Medical Journal of Bakırköy

Med J Bakirkoy 2022;18:218-224
DOI: 10.4274/BMJ.galenos.2022.2022.3-3

Research

The Effect of Comorbidities and Obesity on Postoperative Outcomes

Obezite ve Komorbiditelerin Postoperatif Sonuçlara Etkisi

Güneş Özlem Yıldız[1], Gökhan Sertçakacılar[1,2], Furkan Tontu[3], Duygu Akyol[4]

[1]University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Anesthesiology and Reanimation, Division of Intensive Care, Istanbul, Turkey
[2]Cleveland Clinic, Anesthesiology Institute, Department of Outcomes Research, Cleveland, OH, USA
[3]Ağrı Training and Research Hospital, Clinic of Anesthesiology and Reanimation, Division of Intensive Care, Ağrı, Turkey
[4]University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital, Clinic of Anesthesiology and Reanimation, Division of Intensive Care, Istanbul, Turkey

ABSTRACT

Objective: Obesity is a major public health issue worldwide. Obesity, along with its associated comorbidities, may impact surgical outcomes. Obesity is linked to wound infection, thromboembolic complications, and respiratory difficulties in surgical patients. Obesity may or may not have a negative impact on postoperative outcomes.

Methods: Patients over the age of 18 who had endometrial cancer surgery were screened retrospectively. Patient data from the hospital database were retrieved in terms of demographics, comorbidities, American Society of Anesthesiologists (ASA) score, Charlson Comorbidity index (CCI) score, duration of operation and anesthesia, postoperative intensive care admission, complications, and length of hospital stay. They were also reviewed and recorded from the patient file.

Results: The subjects' mean age was 57.2±9.8 years (range: 31-84 years). In patients with endometrial cancer, American Society of Anesthesiologist (ASA) (p=0.001), Charlson Comorbidity Index (CCI) (p=0.001) scores, operation time, postoperative complication risk (p=0.004), and hospital stay increase (p=0.029) as we progress from the normal group to the obese and morbidly obese groups.

Conclusion: Obesity increases the risk of postoperative complications such as wound infection, sepsis, acute renal damage, evisceration, and hospital stay in patients who have had endometrial cancer surgery. The ASA and CCI scores were related to postoperative complications, with the CCI score also being related to the length of hospital stay. The fact that these scores provide information about the postoperative outcomes of patients from the preoperative period emphasizes the significance of these scores once more.

Keywords: Charlson comorbidity index, endometrial cancer, intensive care, obesity

ÖZ

Amaç: Obezite tüm dünyada önemli bir halk sağlığı sorunudur. Obezite, eşlik eden komorbiditeleri ile birlikte cerrahi sonuçları etkileyebilir. Obezite cerrahi hastalarda yara enfeksiyonu, tromboembolik komplikasyonlar ve solunum güçlükleri ile bağlantılıdır. Obezite ameliyat sonrası sonuçlar üzerinde olumsuz bir etkiye sahip olabilir veya olmayabilir.

Gereç ve Yöntem: On sekiz yaş üstü endometriyal kanser cerrahisi geçiren hastalar retrospektif olarak tarandı. Hastane veri tabanından hasta verileri demografik özellikler, komorbiditeler, Amerikan Anesteziyoloji Derneği (ASA) skoru, Charlson Komorbidite indeksi (CCI) skoru, operasyon ve anestezi süresi, postoperatif yoğun bakıma yatış, komplikasyonlar ve hastanede kalış süresi açısından gözden geçirildi ve kaydedildi.

Bulgular: Hastaların ortalama yaşı 57.2±9.8 yıldı (aralık: 31-84 yıl). Endometriyum kanserli hastalarda normal gruptan obez ve morbid obez gruplara doğru ilerledikçe ASA (p=0.001), CCI (p=0.001) skorları, operasyon süresi, postoperatif komplikasyon riski (p=0.004) ve hastanede kalış süresi (p=0.029) artmaktadır.

Sonuç: Obezite, endometriyum kanseri ameliyatı geçirmiş hastalarda yara enfeksiyonu, sepsis, akut böbrek hasarı, eviserasyon ve hastanede kalış gibi postoperatif komplikasyon riskini artırır. ASA ve CCI skorlarının postoperatif komplikasyonlarla ilişkili olduğu, ek olarak CCI skorunun

Address for Correspondence: Güneş Özlem Yıldız, University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Anesthesiology and Reanimation, Division of Intensive Care, Istanbul, Turkey
Phone: +90 212 414 71 71 E-mail: gunesozlemyildiz@gmail.com ORCID ID: orcid.org/0000-0002-4557-9517

Cite as: Yıldız GÖ, Sertçakacılar G, Tontu F, Akyol D. The Effect of Comorbidities and Obesity on Postoperative Outcomes. Med J Bakirkoy 2022;18:218-224

Received: 18.03.2022
Accepted: 11.05.2022

hastanede kalış süresi ile de ilişkili olduğu bulundu. Bu skorların hastaların ameliyat öncesi dönemdeki ameliyat sonrası sonuçları hakkında bilgi vermesi, bu skorların önemini bir kez daha vurgulamaktadır.

