Surgical Endoscopy (2023) 37:5687–5695
https://doi.org/10.1007/s00464-023-10017-w

2023 SAGES POSTER

Does ASA classification effectively risk stratify patients undergoing bariatric surgery: a MBSAQIP retrospective cohort of 138,612 of patients

Sukhdeep Jatana[1] · Kevin Verhoeff[1] · Valentin Mocanu[1] · Uzair Jogiat[1] · Daniel W. Birch[1,2] · Shahzeer Karmali[1,2] · Noah J. Switzer[1]

Received: 10 October 2022 / Accepted: 12 March 2023 / Published online: 24 March 2023

Abstract

Introduction It is important to appropriately risk stratify bariatric surgery patients, as these patients often have obesity-related comorbidities which can increase postoperative complication risk but also benefit the most from bariatric surgery. We aimed to evaluate the utility of risk stratification using ASA class for bariatric surgery patients and assessed predictive factors of postoperative complications.

Methods The 2020 MBSAQIP database was analyzed, and an ASA-deemed high-risk cohort (class IV) and normal-risk (ASA class II and III) cohort were compared. Univariate analysis was performed to characterize differences between cohorts and to compare complication rates. Multivariate logistic regression analysis was performed to determine factors associated with increased odds of postoperative complications.

Results We evaluated 138 612 patients with 5380 (3.9%) considered high-risk and 133 232 (96.1%) normal-risk. High-risk patients were more likely to be older (46.2 ± 12.0vs.43.4 ± 11.9, p < 0.001), male (30.9%vs.18.4%, p < 0.001), have higher BMI (51.4 ± 10.2vs.44.9 ± 7.4, p < 0.001), and have more comorbidities. High-risk patients were more likely to have increased 30-day serious complications (4.5%vs.2.8%, p < 0.001) and death (0.2%vs.0.1%, p = 0.001) but not anastomotic leak (0.2%vs.0.2%, p = 0.983). Multivariate models showed ASA class IV patients were at higher odds for any serious complication by 30 days (aOR 1.36, 95%CI 1.18–1.56, p < 0.001) but not for death (aOR 1.04, 95%CI 0.49–2.21, p = 0.921). The factor independently associated with the highest odds of complication in both models was functional status preoperatively (partially dependent aOR 2.06, 95%CI 1.56–2.72, p < 0.001; fully dependent aOR 3.19, 95%CI 1.10–9.28, p = 0.033 for any serious complication; partially dependent aOR 5.08, 95%CI 2.16–12.00, p < 0.001 for death).

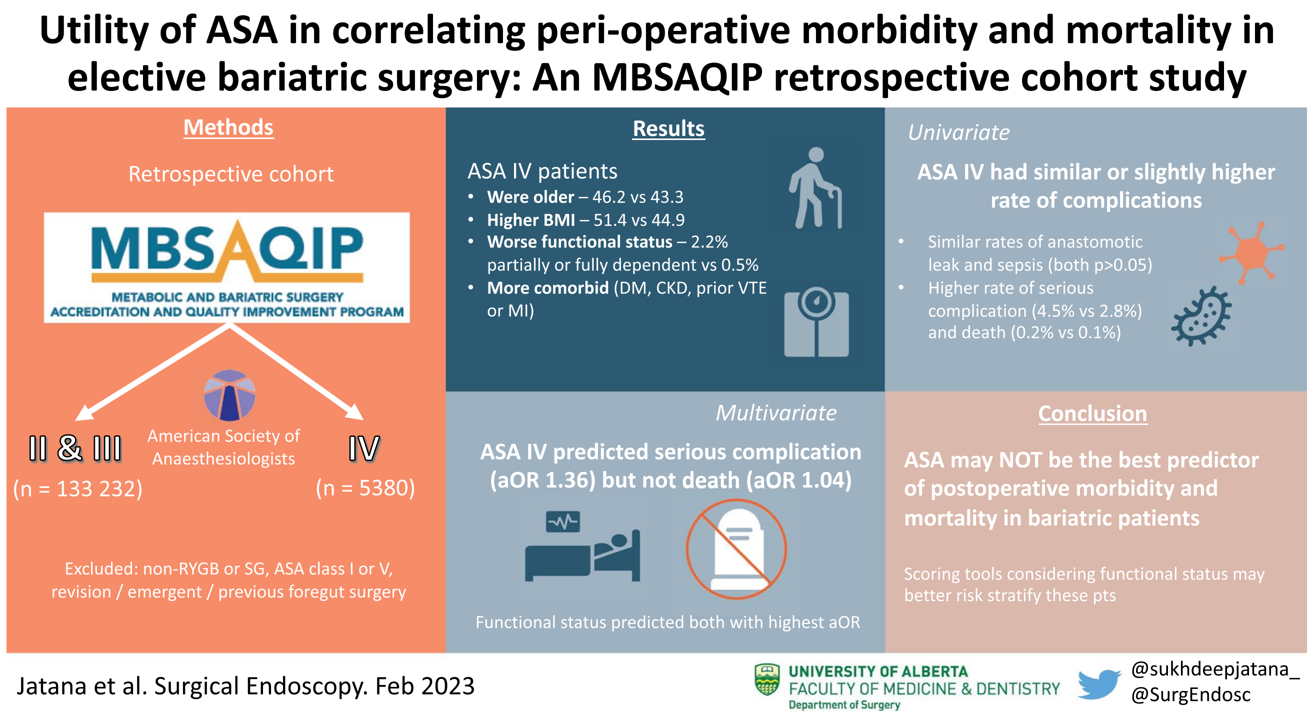
Conclusions While elevated ASA class correlates with increased serious complications, pre-operative functional status appears to have a much greater contribution to odds of serious complications and mortality. These findings question the utility of using ASA to risk stratify patients peri-operatively and provides evidence for using a simpler and more practical functional status approach.

