

# Malnutrition is Associated with Poor Postoperative Outcomes Following Laparoscopic Hysterectomy

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## ABSTRACT

**Background:** Malnutrition continues to be pervasive among the general population, with rates as high as 50% of patients undergoing surgical procedures. Data is limited about women undergoing surgery for non-malignant gynecologic indications (generally elective laparoscopic hysterectomies, after failed conservative measures). With the significant increase in benign gynecologic surgery, it is of the utmost importance that surgeons optimize modifiable risk factors for patients undergoing laparoscopic hysterectomy. The purpose of this study is to identify the impact of malnutrition on postoperative outcomes in patients undergoing laparoscopic hysterectomy for benign conditions.

**Methods:** A retrospective cohort study was conducted utilizing data that was collected through the American College of Surgeon's National Surgical Quality Improvement Program (NSQIP) Database. All patients that

underwent laparoscopic hysterectomy for benign indications were identified. Patients with malnutrition were identified by either low albumin ( $\leq 3.5$  g/dL), low body mass index ( $\leq 18.5$ ), or 10% weight loss within 6 months. The frequency of postoperative complications was evaluated with univariate and multivariate analyses where appropriate.

**Results:** Following adjustment, multivariate analysis illustrated pre-operative malnutrition to be a risk factor for the following complications: any complication, death, bleeding requiring transfusion, wound, cardiac, pulmonary, renal, thromboembolic, sepsis complications, extended length of stay, and reoperation ( $p \leq 0.05$  for all).

**Conclusion:** Malnourished patients were at significantly higher risk of developing postoperative complications during the acute postoperative period. With elective laparoscopic hysterectomies, pre-operative evaluation and intervention for malnutrition should be considered to improve nutritional status.

**Key Words:** Malnutrition, Laparoscopic Hysterectomy, Hysterectomy, Postoperative Complications.

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## INTRODUCTION

Malnutrition continues to be pervasive among the general population, with rates as high as 50% of patients undergoing surgical procedures.<sup>1</sup> In addition, malnutrition has been associated with significant complications among patients undergoing elective surgeries.<sup>2-6</sup> Malnourished surgical patients endure significantly longer durations of hospitalization, are more likely to require readmission within 30 days of discharge, and have increased health-care costs.<sup>7,8</sup> A review of hospital discharges from the 2010 Healthcare Cost and Utilization Project found that patients with a malnutrition diagnosis were more likely to have 27 out of 29 comorbidities and five times more likely to pass away while in the hospital.<sup>9</sup>

A variety of diagnostic definitions have been proposed for malnutrition, including anthropometric measurements,<sup>10-12</sup> various serologic laboratory values,<sup>10,13-15</sup> and standardized nutrition score tools.<sup>16-18</sup> Hu and colleagues assessed the effects of low body mass index (BMI) ( $\leq 18.5$  kg/m<sup>2</sup>), and body weight loss as malnutrition markers on postoperative complications regarding colorectal surgery and concluded that these were not useful markers for complication prediction.<sup>19</sup> Among specific serologic laboratory values, albumin (cutoff < 3.5 g/dL), total lymphocyte count (cutoff < 1500 cells/mm<sup>3</sup>) and transferrin (cutoff < 200 mg/dL) have been proposed with varying success.<sup>20</sup> Despite the vast selection of diagnostic modalities, there is no gold standard for defining malnutrition. However, serum-defined malnutrition remains the most widely used- with albumin as the most commonly used across all domains.<sup>21</sup> Prior research has indicated that hypoalbuminemia, defined as albumin < 3.5 g/dL, may have significant procedure-specific impact upon peri-operative outcome, and is associated with poor postoperative outcomes.<sup>6</sup> While it is known that patients undergoing surgery for gynecologic malignancies with malnutrition, as indicated by hypoalbuminemia, have significantly higher odds of developing postoperative complications, oncologic patients vary significantly in coexisting comorbidities and in prognosis from patients with benign conditions.<sup>4</sup> Thus, this paper reviews elective cases, as those involve non-malignant etiologies. Gynecologic surgery for benign conditions has significantly increased over the past decade, specifically the utility of laparoscopic or robotically assisted modalities.<sup>22</sup> The indication for hysterectomy is most often benign, including conditions such as abnormal uterine bleeding, fibroids, prolapse, and pelvic pain.<sup>23</sup> It is unknown if hypoalbuminemia, as a marker for malnourishment, in patients undergoing gynecologic surgery for benign conditions has similar prognostic power with regard to perioperative outcomes as it does for oncology patients. While several studies have examined the impact of malnutrition on surgical outcomes, none have looked specifically at malnutrition with respect to gynecologic surgery for a benign condition. This is of importance, as malnutrition is a significant modifiable risk factor for postoperative complications and increased length of hospital stay, undoubtedly leading to increased cost of care.

