicable EQUATOR Network (<https://www.equator-network.org/>) guidelines during the conduct of this research project.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

- Fielding RA, Vellas B, Evans WJ, Bhasin S, Morley JE, Newman AB, *et al.* Sarcopenia: An undiagnosed condition in older adults. Current consensus definition: Prevalence, etiology, and consequences. International working group on sarcopenia. *J Am Med Dir Assoc* 2011;12:249-56.
- Pipek LZ, Baptista CG, Nascimento RF, Taba JV, Suzuki MO, do Nascimento FS, *et al.* The impact of properly diagnosed sarcopenia on postoperative outcomes after gastrointestinal surgery: A systematic review and meta-analysis. *PLoS One* 2020;15:e0237740.
- Zhuang CL, Shen X, Zou HB, Dong QT, Cai HY, Chen XL, *et al.* EWGSOP2 versus EWGSOP1 for sarcopenia to predict prognosis in patients with gastric cancer after radical gastrectomy: Analysis from a large-scale prospective study. *Clin Nutr* 2020;39:2301-10.
- McQuade C, Kavanagh DO, O'Brien C, Hunter K, Nally D, Hickie C, *et al.* CT-determined sarcopenia as a predictor of post-operative outcomes in patients undergoing an emergency laparotomy. *Clin Imaging* 2021;79:273-7.
- Tan EW, Yeo JY, Lee YZ, Lohan R, Lim WW, Lee DJ. Low skeletal muscle mass predicts poor prognosis of elderly patients after emergency laparotomy: A single Asian institution experience. *Ann Acad Med Singap* 2022;51:766-73.
- Wu XL, Shen J, Danzeng CD, Xu XS, Cao ZX, Jiang W. CT psoas calculations on the prognosis prediction of emergency laparotomy: A single-center, retrospective cohort study in Eastern Asian population. *World J Emerg Surg* 2022;17:31.
- Body S, Ligthart MA, Rahman S, Ward J, May-Miller P, Pucher PH, *et al.* Sarcopenia and myosteatosis predict adverse outcomes after emergency laparotomy: A multi-center observational cohort study. *Ann Surg* 2022;275:1103-11.
- Hamidi M, Ho C, Zeeshan M, O'Keeffe T, Hamza A, Kulvatunyou N, *et al.* Can sarcopenia quantified by computed tomography scan predict adverse outcomes in emergency general surgery? *J Surg Res* 2019;235:141-7.
- Brandt E, Tengberg LT, Bay-Nielsen M. Sarcopenia predicts 90-day mortality in elderly patients undergoing emergency abdominal surgery. *Abdom Radiol (NY)* 2019;44:1155-60.
- Francomacaro LM, Walker C, Jaap K, Dove J, Hunsinger M, Widom K, *et al.* Sarcopenia predicts poor outcomes in urgent exploratory laparotomy. *Am J Surg* 2018;216:1107-13.
- Trotter J, Johnston J, Ng A, Gatt M, MacFie J, McNaught C. Is sarcopenia a useful predictor of outcome in patients after emergency laparotomy? A study using the NELA database. *Ann R Coll Surg Engl* 2018;100:377-81.
- Rangel EL, Rios-Diaz AJ, Uyeda JW, Castillo-Angeles M, Cooper Z, Olufajo OA, *et al.* Sarcopenia increases risk of long-term mortality in elderly patients undergoing emergency abdominal surgery. *J Trauma Acute Care Surg* 2017;83:1179-86.
- Stewart B, Khanduri P, McCord C, Ohene-Yeboah M, Uranues S,