✉ Kevin Verhoeff
verhoeff@ualberta.ca

1 Department of Surgery, University of Alberta, Dvorkin Lounge Mailroom2G2 Walter C. Mackenzie Health Sciences Centre, 8440 - 112 ST NW, Edmonton, AB T6G 2B7, Canada

2 Centre for Advancement of Surgical Education and Simulation (CASES), Royal Alexandra Hospital, Edmonton, AB, Canada

Graphical abstract



Keywords ASA · Bariatric surgery · Complications · Preoperative assessment · Risk factors

Bariatric surgery remains the most effective long-term treatment for obesity, with a growing armamentarium of procedures available based on patient demographics and comorbidities [1]. Selecting the optimal intervention for patients, especially those with severe obesity-related metabolic [2], cardiac [3, 4], hepatic [5, 6] complications, who experience the greatest risk of complications yet stand to benefit the most from surgery is an ever-growing challenge. Risk stratification scores can aid surgical teams in identifying patients at risk of surgical complications and enable improved patient or procedural selection. Additionally, their value in characterizing and evaluating perioperative outcomes is crucial to the ongoing improvement of bariatric procedures. While the American Society of Anesthesiologist (ASA) score provides a global, operationally defined, measure of comorbidity, its utility in predicting perioperative morbidity and mortality in bariatric surgery patients is unclear, especially in the context of other bariatric surgery-specific risk stratification tools.

While the ASA score is widely used and historically validated for surgical patients [7], a growing number of bariatric surgery-specific assessment scores have recently been introduced to aid with procedural selection and outcome assessment. Despite novel tools, ASA remains the primary marker of comorbidity within surgical databases. On the other hand, frailty-associated scales have shown to correlate well to postoperative complications, including in bariatric surgery [8–10]. The Edmonton Obesity Staging System has also been shown to be quite promising in predicting perioperative morbidity and mortality in bariatric surgery patients [11]. Given the known benefits of bariatric surgery in higher risk patients [12], evaluating the utility of the widely-used, easily applied ASA tool as a global assessment of comorbidity to predict outcomes and for use in research in this population is required, especially in the context of novel evaluation tools taking into consideration functional status.

Using the multicentre prospectively collected database from the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP), the first aim of this study is to compare the rate of postoperative complications for bariatric surgery patients deemed high-risk versus those considered normal-risk, classified by ASA score. The second aim is to assess risk factors associated with 30-day serious complications and 30-day death in patients undergoing bariatric surgery. This will allow for assessment of utility of ASA scores for risk assessment and identify factors associated with postoperative comorbidity and mortality.

Materials and methods

Study design

Written consent or ethics approval was not obtained for this study as the data was collected anonymously and stored in a secure database for patients of MBSAQIP centers. A retrospective cohort study was done evaluating clinical characteristics and rate of complications in patients' anesthesia-deemed high-risk by ASA class (class IV) to normal-risk (class II and III). The primary outcome is to compare mortality and any serious complication rate between high-risk and normal-risk groups. Additional outcomes include rate of individual complications, as detailed below. Furthermore, different patient and operation characteristics were assessed to determine predictors of postoperative 30-day mortality and 30-day serious complications.

Study population

Patient data was retrieved from the 2020 MBSAQIP database, which collects information about bariatric surgery patients from 885 North American centers. Detailed information about collection of information and reporting of outcomes including detailed outcome definitions is available in the Participant Use Data File [13]. Data is collected from and available to MBSAQIP-accredited centers and is subject to frequent reviews to maintain accuracy. Patients who met the following inclusion criteria were included: adult patients (≥ 18) undergoing elective Roux-en-Y gastric bypass (RYGB) or sleeve gastrectomy (SG). Only RYGB and SG were evaluated as these represent the majority of procedures performed [14] and provide a representative sample for most centers. Patients undergoing revision or emergency surgery, history of foregut surgery, and patients without ASA information available or deemed to be ASA class I and V were excluded. ASA class I patients, who are healthy patients without any acute or chronic conditions, were excluded as, by definition, obesity excludes patients from being categorized as ASA class I [15]. ASA class V patients are "moribund patient[s] who [are] not expected to survive without the operation", such as those with ruptured abdominal aneurysms [15]. These patients would not be suitable for bariatric surgery, which is often elective. By excluding these groups, it also may also assist with decreasing data coding errors. The MBSAQIP database also excludes certain cases from entering the database [13]. ASA classes II and III were grouped together as they represent a majority of lower risk bariatric surgery patients and have frequent overlap clinically [7], while ASA class IV patients, which are defined as "[having] systemic disease that is constant threat to life" [15] was used to accurately represent a high risk cohort.