This study intends to elucidate and quantify the impact of malnutrition, utilizing albumin as a surrogate, on perioperative outcomes for patients undergoing laparoscopic hysterectomy for benign conditions. We hypothesize that patients who are malnourished at the time of surgical intervention will be at significantly increased risk of postoperative complications.

## METHODS

This retrospective cohort study was conducted using data extracted from the American College of Surgeons National Surgical Quality Improvement Program Database from January 1, 2005 to December 31, 2018. Patients were included in the study if they underwent laparoscopic hysterectomy for benign indication during our predefined interval. Malignant indications were defined as patients with a postoperative ICD code of the following- ICD-9-CM codes containing '179', '180', '182', '183', '184', and ICD-10-CM codes containing 'C52', 'C53', 'C54', 'C55'. Patients who underwent hysterectomy were identified utilizing current procedural terminology codes indicative of total laparoscopic hysterectomy (58570, 58571, 58572, 58573), laparoscopically assisted vaginal hysterectomy (58550, 58552, 58553, 58554), and laparoscopic supracervical hysterectomy (58541, 58542, 58543, 58544). Demographic information, comorbidities, and postoperative complications within 30 days of index surgery were collected. Patients with malnutrition were defined as the following: pre-operative albumin levels below 3.5g/dL, BMI less than 18.5kg/m<sup>2</sup>, or having a 10% weight loss over 6 months. Patients without pre-operative albumin levels were considered healthy, nourished patients.<sup>24</sup> In addition, patients who were male, had missing data, or required emergent cases were excluded from this analysis.

Baseline demographic information included patient race and age. Additional demographic data collected included: American Society of Anesthesiologist (ASA) class, smoking status, and pre-operative functional status.

Collected data pertaining to medical comorbidities was included if the patients experienced: chronic obstructive pulmonary disease (COPD), congestive heart failure, hypertension, dialysis, renal failure, steroid use, pre-operative transfusion, bleeding disorder, diabetes status, or dyspnea status. Perioperative variables including anesthesia type and operative time were also assessed.

Data pertaining to postoperative complications were aggregated into groupings of 30-day postoperative complications as followed: wound (superficial surgical site infection, deep surgical site infection, organ/space infection, or wound dehiscence), pulmonary (failure to wean from ventilator within 48 hours postoperatively, unplanned reintubation, or pneumonia), renal (either new renal insufficiency, Cr > 2 mg/dl, or acute renal failure requiring dialysis), cardiac (either myocardial infarction or cardiac arrest requiring cardiopulmonary resuscitation), and venous thromboembolism (either deep vein thrombosis, or pulmonary embolism), septic complications (either sepsis

or septic shock). Single complications that were also assessed but not grouped included urinary tract infection (UTI) and perioperative blood transfusion requirement due to blood loss. The 'any complication' composite is defined as the development of at least one of the aforementioned postoperative complications. Additional postoperative outcomes that were evaluated included extended length of stay (defined as greater than 2 days) and unplanned return to the operating room.

Univariate and multivariate analyses on demographic data, comorbidities, and postoperative outcomes were conducted via Statistical Package for the Social Sciences (SPSS; Version 26; Armonk, NY) software. The  $\chi^2$  test and ANOVA were used to perform univariate testing where appropriate. Logistic regression analyses were performed on risk factors with  $P < 0.2$  to determine risk factors for postoperative complications, returning to the operating room, extended length of stay ( $> 2$  days) following adjustment. Potential confounding variables were included in the multivariate analysis if there was a significant difference observed between the cohorts. Analysis was reported with p-values and odds ratios with 95% confidence intervals. A p-value of  $< 0.05$  considered significant.