- Vega Rivera F, *et al.* Global disease burden of conditions requiring emergency surgery. *Br J Surg* 2014;101:e9-22.
14. Hajibandeh S, Hajibandeh S, Jarvis R, Bhogal T, Dalmia S. Meta-analysis of the effect of sarcopenia in predicting postoperative mortality in emergency and elective abdominal surgery. *Surgeon* 2019;17:370-80.
15. Ng ZQ, Cohen R, Misur P, Weber DG. Poorer outcomes associated with sarcopenia following emergency laparotomy: A systematic review and meta-analysis. *ANZ J Surg* 2022;92:3145-53.
16. Humphry N, Jones M, Goodison S, Carter B, Hewitt J. The effect of sarcopenia on postoperative outcomes following emergency laparotomy: A systematic review and meta-analysis. *J Frailty Aging* 2023;12:305-10.
17. Hutton B, Salanti G, Caldwell DM, Chaimani A, Schmid CH, Cameron C, *et al.* The PRISMA extension statement for reporting of systematic reviews incorporating network meta-analyses of health care interventions: Checklist and explanations. *Ann Intern Med* 2015;162:777-84.
18. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, *et al.* The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa: Ottawa Hospital Research Institute; 2000.
19. Wang YH, Tee YS, Wu YT, Cheng CT, Fu CY, Liao CH, *et al.* Sarcopenia provides extra value outside the PULP score for predicting mortality in older patients with perforated peptic ulcers. *BMC Geriatr* 2023;23:269.
20. Barazanchi A, Bhat S, Wells CI, Taneja A, MacCormick AD, Hill AG. Short and long-term impact of sarcopenia on outcomes from emergency laparotomy. *Eur J Trauma Emerg Surg* 2022;48:3869-78.
21. Simpson G, Wilson J, Vimalachandran D, McNicol F, Magee C. Sarcopenia estimation using psoas major enhances P-POSSUM mortality prediction in older patients undergoing emergency laparotomy: Cross-sectional study. *Eur J Trauma Emerg Surg* 2022;48:2003-12.
22. Salem SA, Almogly G, Lev-Cohain N, Bala M, Cohen N, Issachar O, *et al.* Psoas attenuation and mortality of elderly patients undergoing nontraumatic emergency laparotomy. *J Surg Res* 2021;257:252-9.
23. Kubo N, Kawanaka H, Hiroshige S, Tajiri H, Egashira A, Takeuchi H, *et al.* Sarcopenia discriminates poor prognosis in elderly patients following emergency surgery for perforation panperitonitis. *Ann Gastroenterol Surg* 2019;3:630-7.
24. Dirks RC, Edwards BL, Tong E, Schaheen B, Turrentine FE, Shada A, *et al.* Sarcopenia in emergency abdominal surgery. *J Surg Res* 2017;207:13-21.
25. Matsushima K, Inaba K, Jhaveri V, Cheng V, Herr K, Siboni S, *et al.* Loss of muscle mass: A significant predictor of postoperative complications in acute diverticulitis. *J Surg Res* 2017;211:39-44.
26. Du Y, Karvellas CJ, Baracos V, Williams DC, Khadaroo RG, Acute Care and Emergency Surgery (ACES) Group. Sarcopenia is a predictor of outcomes in very elderly patients undergoing emergency surgery. *Surgery* 2014;156:521-7.
27. Yang TR, Luo K, Deng X, Xu L, Wang RR, Ji P. Effect of sarcopenia in predicting postoperative mortality in emergency laparotomy: A systematic review and meta-analysis. *World J Emerg Surg* 2022;17:36.
28. Brzeszczyński FF, Brzeszczyńska JI. Markers of sarcopenia increase 30-day mortality following emergency laparotomy: A systematic review. *Scand J Surg* 2023;112:58-65.
29. Amini N, Spolverato G, Gupta R, Margonis GA, Kim Y, Wagner D, *et al.* Impact total psoas volume on short- and long-term outcomes in patients undergoing curative resection for pancreatic adenocarcinoma: A new tool to assess sarcopenia. *J Gastrointest Surg* 2015;19:1593-602.
30. Peng P, Hyder O, Firoozmand A, Kneuert P, Schulick RD, Huang D, *et al.* Impact of sarcopenia on outcomes following resection of pancreatic adenocarcinoma. *J Gastrointest Surg* 2012;16:1478-86.
31. Onesti JK, Wright GP, Kenning SE, Tierney MT, Davis AT, Doherty MG, *et al.* Sarcopenia and survival in patients undergoing pancreatic resection. *Pancreatol* 2016;16:284-9.
32. Peng PD, van Vledder MG, Tsai S, de Jong MC, Makary M, Ng J, *et al.* Sarcopenia negatively impacts short-term outcomes in patients undergoing hepatic resection for colorectal liver metastasis. *HPB (Oxford)* 2011;13:439-46.
33. Lieffers JR, Bathe OF, Fassbender K, Winget M, Baracos VE. Sarcopenia is associated with postoperative infection and delayed recovery from colorectal cancer resection surgery. *Br J Cancer* 2012;107:931-6.
34. Miyamoto Y, Baba Y, Sakamoto Y, Ohuchi M, Tokunaga R, Kurashige J, *et al.* Sarcopenia is a negative prognostic factor after curative resection of colorectal cancer. *Ann Surg Oncol* 2015;22:2663-8.
35. Reisinger KW, Derikx JP, van Vugt JL, Von Meyenfeldt MF, Hulsewé KW, Olde Damink SW, *et al.* Sarcopenia is associated with an increased inflammatory response to surgery in colorectal cancer. *Clin Nutr* 2016;35:924-7.
36. Fujiwara N, Nakagawa H, Kudo Y, Tateishi R, Taguri M, Watadani T, *et al.* Sarcopenia, intramuscular fat deposition, and visceral adiposity independently predict the outcomes of hepatocellular carcinoma. *J Hepatol* 2015;63:131-40.
37. Yip C, Goh V, Davies A, Gossage J, Mitchell-Hay R, Hynes O, *et al.* Assessment of sarcopenia and changes in body composition after neoadjuvant chemotherapy and associations with clinical outcomes in oesophageal cancer. *Eur Radiol* 2014;24:998-1005.
38. Smith AB, Deal AM, Yu H, Boyd B, Matthews J, Wallen EM, *et al.* Sarcopenia as a predictor of complications and survival following radical cystectomy. *J Urol* 2014;191:1714-20.
39. Psutka SP, Carrasco A, Schmit GD, Moynagh MR, Boorjian SA, Frank I, *et al.* Sarcopenia in patients with bladder cancer undergoing radical cystectomy: Impact on cancer-specific and all-cause mortality. *Cancer* 2014;120:2910-8.
40. Englesbe MJ, Patel SP, He K, Lynch RJ, Schaubel DE, Harbaugh C, *et al.* Sarcopenia and mortality after liver transplantation. *J Am Coll Surg* 2010;211:271-8.
41. Fairchild B, Webb TP, Xiang Q, Tarima S, Brasel KJ. Sarcopenia and frailty in elderly trauma patients. *World J Surg* 2015;39:373-9.