Outcomes and variable definitions

The following demographic information was extracted from this database: age, sex, body mass index (BMI). The following information about cardiovascular comorbidities or cardiovascular-related factors was extracted: smoking status, hypertension, hyperlipidemia, venous stasis, prior cardiac surgery, prior percutaneous coronary intervention, history of venous thromboembolism (VTE) or myocardial infarction (MI), use of preoperative anticoagulation. The following information about other comorbidities was collected: use of chronic immunosuppressants (including steroids), diabetes mellitus (non-insulin dependent vs. insulin-dependent), gastroesophageal reflux disease, chronic obstructive pulmonary disease (COPD), renal insufficiency, sleep apnea. The following information about surgery was collected: ASA class, operative time.

Follow-up for outcomes was up to 30 days. The following postoperative complication data was collected: anastomotic leak, any bleed, wound disruption, need for intervention, need for reoperation. Infectious complications that were collected include surgical site infection, sepsis, and pneumonia. Additionally, data about readmission, unplanned intubation, acute kidney injury, cerebrovascular accident (CVA) and VTE was collected. The definition for anastomotic leak included any of the following: reoperation for anastomotic/staple line leak, readmission for anastomotic/staple line leak, reintervention for anastomotic/staple line leak, drain present 30 days postoperatively, or death caused by anastomotic/staple line leak. Definition for postoperative bleed included any of the following: reoperation for bleed, readmission for bleed, reintervention for bleed, transfusion required in first 72 h of surgery start time, and death caused by bleeding. Definition for serious complication included any of the following: cardiac complications, pneumonia, acute renal failure, reoperation, reintervention, venous thromboembolism, deep surgical site infection, wound disruption, sepsis, unplanned intubation, leak, bleed, coma > 24 h, and cerebral vascular accident.

Statistical analysis

Patients were divided into two groups based on ASA class. Those designated as ASA class IV at time of operation were considered high-risk and those of ASA class II or III were considered normal-risk. Data are represented as n (%) for categorical variables and mean ± standard deviation for continuous variables. Categorical data was compared with chi-squared test and continuous variables with ANOVA.

A non-parsimonious multivariable logistic model evaluated factors associated with serious complications and mortality. Hypothesis-driven purposeful selection methodology was used to develop our model. A preliminary main effects model was generated by using bivariable analysis of variables with a p-value < 0.1 or from variables previously deemed clinically relevant to our primary outcome. To assess the fit of the model, Brier Score and receiver operating characteristic (ROC) curves were utilized. Data analysis was done using STATA 17 (StataCorp, College Station, TX, USA).

Results

Study population characteristics

A total of 5380 (3.9%) patients were included in the high-risk cohort and 133 232 (96.1%) patients were included in the normal-risk cohort. The normal-risk category included 26 561 (19.9%) ASA class II patients, and 106 671 (80.1%) ASA class III patients (Table 1). High-risk patients tended to be older (46.2 ± 12.0 vs. 43.4 ± 11.9 years, p < 0.001), less often female (69.1% vs. 81.6%, p < 0.001), and had higher BMI (51.4 ± 10.2 vs. 44.9 ± 7.4, p < 0.001). High-risk patients also had more comorbidities such as DM (insulin-independent DM 13.3% vs. 6.4%; insulin-dependent DM 20.4% vs. 16.7%, p < 0.001), hypertension (61.9% vs. 43.4%, p < 0.001), COPD (3.9% vs. 1.1%, p < 0.001), hyperlipidemia (32.3% vs. 22.0%, p < 0.001), renal insufficiency (2.9% vs. 0.5%, p < 0.001), dialysis dependence (3.0% vs. 0.2%, p < 0.001), venous stasis (1.9% vs. 0.7%, p < 0.001), sleep apnea (56.1% vs. 36.9%, p < 0.001), history of MI (3.2% vs. 0.9%, p < 0.001), and history of VTE (5.5% vs. 2.3%, p < 0.001). They were also more likely to have procedures such as prior cardiac surgery (3.6% vs. 0.8%, p < 0.001), and prior percutaneous coronary intervention (5.2% vs. 1.3%, p < 0.001). Preoperative therapeutic anticoagulation was more common in the high-risk group (8.8% vs. 2.5%, p < 0.001). High-risk patients tended to have worse functional status preoperatively (partially dependent 2.1% vs. 0.5%; fully dependent 0.1% vs. 0.0%, p < 0.001).

Surgical approach also differed between the two groups. High-risk patients were more likely to undergo Roux-en-Y gastric bypass (30.6% vs. 26.4%, p < 0.001). Both high-risk and normal-risk groups most often underwent a laparoscopic approach (5376 patients, 99.9% vs 133 203 patients, 100.0%, p < 0.001) (Table 1). Twenty-five patients in the normal-risk group underwent endoscopic approach while zero did in the high-risk group. Four patients from each group underwent open approach. These were statistically different but unlikely to be clinically significant with < 0.1% difference noted. Operative time was significantly longer in the high-risk group (86.7 ± 46.4 min vs. 84.7 ± 49.2 min, p = 0.004).