## RESULTS

### Demographics

A total of 202,069 patients underwent laparoscopic hysterectomy for this study (Table 1). A total of 6,704 patients were malnourished (3.3%). The largest malnourished cohort was the hypoalbuminemia cohort. On average, preoperative albumin levels were drawn 4.1 days (1–10) prior to laparoscopic hysterectomy. Relative to the well-nourished cohort, differences were found regarding age, race, ASA class, smoking, and functional status. Of note, all malnourished groups had higher smoking rates and lower functional status. Patients with hypoalbuminemia or weight loss had a higher ASA class relative to the well-nourished cohort.

### Comorbidities

Patients with either hypoalbuminemia, low BMI, or body weight loss had higher rates of COPD and hypertension relative to the well-nourished cohort (Table 2). While patients in the hypoalbuminemia or body weight loss cohort had higher rates of diabetes mellitus and dyspnea severity relative to the well-nourished cohort. The lower BMI cohort had less rates of diabetes mellitus and dyspnea severity. When assessing all three malnourished cohorts, the

hypoalbuminemia cohort had the highest amount of comorbidity differences relative to the well-nourished cohort.

### Complications

Table 3 describes the postoperative complications regarding laparoscopic hysterectomy. Patients with any type of malnourishment had significantly higher rates of developing any postoperative complications. Patients with body weight loss had the highest any-complication rate (15%). The most common composite of complications were wound complications. Patients with a low BMI did develop significant increases in postoperative complications relative to the well-nourished cohort. In contrast, both the hypoalbuminemia cohort and the body weight loss cohort developed higher rates of death, perioperative blood transfusions, wound complications, cardiac complications, pulmonary complications, renal complications, thromboembolic complications, and septic complications relative to the well-nourished cohort. No differences in UTI rates were detected among all group comparisons.

When assessing other postoperative outcomes, any type of malnourishment led to significantly increased rates of an extended length of hospital stay greater than 2 days. Only patients with hypoalbuminemia or body weight loss had higher rates of unplanned reoperation.

Following adjustment, malnutrition remained a risk factor for many postoperative complications (Table 4). Having hypoalbuminemia is associated with increased rates of any-complication ( $P \leq .001$ ; odds ratio [OR]: 10.7 [10.6–10.9]), mortality ( $P = .007$ ; OR: 20.7 [10.3–50.4]), perioperative blood transfusion ( $P \leq .001$ ; OR: 30.2 [20.7–30.7]), wound complications ( $P = .021$ ; OR: 10.3 [10.0–10.5]), pulmonary complications ( $P \leq .001$ ; OR: 20.5 [10.8–30.6]), renal complications ( $P \leq .001$ ; OR: 40.6 [20.8–70.5]), thromboembolic complications ( $P = .007$ ; OR: 10.7 [10.2–20.6]), and septic complications ( $P \leq .001$ ; OR: 20.3 [10.7–30.2]) relative to being well-nourished. Having a low BMI is associated with increased rates of extended length of hospital stay ( $P \leq .001$ ; OR: 10.8 [10.4–20.2]) relative to being well-nourished. Having body weight loss is associated with increased rates of any-complication ( $P \leq .001$ ; OR: 20.8 [20.1–30.8]), mortality ( $P \leq .001$ ; OR: 120.3 [40.2–360.2]), perioperative blood transfusion ( $P \leq .001$ ; OR: 40.9 [30.1–70.7]), wound complications ( $P = .001$ ; OR: 20.3 [10.4–30.8]), cardiac complications ( $P = .045$ ; OR: 40.4 [10.0–180.6]), renal complications ( $P = .035$ ; OR: 40.6 [10.1–190.2]), thromboembolic complications ( $P = .005$ ; OR: 30.6 [10.5–80.9]), septic complications ( $P \leq .001$ ; OR: 40.3 [20.0–90.2]), and unplanned reoperation ( $P = .001$ ; OR: 20.7 [10.5–50.0]) relative to being well-nourished.