Supplementary Table 1: Search strategy

Serial
number

Search strategies

PubMed

Search #1 ("Sarcopenia" OR "Sarcopenia"[Mesh] OR "Myopenia"
OR "Muscle Atrophy" [MeSH terms]) AND ("Laparotomy"
OR "Laparotomy"[Mesh] OR "Emergency
Laparotomy" [MeSH terms] OR "emergency surgery")

EMBASE

Search #1 (("Sarcop*":ti, ab, kw) OR ("sarcopenia"/exp))
AND (("emergency laparotomy"/exp) OR ("laparotomy"/
exp))

Cochrane CENTRAL

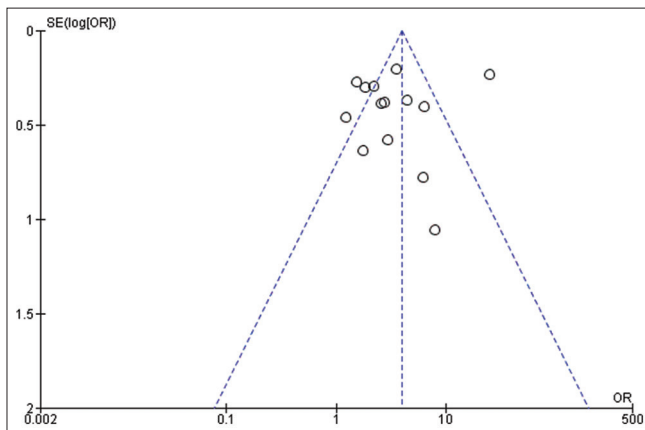
(#1 OR #2) AND (#3 OR #4)

Search #1 ("Laparotomy" OR "Emergency Laparotomy" OR
"emergency surgery"):ti, ab, kw