Comparison of outcomes between high-risk and normal-risk groups

The univariate unadjusted rate of 30-day complications was generally higher in the high-risk group (Table 2). This included postoperative complications such as any bleed (high-risk group 1.6% vs. 0.9% normal-risk group, p < 0.001) but not anastomotic leak (high-risk group 0.2% vs. 0.2% normal-risk group, p = 0.983) or wound dehiscence, both partial (0.1% vs. 0.1%) and fascial (0.0% vs. 0.0%, p = 0.649). Readmission within 30 days (4.1% vs. 2.8%, p < 0.001), intervention within 30 days (1.0% vs. 0.7%, p = 0.015) and reoperation within 30 days (1.3% vs. 0.9%, p < 0.001) was more common in the high-risk group. The high-risk group was more likely to have unplanned intubation (0.3% vs. 0.1%, p < 0.001) and experience an AKI (0.4% vs. 0.1%, p < 0.001). Cardiovascular complications were higher in high-risk groups, including venous thromboembolism (0.6% vs. 0.4%, p = 0.004), cerebrovascular accident (0.1% vs. 0.0%, p < 0.001), and any cardiac complication (0.2% vs. 0.1%, p = 0.002). Pneumonia occurred more frequently in the high-risk group (0.4% vs. 0.2%, p = 0.001) but no other infections such as deep SSI (0.3% vs. 0.3%, p = 0.625) and sepsis (0.1% vs. 0.1%, p = 0.939). There was also higher rate in the high-risk group of any serious complication (4.5% vs. 2.8%, p < 0.001) and death (0.2% vs. 0.1%, p = 0.001).

Multivariate models of risk factors for serious complications and death

Multiple variables were associated with significantly increased odds of any serious complication by 30 days (Table 3). ASA class IV (vs. II and III) was associated with increased odds of 30-day serious complication (aOR 1.36, 95%CI 1.18–1.56, p < 0.001). Other demographic characteristics that are associated with increased odds include age (aOR 1.06, 95%CI 1.03–1.10, p < 0.001), smoking (aOR 1.27, p < 0.001) and functional status preoperatively (compared to fully independent, partially dependent aOR 2.06, 95%CI 1.56–2.72, p < 0.001 and fully dependent aOR 3.19, 95%CI 1.10–9.26, p = 0.033). Comorbidities with the largest increased odds included renal insufficiency (aOR 1.89, 95%CI 1.44–2.47, p < 0.001), previous MI (aOR 1.85, 95%CI 1.49–2.28, p < 0.001), and history of VTE (aOR 1.77, 95%CI 1.53–2.06, p < 0.001). Roux-en-y gastric bypass was also associated with increased odds (aOR 2.07, 95%CI 1.92–2.22, p < 0.001). The receiver operating characteristic (ROC) area under the curve and Brier score were 0.662 and

Table 1 Baseline patient characteristics of high risk (ASA class IV) and normal risk (ASA class II and III) patients undergoing bariatric surgery. Significant values are italicized. Data represented as n (%) unless otherwise stated

	Normal-risk (n = 133 232)	High-risk (n = 5380)	p-value
Age, years (mean ± SD)	n = 133206	n = 5376	
	43.4 ± 11.9	46.2 ± 12.0	*< 0.001*
Sex			*< 0.001*
Female	108,668 (81.6)	3716 (69.1)	
Male	24,564 (18.4)	1664 (30.9)	
BMI, kg/m^2 (mean ± SD)	n = 133229	n = 5380	
	44.9 ± 7.4	51.4 ± 10.2	*< 0.001*
ASA class			–
2	26,561 (19.9)	–	
3	106,671 (80.1)	–	
4	–	5380 (100.0)	
Functional status preoperatively			*< 0.001*
Fully independent	132,445 (99.5)	5252 (97.7)	
Partially dependent	616 (0.5)	115 (2.1)	
Fully dependent	25 (0.0)	7 (0.1)	
Smoker	9381 (7.0)	366 (6.8)	0.503
Diabetes mellitus			*< 0.001*
Non-diabetic	102,491 (76.9)	3567 (66.3)	
Insulin-independent	8485 (6.4)	714 (13.3)	
Insulin-dependent	22,256 (16.7)	1099 (20.4)	
Hypertension	58,432 (43.4)	3331 (61.9)	*< 0.001*
GERD	39,266 (29.6)	1624 (30.2)	0.314
COPD	1466 (1.1)	209 (3.9)	*< 0.001*
Hyperlipidemia	29,277 (22.0)	1740 (32.3)	*< 0.001*
Chronic immunosuppressant use	2749 (2.1)	125 (2.3)	0.189
Renal insufficiency	643 (0.5)	154 (2.9)	*< 0.001*
Dialysis-dependent	282 (0.2)	159 (3.0)	*< 0.001*
History of VTE	3120 (2.3)	294 (5.5)	*< 0.001*
Venous stasis	881 (0.7)	102 (1.9)	*< 0.001*
Preoperative therapeutic anticoagulation	3385 (2.5)	474 (8.8)	*< 0.001*
Sleep apnea	49,195 (36.9)	3016 (56.1)	*< 0.001*
History of MI	1257 (0.9)	174 (3.2)	*< 0.001*
Prior cardiac surgery	1036 (0.8)	192 (3.6)	*< 0.001*
Prior percutaneous coronary intervention	1736 (1.3)	278 (5.2)	*< 0.001*
Roux-en-Y bypass	35119 (26.4)	1636 (30.4)	*< 0.001*
Operative time, minutes (mean ± SD)	n = 132374	n = 5359	
	84.7 ± 49.2	86.7 ± 46.4	*0.004*
Surgical approach			*< 0.001*
Endoscopic	25 (0.0)	0 (0.0)	
Laparoscopic	133,203 (100.0)	5376 (99.9)	
Open	4 (0.0)	4 (0.1)	