**Table 1.**  
Demographics and Clinical Characteristics for Patients Undergoing Laparoscopic Hysterectomies

Demographics	Normal	Albumin < 3.5 g/dL	BMI < 18.5 kg/m <sup>2</sup>	Weight Loss	p-Value: Albumin < 3.5 g/dL vs. Normal	p-Value: BMI < 18.5 kg/m <sup>2</sup> vs. Normal	p-Value: Weight Loss vs. Normal
Total patients, n	195,365	4,055	2,275	374			
Ethnicity, n (%)					<b>&lt; 0.001¶</b>	<b>&lt; 0.001¶</b>	0.052¶
Caucasian	126,389 (71.8)	2,431 (62.8)	1,439 (75.2)	256 (77.8)			
Black or African American	23,115 (13)	808 (20.9)	161 (8.4)	37 (11.2)			
Hispanic	18,249 (10.4)	483 (12.5)	149 (7.8)	20 (6.1)			
American Indian or Alaska Native	1,019 (0.6)	35 (0.9)	20 (1.0)	1 (0.3)			
Asian	6,321 (3.6)	89 (2.3)	138 (7.2)	11 (3.3)			
Native Hawaiian or Pacific Islander	1,046 (0.6)	25 (0.6)	7 (0.4)	4 (1.2)			
ASA, n (%)					<b>&lt; 0.001¶</b>	<b>&lt; 0.001¶</b>	<b>&lt; 0.001¶</b>
I	20,908 (10.7)	122 (3.0)	362 (15.9)	14 (3.7)			
II	127,205 (64.9)	1,841 (45.2)	1,516 (66.4)	172 (46.0)			
III	46,442 (23.7)	1,927 (47.3)	395 (17.3)	176 (47.1)			
IV	1,353 (0.7)	182 (4.5)	10 (0.4)	12 (3.2)			
V	6 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)			
Smoker, n (%)	31,374 (16.0)	738 (18.1)	562 (24.6)	105 (28.1)	<b>&lt; 0.001¶</b>	<b>&lt; 0.001¶</b>	<b>&lt; 0.001¶</b>
Functional status preoperative, n (%)					<b>&lt; 0.001¶</b>	<b>&lt; 0.001¶</b>	<b>&lt; 0.001¶</b>
Independent	194,786 (99.7)	3,974 (98.0)	2,255 (99.1)	369 (98.7)			
Partially dependent	511 (0.3)	70 (1.7)	15 (0.7)	5 (1.3)			
Totally dependent	68 (0.0)	11 (0.3)	5 (0.2)	0 (0.0)			
Mean age, yrs (SD)	48.66 (11.62)	51.11 (13.04)	47.50 (13.00)	56.17 (14.46)	<b>&lt; 0.001**</b>	<b>&lt; 0.001**</b>	<b>&lt; 0.001**</b>

¶Pearson's  $\chi^2$  test.

\*\*Analysis of variance.

Bolding equals significance  $P < .05$ .

ASA, American Society of Anesthesiologists; SD, standard deviation; BMI, body mass index.

## DISCUSSION

Multiple studies have identified serologic definition malnutrition as a risk factor for postoperative complications and extended lengths of stay.<sup>4,6,25-29</sup> Prior research has compared open versus laparoscopic procedures in malnourished patients undergoing gastrectomy, concluding that laparoscopic procedures lead to less postoperative complications.<sup>29</sup> Similarly, previous research has demonstrated an increased risk of postoperative complications for open hysterectomy in malnourished patients with gynecologic

malignancies.<sup>4</sup> To our knowledge, this is the first study to observe the impact of malnutrition, gauged by serum albumin levels, BMI, and body weight loss over six months, on postoperative care in patients undergoing laparoscopic hysterectomy for benign indications. We found that malnourished patients, specifically patients with hypoalbuminemia or body weight loss, were more likely to present with other comorbidities. Similarly, Wolf et al. reported that malnourished patients were more likely to be smokers, have dyspnea, have pre-existing COPD, and a higher ASA.<sup>30</sup> It may be useful to pre-operatively assess for malnutrition, such as