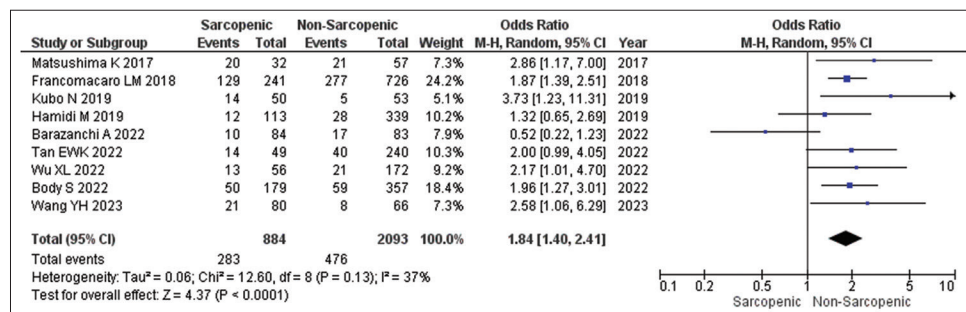
Search #2 MeSH descriptor: [Laparotomy] explode all trees

Search #3 "Sarcop*":ti, ab, kw

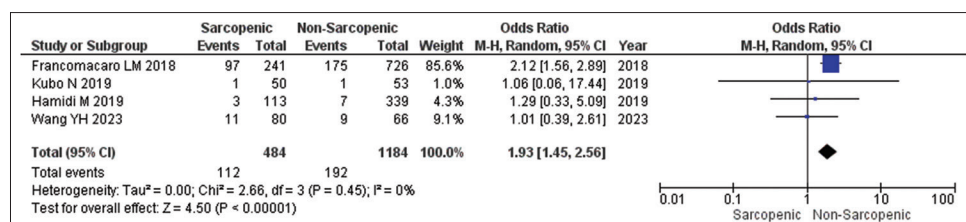
Search #4 MeSH descriptor: [Sarcopenia] explode all trees



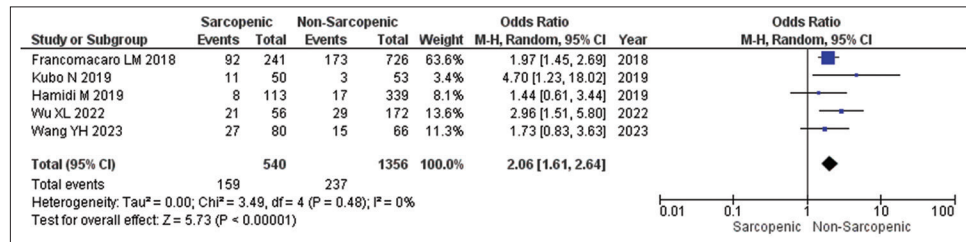
Supplementary Figure 1: Funnel plot



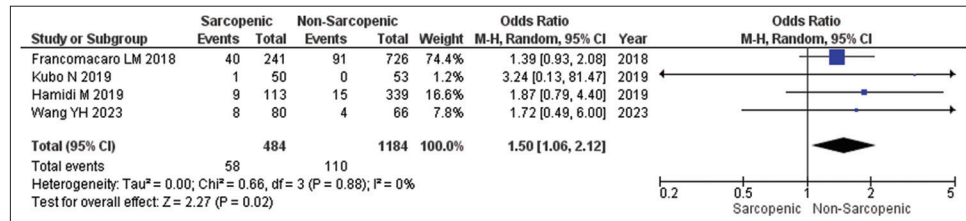
Supplementary Figure 2: Forest plot of severe complications (>3 Clavien-Dindo classification)



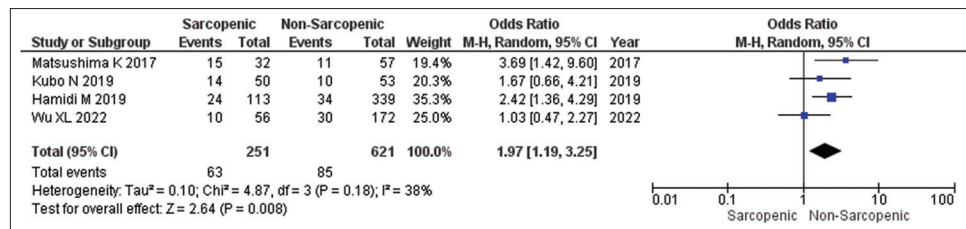
Supplementary Figure 3: Forest plot of cardiac complications