Anahtar Kelimeler: Charlson komorbidite indeksi, endometriyal kanser, yoğun bakım, obezite,

INTRODUCTION

Obesity is a major public health issue worldwide (1,2). Endometrial cancer, one of the most common cancers worldwide, is strongly linked to obesity (3,4). Endometrial cancer is primarily treated through surgery (5). Obesity, along with its associated comorbidities, is thought to impact surgical outcomes. Obesity is associated with wound infection, thromboembolic problems, and respiratory problems in patients undergoing surgery, but whether obesity causes a negative postoperative outcome is debatable (6,7). As a result, studying the effect of obesity on postoperative outcomes is critical for predicting morbidity and hospital stay in patients undergoing surgery. Because of the numerous comorbid diseases that accompany obese patients, a practical preoperative evaluation is essential (8,9).

For more than sixty years, the American Society of Anesthesiologists (ASA) score has been the most commonly used score for preoperative patient evaluation by anesthesiologists. When combined with other factors (for example, the type of surgery), the score, which was last updated in 2020, is extremely useful in estimating perioperative risk (10). Obese patients [body mass index (BMI); 30-40] with no other comorbidities, for example, were classified as ASA-II; morbidly obese patients (BMI>40) were classified as ASA-III. In other words, according to the ASA score, the presence/increase of obesity alone raises the perioperative risk. However, the ability of this score to predict postoperative risk is unclear. The management of obese patients is difficult because of accompanying metabolic dysfunction, impaired glucose intolerance, and respiratory and cardiovascular diseases (11).

The Charlson Comorbidity index (CCI) was developed to assess the one-year mortality risk by allocating specific points to each of the seventeen comorbidities (12). CCI is a simple and easily applicable method for estimating the risk of death from comorbid disease (13). This index was later adapted for use with the International Classification of Diseases nine and ten, and it was used to estimate mortality (14,15). There are also studies on the use of CCI to predict postoperative outcomes in the literature (16,17). Obesity is not listed as a risk factor in CCI. Obesity, on the other hand, can be accompanied by diseases such as diabetes mellitus and stroke. In studies, the accuracy of the hypothesis is that as obesity increases, so do comorbid disorders and, consequently, CCI has not been fully clarified (18). CCI studies in obese patients are also important in testing this hypothesis.

The purpose of this retrospective study was to assess the effect of obesity on postoperative complications in endometrial cancer patients, including the role of two commonly used scoring systems (ASA, CCI) in predicting postoperative complications.

METHODS

Bakırköy Dr. Sadi Konuk Training and Research Hospital Ethics Committee approval was obtained (protocol no: 2020/221, date: 08.06.2020). Patients over the age of 18 who had endometrial cancer surgery between January 2018 and April 2020 were screened retrospectively. Demographic information, comorbidities, ASA score, CCI score, duration of operation, duration of anesthesia, hospitalization in the postoperative intensive care unit (ICU), complications, and length of hospital stay of patients included in the study. In terms of time, patient data were analyzed and recorded from the hospital database and patient file. Patients who presented to the gynecological oncology clinic with the diagnosis of endometrial cancer were also included. Patients with missing data were barred from participation in the study.

All patients undergoing endometrial ca are subjected to a standard anesthesia protocol developed in our clinic. Patients who undergo a preoperative anesthesia examination have detailed physical examination and laboratory results, ASA scores based on comorbidities, and anesthesia risks recorded. The ASA standard (electrocardiogram, peripheral oxygen saturation, and non-invasive blood pressure) is used to monitor each patient brought into the operating room. An infusion of 4-6 mL/kg/h crystalloid fluid is initiated, and antibiotic therapy is initiated. Following anesthesia induction with 2 mcg/kg iv fentanyl, 2-3 mg/kg propofol, and 0.6 mg/kg rocuronium, patients are intubated and connected to the anesthesia device in volume control mode. The tidal volume is 6-8 mL/kg, and the respiratory frequency is 12 beats per minute. End-tidal CO_2 is adjusted to stay between 35 and 45 mmHg. For anesthesia maintenance, sevoflurane (MAC 0.8-1) and remifentanil (0.05-0.2 mcg/kg/min) are used. When the surgical field was being closed, the patients were given paracetamol 1 g and tramadol 1 mg/kg iv as analgesics. In the postoperative recovery room, patients with numerical

rating scale pain scores greater than 4 are given pethidine hydrochloride 0.3 mg/kg as rescue analgesia.