**Table 2.**  
Comorbidities and Intraoperative Variables among Patients Undergoing Laparoscopic Hysterectomies

Comorbidities	Normal	Albumin < 3.5 g/dL	BMI < 18.5 kg/m <sup>2</sup>	Weight Loss	p-Value: Albumin < 3.5 g/dL vs. Normal¶	p-Value: BMI < 18.5 kg/m <sup>2</sup> vs. Normal¶	p-Value: Weight Loss vs. Normal¶
Total patients, n	195,365	4,055	2,275	374			
COPD, n (%)	1,917 (1.0)	127 (3.1)	36 (1.6)	17 (4.5)	<b>&lt; 0.001</b>	<b>0.004</b>	<b>&lt; 0.001</b>
CHF, n (%)	163 (0.1)	33 (0.8)	3 (0.1)	4 (1.1)	<b>&lt; 0.001</b>	0.429	<b>&lt; 0.001</b>
Hypertension, n (%)	55,206 (28.2)	1,788 (43.9)	330 (14.4)	161 (43.0)	<b>&lt; 0.001</b>	<b>&lt; 0.001</b>	<b>&lt; 0.001</b>
Dialysis, n (%)	183 (0.1)	50 (1.2)	5 (0.2)	2 (0.5)	<b>&lt; 0.001</b>	0.053	<b>0.005</b>
Renal failure, n (%)	19 (0.0)	10 (0.2)	1 (0.0)	0 (0.0)	<b>&lt; 0.001</b>	0.107	0.849
Steroid use, n (%)	2,881 (1.5)	154 (3.8)	31 (1.4)	15 (4.0)	<b>&lt; 0.001</b>	0.653	<b>&lt; 0.001</b>
Bleeding disorder, n (%)	1,768 (0.9)	144 (3.5)	14 (0.6)	18 (4.8)	<b>&lt; 0.001</b>	0.145	<b>&lt; 0.001</b>
Preoperative transfusion, n (%)	628 (0.3)	126 (3.1%)	11 (0.5%)	5 (1.3%)	<b>&lt; 0.001</b>	0.177	<b>0.001</b>
DM status, n (%)					<b>&lt; 0.001</b>	<b>&lt; 0.001</b>	<b>&lt; 0.001</b>
No DM	178,284 (91.0)	3,173 (77.9)	2,218 (97.0)	320 (85.6)			
Noninsulin-dependent DM	13,145 (6.7)	470 (11.5)	46 (2.0)	35 (9.4)			
Insulin-dependent DM	4,592 (2.3)	431 (10.6)	22 (1.0)	19 (5.1)			
Dyspnea, n (%)					<b>&lt; 0.001</b>	<b>0.001</b>	<b>&lt; 0.001</b>
No dyspnea	190,581 (97.2)	3,741 (91.8)	2,251 (98.5)	341 (91.2)			
Moderate exertion	5,273 (2.7)	313 (7.7)	34 (1.5)	32 (8.6)			
At rest	167 (0.1)	20 (0.5)	1 (0.0)	1 (0.3)			
Anesthesia type, n (%)					0.220	0.129	<b>&lt; 0.001</b>
General	195,582 (99.8)	4,068 (99.9)	2,280 (99.7)	373 (99.7)			
Neuraxial	229 (0.1)	2 (0.0)	3 (0.1)	0 (0.0)			
Regional	26 (0.0)	1 (0.0)	2 (0.1)	0 (0.0)			
MAC	73 (0.0)	0 (0.0)	1 (0.0)	0 (0.0)			
OR Time > 3 hours, n (%)	40,814 (20.8)	965 (23.7)	415 (18.2)	90 (24.1)	<b>&lt; 0.001</b>	<b>0.002</b>	0.123

¶Pearson's  $\chi^2$  test.

Bolding equals significance  $P < .05$ .

BMI, body mass index; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; DM, diabetes mellitus; MAC, monitored anesthetic care; OR, operating room.

hypoalbuminemia or weight loss, since it is prevalent among many comorbidities.