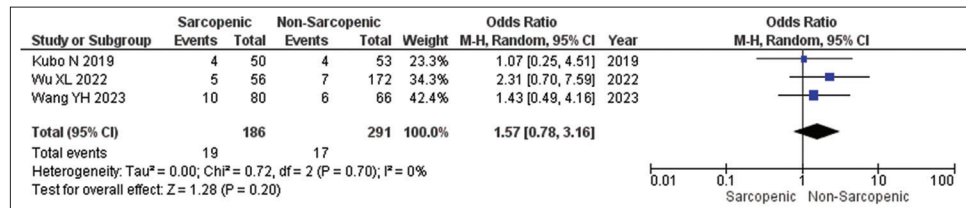
Supplementary Figure 4: Forest plot of pulmonary complications



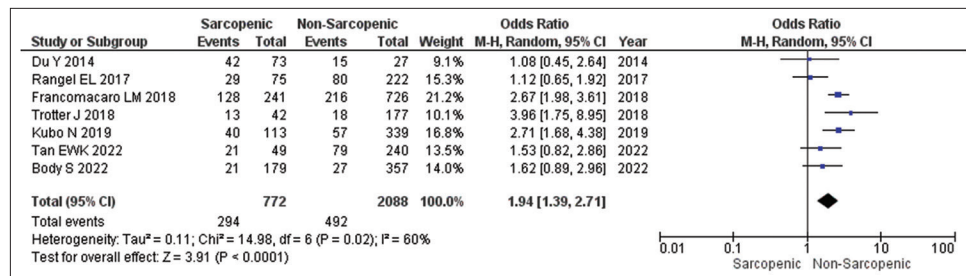
Supplementary Figure 5: Forest plot of renal complications



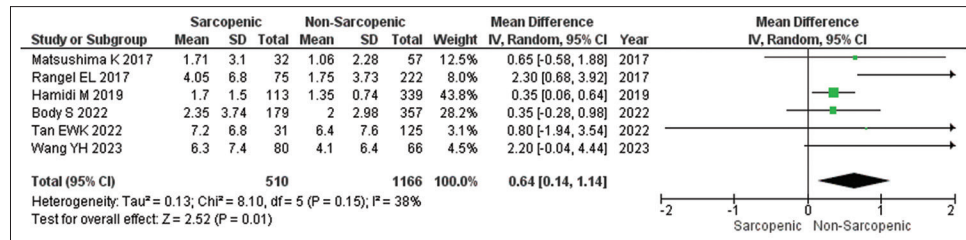
Supplementary Figure 6: Forest plot of postoperative infections



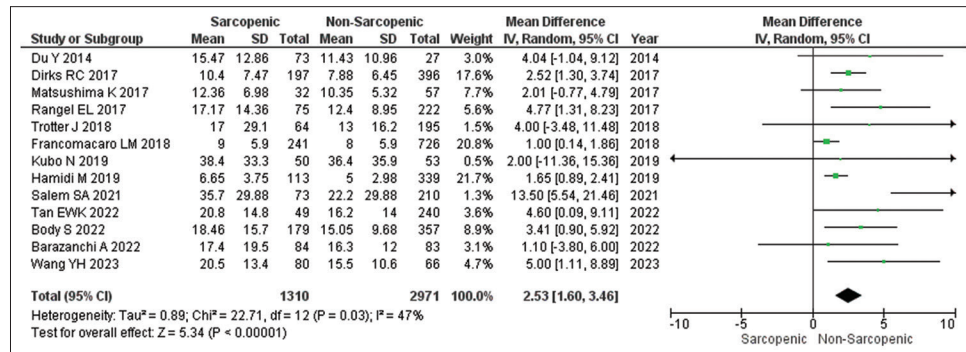
Supplementary Figure 7: Forest plot of leakage



Supplementary Figure 8: Forest plot of unfavorable discharge



Supplementary Figure 9: Forest plot of length of stay in intensive care unit



Supplementary Figure 10: Forest plot of length of stay in hospital