Italics within the tables represent p < 0.05

ASA American Society of Anesthesiologist, *BMI* body mass index, *COPD* chronic obstructive pulmonary disease, *GERD* gastroesophageal reflux disease, *MI* myocardial infarction, *VTE* venous thromboembolism

0.0274 respectively, indicating the appropriateness of the model to predict the selected outcomes.

The trend was similar for a multivariate analysis done for 30-day mortality. Demographic characteristics that are associated with increased odds include age (aOR 2.01, 95%CI 1.61–2.51, p < 0.001), BMI (aOR 1.05, 95%CI 1.03–1.08, p < 0.001) and functional status preoperatively (compared to fully independent, partially dependent aOR 5.08, 95%CI 2.16–12.00, p < 0.001). Functional status defined as fully dependent was not included in the model by the statistical

Table 2 Complication rate by categorization of risk according to ASA class. Significant values are italicized. Data represented as n (%) unless otherwise stated

	Normal-risk (n = 133 232)	High-risk (n = 5380)	p-value
Anastomotic leak	299 (0.2)	12 (0.2)	0.983
Any bleed	1208 (0.9)	86 (1.6)	*< 0.001*
Readmission within 30 days	3676 (2.8)	220 (4.1)	*< 0.001*
Intervention within 30 days	891 (0.7)	51 (1.0)	*0.015*
Reoperation within 30 days	1211 (0.9)	68 (1.3)	*0.008*
Any cardiac complication	134 (0.1)	13 (0.2)	*0.002*
Deep SSI	373 (0.3)	17 (0.3)	0.625
Sepsis	103 (0.1)	4 (0.1)	0.939
Wound Disruption			0.649
Partial dehiscence	63 (0.1)	4 (0.1)	
Fascial dehiscence	2 (0.0)	0 (0.0)	
Unplanned intubation	113 (0.1)	15 (0.3)	*< 0.001*
Acute kidney injury	127 (0.1)	19 (0.4)	*< 0.001*
Pneumonia	248 (0.2)	21 (0.4)	*0.001*
Cerebral vascular accident	11 (0.0)	3 (0.1)	*0.001*
Venous thromboembolism	508 (0.4)	34 (0.6)	*0.004*
Any serious complication	3704 (2.8)	240 (4.5)	*< 0.001*
Death	74 (0.1)	9 (0.2)	*0.001*

Italics within the tables represent $p < 0.05$

SSI surgical site infection

program as it predicted outcomes perfectly. Comorbidities with the largest increased odds included insulin-independent DM (aOR 2.26, 95%CI 1.26–4.05, p = 0.006) and previous MI (aOR 4.61, 95%CI 2.25–9.44, p < 0.001). Roux-en-y gastric bypass was not associated with increased odds (aOR 1.34, 95%CI 0.81–2.22, p = 0.256). However, for 30-day mortality, ASA class IV patients did not have increased odds compared to those of class II and III (aOR 1.04, 95%CI 0.49–2.21, p = 0.921). The receiver operating characteristic (ROC) area under the curve and Brier score were 0.837 and 0.0006 respectively, indicating the appropriateness of the model to predict the selected outcomes (Table 4).

Discussion

In this retrospective study including approximately 138 000 patients, high-risk patients classified by ASA class were more likely to experience increased 30-day death, readmission, and reintervention rates. However, absolute complication rate differences were only 0.1%, 1.6%, and 0.3%, respectively, and several important complication measures were not statistically different. Although ASA class IV status was associated with a higher odds of 30-day serious complications compared to class II and III, it was not predictive of 30-day mortality. Importantly, several characteristics such as functional status were much greater independent contributors suggesting a need for increased focus on factors other than preoperative ASA classification to risk stratify bariatric patients.