The need for postoperative intensive care is assessed following the operation, and admission to the ICU is determined based on the patients' comorbidities, the preoperative hemodynamic course, respiratory distress, and the need for vasopressor/inotrope. Patients whose general condition and hemodynamics are stable are extubated and taken to the recovery room. Patients who have a modified Aldrete score of more than 8 in their follow-up are referred to the service.

Statistical Analysis

Data were analyzed using SPSS 20 for Windows (IBM Corp., Armonk, NY, USA). The normal distribution of the data was evaluated using the Kolmogorov-Smirnov test. The normally distributed variables were presented as the mean ± standard deviation, while the non-normally distributed variables were presented as the median (interquartile range: 25-75 percentiles). Categorical variables were presented as numbers and percentages. ANOVA test (post-hoc: Bonferroni correction) was used for the group comparison of the normally distributed variables and the Kruskal-Wallis H test (post-hoc: Dunn's correction) was used for the intergroup comparison of the non-normally distributed variables. The chi-square and Fisher Exact tests were used for the intergroup comparison of the categorical variables. Possible risk factors for developing postoperative complications were determined by Cox regression analysis. Variables related to operation time and complication development time were analyzed by Spearman correlation analysis. $P<0.05$ was accepted as statistically significant.

RESULTS

The mean age of the subjects was 57.2±9.8 years (range: 31-84 years), and BMI was 35.1±8.8 kg/m^2. According to ASA classification the percentage of ASA II patients' were 54.7% (n=70) and ASA III patients' were 45.3% (n=58). In addition, 35.9% of patients had normal BMI levels. While 32.8% patients were obese, 31.3% were morbidly obese. Comorbidities were present in 67.2% of the patients. Postoperative complications developed in 16.4% of the patients. The median length of hospital stay was five days, and the mortality rate was 1.6%. The comorbidity ratio and ASA-III rate ratio were higher in the morbid obese group compared to the other groups. The highest value of median CCI scores was in the morbid obesity group. The complication ratio was higher in the morbid obese group than in the other groups, and higher in the obese group than the normal weight. The duration of hospital stay was longer in the morbid obese group compared to the other groups, while it was similar in the obese group and normal weight (Table 1).

The factors associated with the risk of complications are shown in Table 2. Increased BMI, morbid obesity, the presence of respiratory diseases, ASA-III score, increased duration of operation, and hospitalization in the ICU are associated with the risk complications (Table 2). In the regression model, including all risk factors, the independent risk factors that increased the risk of complications were morbid obesity [hazard ratio (HR)= 6.03, p=0.008] and hospitalization in ICU (HR=10.2, p=0.001). A positive correlation was found between BMI level and length of hospital stay (r=0.336, p=0.007), and a negative correlation was found between the time of complication development (r=-0.328, p=0.013) (Table 3).

Compared with the normal BMI group, ASA ($p<0.001$) and CCI ($p<0.001$) scores, operation time, length of hospital stay (p=0.029) and postoperative complication risk (p=0.004) were increased in the obese and morbidly obese patient group.

DISCUSSION

The current study assessed the effect of obesity on postoperative complications in patients undergoing endometrial cancer surgery, as well as the ability of ASA, CCI, one of the widely used scoring systems, to predict postoperative outcome. Our secondary goal was to assess the impact of obesity on these patients' length of hospital stay and the ability of the scores to indicate this.

In our study, it was found that as BMI increased in patients with endometrial cancer, the rate of comorbidity increased (p=0.005), the CCI score increased ($p<0.001$) and the length of hospital stay was prolonged. Obesity is associated with a number of comorbid diseases, independent of endometrial cancer. Insulin resistance, type 2 diabetes mellitus, hypertension, dyslipidemia, cardiovascular disease, stroke and sleep apnea are the most serious ones (19,20). In our study, we observed a significant increase in hypertension, diabetes and respiratory tract diseases as BMI increased ($p<0.05$). While the presence of respiratory tract diseases increased the risk of postoperative complications in our patients ($p<0.05$), the presence of diabetes mellitus and hypertension did not increase the risk of complications. In addition to the increase in comorbid diseases seen in obese patients, chronic inflammation and dysmetabolism have been shown to adversely affect postoperative outcomes (7,21). However, there are also studies stating that the risk