In addition, our findings indicate that patients with hypoalbuminemia or body weight loss experienced increased rates of any complications compared to the well-nourished group, notably higher odds of postoperative mortality, wound infections, sepsis, renal complications, perioperative blood transfusions, thromboembolic complications, and extended length of hospital stay. Our results support prior research which has also demonstrated that malnutrition results in suboptimal clinical outcomes.<sup>28</sup> This reinforces

findings associating hypoalbuminemia, one of the surrogate markers for malnutrition, with increased overall complications including a higher likelihood of requiring transfusion and longer operative time. Furthermore, our results are in concordance with research that previously identified increased risk of postoperative pulmonary complications in malnourished patient populations.<sup>6,26</sup> Interestingly, we found that patients with low BMI ( $\leq 18.5$  kg/m<sup>2</sup>) were not accurate predictors for increased postoperative complications from laparoscopic hysterectomy. In fact, many of these patients had less comorbidities than the well-nourished group and was only a predictor for having increased odds

**Table 3.**  
Univariate Analysis of Postoperative Complications of Patients following Laparoscopic Hysterectomies

Complications	Normal	Albumin < 3.5 g/dL	p-Value: Albumin < 3.5 g/dL vs. Normal¶	BMI <18.5 kg/m <sup>2</sup>	p-Value: BMI < 18.5 kg/m <sup>2</sup> vs. Normal¶	Weight Loss	p-Value: Weight Loss vs. Normal¶
Total patients, n	195,365	4,055		2,275		374	
Any complication, n (%)	11,370 (5.8)	470 (11.5)	<b>&lt; 0.001</b>	148 (6.5)	0.171	56 (15.0)	<b>&lt; 0.001</b>
Mortality, n (%)	65 (0.0)	11 (0.3)	<b>&lt; 0.001</b>	0 (0.0)	0.384	4 (1.1)	<b>&lt; 0.001</b>
Perioperative blood transfusion, n (%)	2,288 (1.2)	205 (5.0)	<b>&lt; 0.001</b>	35 (1.5)	0.108	21 (5.6)	<b>&lt; 0.001</b>
Wound complication, n (%)	4,159 (2.1)	126 (3.1)	<b>&lt; 0.001</b>	54 (2.4)	0.428	17 (4.5)	<b>0.001</b>
Cardiac complication, n (%)	106 (0.1)	8 (0.2)	<b>&lt; 0.001</b>	1 (0.0)	0.833	2 (0.5)	<b>&lt; 0.001</b>
Pulmonary complication, n (%)	396 (0.2)	41 (1.0)	<b>&lt; 0.001</b>	5 (0.2)	0.860	5 (1.3)	<b>&lt; 0.001</b>
Renal complication, n (%)	121 (0.1)	23 (0.6)	<b>&lt; 0.001</b>	2 (0.1)	0.623	3 (0.8)	<b>&lt; 0.001</b>
Thromboembolic complication, n (%)	623 (0.3)	27 (0.7)	<b>&lt; 0.001</b>	5 (0.2)	0.402	5 (1.3)	<b>&lt; 0.001</b>
Sepsis complication, n (%)	760 (0.4)	50 (1.2)	<b>&lt; 0.001</b>	8 (0.3)	0.773	7 (1.9)	<b>&lt; 0.001</b>
Urinary tract infection, n (%)	4,421 (2.3)	106 (2.6)	0.141	54 (2.4)	0.732	12 (3.2)	0.215
Extended length of stay (> 2 days), n (%)	6,224 (3.2)	556 (13.6)	<b>&lt; 0.001</b>	114 (5.0)	<b>&lt; 0.001</b>	47 (12.6)	<b>&lt; 0.001</b>
Unplanned reoperation, n (%)	2,476 (1.3)	68 (1.7)	<b>0.022</b>	39 (1.7)	0.060	15 (4.0)	<b>&lt; 0.001</b>

¶Pearson's  $\chi^2$  test.

Bolding equals significance  $P < .05$ .

BMI, Body Mass Index.