Overall, these results suggest that the ASA score may not be the best risk stratification tool for bariatric surgery patients with respect to 30-day morbidity and mortality. There are limitations for using ASA to predict postoperative outcomes. ASA scores were initially developed in 1963 to stratify baseline health status of patients undergoing surgery, and has undergone many revisions since [16]. Though it has been shown to correlate with outcomes in many studies, its applicability is more limited in pediatrics [17] and obstetric patients [18], where there was more variability or uncertainty for assigning classification. Misclassification of ASA can have implications, such as its role in determining preoperative workup done in the UK [19]. Hence the use of ASA might be limited in certain populations because of discrepancies in classifications and its impact, for which this study would argue bariatrics should be included. ASA is also determined by the anesthesia team who meets patients in a narrow preoperative period. Clinically, this may lead to limited room for perioperative optimization. For research it may provide an inaccurate assessment of risk as there may be inadequate longitudinal follow-up for this complex patient population. Furthermore, patients undergoing bariatric surgery often have multiple obesity-related comorbidities, including cardiovascular, pulmonary, and renal. Though ASA scores

Table 3 Multivariable logistic regression for serious complications. Significant p-values are italicized

Risk Factor	Adjusted Odds Ratio	95% confidence interval	p-value
Age	1.06	1.03–1.10	*< 0.001*
Race (vs. white)			
Black	1.26	1.16–1.37	*< 0.001*
Other	0.99	0.90–1.10	0.906
GERD	1.24	1.16–1.33	*< 0.001*
Female sex	1.01	0.93–1.10	0.829
Smoker	1.27	1.13–1.42	*< 0.001*
High-risk (ASA class IV vs. class I, II and III)	1.36	1.18–1.56	*< 0.001*
Sleep apnea	1.01	0.95–1.09	0.698
Previous MI	1.85	1.49–2.28	*< 0.001*
Roux-en-y gastric bypass	2.07	1.92–2.22	*< 0.001*
Hypertension	1.17	1.09–1.27	*< 0.001*
Hyperlipidemia	1.04	0.95–1.13	0.404
Diabetes			
Insulin-independent	1.16	1.03–1.30	*0.013*
Insulin-dependent	1.00	0.92–1.09	0.994
Functional status preoperatively			
Partially dependent	2.06	1.56–2.72	*< 0.001*
Fully dependent	3.19	1.10–9.28	*0.033*
Renal insufficiency	1.89	1.44–2.47	*< 0.001*
COPD	1.17	0.94–1.47	0.163
History of VTE	1.77	1.53–2.06	*< 0.001*
BMI	1.00	1.00–1.00	0.961
Operative length	1.00	1.00–1.00	*< 0.001*

Italics within the tables represent $p < 0.05$

ASA American Society of Anesthesiologists, *COPD* chronic obstructive pulmonary disease, *GERD* gastroesophageal reflux disease, *MI* myocardial infarction, *VTE* venous thromboembolism

include assessment of comorbidities, not all comorbidities demonstrate the same degree of predictiveness and factors such as preoperative functional status may not be capture [15]. In this study, ASA predicted higher 30-day serious complication rate in a multivariate analysis but not 30-day death; it also behind many other variables for independent effect on odds ratio. From the results of our multivariate analysis, the best alternatives for anticipating increased odds of complications following elective bariatric surgery include previous MI and functional status preoperatively. This aligns with multivariate analyses of other studies showing functional status as one of the best predictors of mortality and odds of discharge to alternate care facility for bariatric surgery patients [20, 21]. Despite the relative low complication rate of bariatric surgery as demonstrated in this study, higher risk patients are undergoing elective surgery, such as geriatric populations and those with super obesity (BMI ≥ 50 kg/m^2), secondary to the favorable risk–benefit ratios [22, 23]. Thus, a risk stratification tool, especially for these higher risk populations, offers substantial opportunity to identify those at most risk to modify care pathways and improve outcomes.

Alternatively, scales such as the Edmonton Frail Scale [24], Edmonton Obesity Staging System [11], or Clinical Frail Scale [25] may be better tools for risk stratification to optimize patient and procedural selection and can be used as an alternative to ASA. Previous studies using the MBSAQIP database have shown that frailty in older patients with associated with increased postoperative adverse events [9]. Scales such as the Edmonton Frail Scale have been shown to correlate well to postoperative complication in older patients in both retrospective [8] and prospective [10] studies. While frailty-based scales are often designated for older individuals (e.g., > 70), the Edmonton Obesity Staging System also serves as a strong predictor of postoperative morbidity and mortality. This scale, which amalgamates the patient's functional limitations and obesity-related comorbidities (medical and psychological), was shown to be predictive of complications in a retrospective cohort study of 378 patients undergoing bariatric surgery [11]. The Duke Activity Status Index (DASI) can also be used to estimate functional capacity in metabolic equivalents (METs) [26]. Current recommended surgical risk calculators such as the Revised Cardiac Risk Index (RCRI) do not take into consideration functional status but others such as the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Myocardial Infarction or Cardiac Rest (MICA) or American College of Surgeons NSQIP Surgical risk calculators include this factor [27]. Indeed, the importance of functional assessment should be highlighted and further comparative study of these tools with inclusion of bariatric populations will be beneficial to optimize care moving forward.

Limitations of this study include the retrospective study methodology, using the MBSAQIP database. Utilizing such databases can introduce selection bias. However, it remains the largest database for bariatric surgery patients in North America and data is collected prospectively. Furthermore, the use of ASA scores to classify patients as high-risk considers the cumulative comorbidity of a patient's medical conditions and history. Thus, the performed multivariate analysis considers the individual effects of many medical comorbidities and detracts from the inherent value of using a single scoring system. Nonetheless, an aim of this study is to demonstrate that assessing risk of complications and death in patients considers multiple factors, and only using ASA to determine risk in patients who are at higher baseline risk may not be sufficient in the bariatric surgery population. ASA is also a subjective measure and may not be consistent among various healthcare professionals. Furthermore, variables were self-selected, and important demographic

Table 4 Multivariable logistic regression for death by 30 days. Significant p-values are italicized

Risk Factor	Adjusted Odds Ratio	95% confidence interval	p-value
Age	2.01	1.61–2.51	*< 0.001*
Race (vs. white)			
Black	1.59	0.93–2.72	0.087
Other	1.27	0.62–2.59	0.516
GERD	1.09	0.68–1.73	0.724
Female	0.33	0.21–0.53	*< 0.001*
High-risk (ASA class IV vs. class II and III)	1.04	0.49–2.21	0.921
Sleep apnea	0.58	0.36–0.92	0.020
Previous MI	4.61	2.25–9.44	*< 0.001*
Roux-en-y gastric bypass	1.34	0.81–2.22	0.256
Hypertension	1.10	0.63–1.92	0.730
Hyperlipidemia	0.80	0.47–1.35	0.398
Diabetes			
Insulin-independent	2.26	1.26–4.05	*0.006*
Insulin-dependent	1.08	0.60–1.97	0.796
Functional status preoperatively			
Partially dependent	5.09	2.16–12.00	*< 0.001*
Fully dependent	–[a]	–	–
Renal insufficiency	1.77	0.60–5.24	0.302
COPD	1.01	0.35–2.94	0.988
History of VTE	1.75	0.81–3.78	0.155
BMI	1.05	1.03–1.08	*< 0.001*
Operative length, by minute	1.00	1.00–1.01	0.177

Italics within the tables represent $p < 0.05$

ASA American Society of Anesthesiologists, *BMI* body mass index, *COPD* chronic obstructive pulmonary disease, *GERD* gastroesophageal reflux disease, *MI* myocardial infarction, *VTE* venous thromboembolism

[a]Not included in the model by the statistical software as it predicted outcome perfectly

information or data about comorbidity may not have been included. As well, while individual odds ratios may be higher for certain variables in the multivariate analysis, it is not possible to state with full confidence that optimizing these factors will result in a change in rate of complications.

Despite our limitations, this study will help clinicians risk stratify our patients. The use of ASA may not be the best tool for risk stratification scores in bariatric surgery and its use should be reconsidered in context of other well-validated evaluative tools for both perioperative risk assessment and use in clinical studies. Additionally, inclusion of alternative, bariatric specific global measures of comorbidity may be better to collect in important databases such as the MBSA-QIP. Future studies in this domain should be prospective in nature and validate using functional status risk assessment scores to assess rate of complications.

Conclusion

Despite higher complications rates in patients deemed high-risk by ASA classification, the absolute risks for these patients are only marginally higher and remain low overall. ASA classification is associated with higher independent odds of serious complication but not mortality. However, functional status has a higher independent odds ratio for both serious complications and mortality and is a better tool than ASA for assessing risk of postoperative complications. Alternative risk assessment tools, including ones taking into consideration functional status, should be considered instead of ASA for clinical and research use in the bariatric surgery population.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00464-023-10017-w.

Funding No funding to be disclosed.

Declarations

Disclosures None of the authors of this manuscript, including Sukhdeep Jatana, Kevin Verhoeff, Valentin Mocanu, Uzair Jogiat, Daniel W. Birch, Shahzeer Karmali, and Noah J. Switzer) have any disclosures.