**Table 4.**  
Multivariate Analysis of Postoperative Complications of Patients Following Laparoscopic Hysterectomies

Complications	Albumin < 3.5 g/dL		BMI < 18.5 kg/m <sup>2</sup>		Weight Loss	
	p-value	Odds ratio (Albumin < 3.5 g/dL/Normal) (95% CI)	p-value	Odds ratio (BMI < 18.5 kg/m <sup>2</sup> /Normal) (95% CI)	p-value	Odds ratio (Weight Loss/Normal) (95% CI)
Any complication	<b>&lt; 0.001</b>	1.723 (1.551 to 1.913)	-	-	<b>&lt; 0.001</b>	2.836 (2.108 to 3.815)
Mortality	<b>0.007</b>	2.664 (1.305 to 5.441)	-	-	<b>&lt; 0.001</b>	12.275 (4.166 to 36.163)
Perioperative blood transfusion	<b>&lt; 0.001</b>	3.180 (2.705 to 3.739)	-	-	<b>&lt; 0.001</b>	4.878 (3.086 to 7.711)
Wound complication	<b>0.021</b>	1.251 (1.034 to 1.514)	-	-	<b>0.001</b>	2.314 (1.393 to 3.844)
Cardiac complication	0.284	1.524 (0.705 to 3.296)	-	-	<b>0.045</b>	4.383 (1.033 to 18.600)
Pulmonary complication	<b>&lt; 0.001</b>	2.543 (1.793 to 3.606)	-	-	0.050	2.745 (1.002 to 7.518)
Renal complication	<b>&lt; 0.001</b>	4.597 (2.807 to 7.528)	-	-	<b>0.035</b>	4.617 (1.110 to 19.207)
Thromboembolic complication	<b>0.007</b>	1.741 (1.162 to 2.610)	-	-	<b>0.005</b>	3.638 (1.485 to 8.911)
Sepsis complication	<b>&lt; 0.001</b>	2.336 (1.730 to 3.154)	-	-	<b>&lt; 0.001</b>	4.293 (2.010 to 9.170)
Extended length of stay (> 2 days)	0.999	1.102 (0.000 to -)	<b>&lt; 0.001</b>	1.767 (1.414 to 2.208)	1.000	0.963 (0.000 to -)
Unplanned reoperation	0.174	1.193 (0.925 to 1.540)	-	-	<b>0.001</b>	2.707 (1.477 to 4.961)

Bolding equals significance  $P < .05$ .

BMI, Body Mass Index; CI, confidence interval.

of a hospital length of stay  $\geq$  2 days. Previous studies have also reported low BMI as an inaccurate predictor for postoperative outcomes.<sup>19,31</sup>

There are a variety of limitations to this study, which fall subject to inherent bias in study design given its retrospective nature. The specific indication for a patient's surgery, beyond the categories of benign or malignant, is unknown and may have significant impact upon surgical outcomes. Furthermore, one may infer that malnourished patients presented with more complex pathology based upon their longer operative times and enlarged uteri. It is important to recognize that there is no gold standard in diagnosing malnutrition, and there has been debate surrounding the efficacy of surrogate markers for nutritional status, including albumin.<sup>30</sup> Alternative serologic parameters that have been used as markers for nutrition status include total lymphocyte count, prealbumin level, and transferrin level.<sup>20</sup> Each of these limitations are of impact in the evaluation of potential surgical candidates, as a more detailed understanding of the relationship between albumin levels, malnutrition, and perioperative outcomes would allow surgeons to more specifically stratify risk level of patients. Similarly, the opportunity to improve malnutrition prior to surgery may allow for superior patient outcomes. However, the NSQIP database does not provide postoperative outcome data regarding malnutrition improvement prior to laparoscopic hysterectomy. Despite this limitation, previous prospective studies have noted that correction of malnutrition preoperatively or perioperatively can improve postoperative outcomes.<sup>32</sup> Future studies should be done to observe whether preoperative or perioperative optimization of nutritional status can improve postoperative outcomes regarding laparoscopic hysterectomy. Lastly, surgical experience could not be accounted for in this study and it was not separated into years. More complications were likely to be experienced in earlier years compared to the later years as the procedure required a steep learning curve.

In conclusion, this study aimed to determine the impact of malnutrition on postoperative complications for patients undergoing laparoscopic hysterectomies for benign conditions. After evaluating 202,069 patients, malnourished patients with hypoalbuminemia or body weight loss over 6 months had increased risk of postoperative complications. However, low BMI was also a malnutrition marker that could predict for an extended length of hospital stay. By utilizing albumin level, BMI, and body weight loss, which are easily obtainable variables, as surrogates for the nutritional status of pre-operative patients, surgeons have the opportunity to

identify and optimize a significant risk factor for postoperative surgical complications. Future studies should look at vaginal versus abdominal hysterectomies with regards to malnutrition status and compare the results.

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