References

1. Chang SH, Stoll CR, Song J, Varela JE, Eagon CJ, Colditz GA (2014) The effectiveness and risks of bariatric surgery: an updated systematic review and meta-analysis, 2003–2012. JAMA Surg 149:275–287
2. Ikramuddin S, Korner J, Lee WJ, Connett JE, Inabnet WB, Billington CJ, Thomas AJ, Leslie DB, Chong K, Jeffery RW, Ahmed L, Vella A, Chuang LM, Bessler M, Sarr MG, Swain JM, Laqua P, Jensen MD, Bantle JP (2013) Roux-en-Y gastric bypass vs intensive medical management for the control of type 2 diabetes, hypertension, and hyperlipidemia: the Diabetes Surgery Study randomized clinical trial. JAMA 309:2240–2249
3. Doumouras AG, Wong JA, Paterson JM, Lee Y, Sivapathasundaram B, Tarride JE, Thabane L, Hong D, Yusuf S, Anvari M (2021) Bariatric surgery and cardiovascular outcomes in patients with obesity and cardiovascular disease: a population-based retrospective cohort study. Circulation 143:1468–1480
4. van Veldhuisen SL, Gorter TM, van Woerden G, de Boer RA, Rienstra M, Hazebroek EJ, van Veldhuisen DJ (2022) Bariatric surgery and cardiovascular disease: a systematic review and meta-analysis. Eur Heart J 43:1955–1969
5. Aminian A, Al-Kurd A, Wilson R, Bena J, Fayazzadeh H, Singh T, Albaugh VL, Shariff FU, Rodriguez NA, Jin J, Brethauer SA, Dasarathy S, Alkhouri N, Schauer PR, McCullough AJ, Nissen SE (2021) Association of bariatric surgery with major adverse liver and cardiovascular outcomes in patients with biopsy-proven nonalcoholic steatohepatitis. JAMA 326:2031–2042
6. Moulla Y, Lyros O, Bluher M, Simon P, Dietrich A (2018) Feasibility and safety of bariatric surgery in high-risk patients: a single-center experience. J Obes 2018:7498258
7. Sankar A, Johnson SR, Beattie WS, Tait G, Wijeysundera DN (2014) Reliability of the American Society of Anesthesiologists physical status scale in clinical practice. Br J Anaesth 113:424–432
8. Dasgupta M, Rolfson DB, Stolee P, Borrie MJ, Speechley M (2009) Frailty is associated with postoperative complications in older adults with medical problems. Arch Gerontol Geriatr 48:78–83
9. Gondal AB, Hsu CH, Zeeshan M, Hamidi M, Joseph B, Ghaderi I (2019) A frailty index and the impact of frailty on postoperative outcomes in older patients after bariatric surgery. Surg Obes Relat Dis 15:1582–1588
10. He Y, Li LW, Hao Y, Sim EY, Ng KL, Lee R, Lim MS, Poopalalingam R, Abdullah HR (2020) Assessment of predictive validity and feasibility of Edmonton Frail Scale in identifying postoperative complications among elderly patients: a prospective observational study. Sci Rep 10:14682
11. Skulsky SL, Dang JT, Switzer NJ, Sharma AM, Karmali S, Birch DW (2021) Higher Edmonton Obesity Staging System scores are independently associated with postoperative complications and mortality following bariatric surgery: an analysis of the MBSAQIP. Surg Endosc 35:7163–7173
12. Maciejewski ML, Livingston EH, Smith VA, Kavee AL, Kahwati LC, Henderson WG, Arterburn DE (2011) Survival among high-risk patients after bariatric surgery. JAMA 305:2419–2426
13. American College of Surgeons (2022) MBSAQIP 2021 Participant Use Data File (PUF). American College of Surgeons
14. Ozsoy Z, Demir E (2018) Which bariatric procedure is the most popular in the world? a bibliometric comparison. Obes Surg 28:2339–2352
15. American Society of Anesthesiologists (2020) ASA Physical Status Classification System.
16. Daabiss M (2011) American Society of Anaesthesiologists physical status classification. Indian J Anaesth 55:111–115
17. Aplin S, Baines D, Del J (2007) Use of the ASA physical status grading system in pediatric practice. Paediatr Anaesth 17:216–222
18. Barbeito A, Shultz J, Gan T, Muir H (2003) ASA physical status classification in pregnant patients. Anesthesiology Annual Meeting 2003, pp A-1195
19. National Institute for Health and Care Excellence (NICE) (2016) Routine preoperative tests for elective surgery - NICE Guidance 45.
20. McLean C, Mocanu V, Birch DW, Karmali S, Switzer NJ (2021) Hypoalbuminemia predicts serious complications following elective bariatric surgery. Obes Surg 31:4519–4527
21. Mocanu V, Dang JT, Birch DW, Karmali S, Switzer NJ (2021) Factors implicated in discharge disposition following elective bariatric surgery. Surg Obes Relat Dis 17:104–111
22. Verhoeff K, Mocanu V, Dang J, Purich K, Switzer NJ, Birch DW, Karmali S (2022) Five years of MBSAQIP data: characteristics, outcomes, and trends for patients with super-obesity. Obes Surg 32:406–415
23. Dang JT, Mocanu V, Verhoeff K, Allemang M, Kroh M, Karmali S (2023) Predicting serious complications following bariatric surgery in geriatric patients: development of the GeriBari scoring tool using the MBSAQIP database. Surg Obes Relat Dis 19(3):195–202. https://doi.org/10.1016/j.soard.2022.08.019
24. Rolfson DB, Majumdar SR, Tsuyuki RT, Tahir A, Rockwood K (2006) Validity and reliability of the Edmonton Frail Scale. Age Ageing 35:526–529
25. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, Mitnitski A (2005) A global clinical measure of fitness and frailty in elderly people. CMAJ 173:489–495
26. Hlatky MA, Boineau RE, Higginbotham MB, Lee KL, Mark DB, Califf RM, Cobb FR, Pryor DB (1989) A brief self-administered questionnaire to determine functional capacity (the Duke Activity Status Index). Am J Cardiol 64:651–654
27. Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, Bozkurt B, Davila-Roman VG, Gerhard-Herman MD, Holly TA, Kane GC, Marine JE, Nelson MT, Spencer CC, Thompson A, Ting HH, Uretsky BF, Wijeysundera DN (2014) 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation 130:e278-333