Table 1. Demographic, clinical and laboratory findings

Variables	Normal n=46	Obesity n=42	Morbid obesity n=40	p
Age, years	55.3±0.6	57.5±11.0	58.7±7.2	0.242
BMI, kg/m^2	**26.7±2.1**	**34.5±2.8**	**45.5±6.7**	<0.001*
Co-morbidity, n (%)				
No	22 (47.8)	**14 (33.3)**	**6 (15.0)**	0.005*
Yes	24 (52.2)	**28 (66.7)**	**34 (85.0)**	
Hypertension	12 (26.1)	11 (26.2)	**20 (50.0)**	0.035*
Diabetes mellitus	**2 (4.3)**	11 (26.2)	11 (27.5)	0.004*
Cerebrovascular event	1 (2.2)	1 (2.4)	3 (7.5)	0.444
Thyroid disorders	2 (4.3)	4 (9.5)	6 (15.0)	0.220
Respiratory diseases	6 (13.0)	7 (16.7)	**15 (37.5)**	0.021*
Rheumatological diseases	2 (4.3)	2 (4.8)	2 (5.0)	0.999
Psychological diseases	1 (2.2)	1 (2.4)	1 (2.5)	0.999
ASA, n (%)				
2	37 (79.6)	33 (78.6)	-	<0.001*
3	9 (19.6)	9 (21.4)	40 (100.0)	
CCI score	**3 (3-4)**	4.5 (3-8)	5 (3-8)	<0.001*
Duration of operation, min	**180 (160-300)**	240 (190-300)	240 (180-280)	<0.001*
Duration of anesthesia, min	220 (200-315)	300 (210-350)	267 (205-318)	0.173
Hospitalization in ICU, n (%)	2 (4.3)	5 (11.9)	6 (15.0)	0.071
Complication, n (%)				
No	**42 (93.3)**	**37 (88.1)**	**27 (67.5)**	0.004*
Yes	**3 (6.7)**	**5 (11.9)**	**13 (32.5)**	
Wound infection	3 (6.5)	3 (7.1)	4 (10.0)	0.844
Acute renal failure	-	1 (2.4)	3 (7.5)	0.073
DVT	-	-	1 (2.5)	0.312
Evisceration	-	-	1 (2.5)	0.312
Ilius	-	-	1 (2.5)	0.312
Incisional hernia	-	-	1 (2.5)	0.312
Pneumonia	-	1 (2.4)	-	0.641
VTE	-	-	1 (2.5)	0.312
Sepsis	-	-	1 (2.5)	0.312
Mortality, n (%)	-	-	2 (5.0)	0.202
Duration of stay in hospital, days	5 (4-6)	5 (4-6)	**8 (5-15)**	0.029*

Numerical variables with normal distribution were shown as mean ± standard deviation. Numerical variables that do not show normal distribution are shown as median (IQR). Categorical variables were shown as numbers (%). *p<0.05 shows statistical significance. Bold characters represent the group that differs in significance. ASA: American Society of Anesthesiologists, BMI: Body mass index, ICU: Intensive care unit, CCI: Charlson Comorbidity index, DVT: Deep vein thrombosis, VTE: Venous thromboembolism, IQR: Interquartile range

Table 2. Factors associated with risk of complications

Variables	Complication		Univariable regression		
	No n=107	Yes n=21	HR	95% CI	p
Age, years	56.7±10	59.1±9	1.02	0.98-1.07	0.336
BMI, kg/m^2	34.1±8.6	40.3±8.2	1.06	1.02-1.10	0.003*
Normal	43 (40.2)	3 (14.3)	ref		
Obesity	37 (34.6)	5 (23.8)	1.93	0.46-8.09	0.367
Morbid obesity	27 (25.2)	13 (61.9)	6.15	1.75-21.70	0.005*
Co-morbidity, n (%)					
No	38 (35.5)	4 (19.0)	ref		
Yes	69 (64.5)	17 (81.0)	2.21	0.74-6.56	0.155
Hypertension	35 (32.7)	8 (38.1)	1.26	0.52-3.05	0.602
Diabetes mellitus	21 (19.6)	3 (14.3)	0.74	0.22-2.51	0.627
SVO	3 (2.8)	2 (9.5)	2.74	0.64-11.78	0.175
Thyroid disorders	9 (8.4)	3 (14.3)	1.76	0.52-6.00	0.364
Respiratory diseases	19 (17.8)	9 (42.9)	2.93	1.23-6.96	0.015*
Rheumatological diseases	5 (4.7)	1 (4.8)	0.95	0.13-7.06	0.958
ASA, n (%)					
II	78 (72.9)	5 (23.8)	ref		
III	29 (27.1)	16 (76.2)	7.26	2.65-19.32	<0.001*
Duration of operation, min	200 (180-300)	250 (200-360)	1.05	1.01-1.10	0.026*
Duration of anesthesia, min	250 (200-320)	285 (250-410)	1.01	0.98-1.09	0.095
Hospitalization in ICU, n (%)	3 (2.8)	9 (42.9)	10.75	4.42-26.15	<0.001*
Mortality, n (%)	-	2 (9.5)	-	-	-
Duration of stay in hospital, days	5 (4-6)	14 (10-21)	-	-	-

Numerical variables with normal distribution are shown as mean ± standard deviation. Numerical variables that do not show normal distribution are shown as medians (minimum-maximum). Categorical variables are shown as numbers (%). *p<0.05 shows statistical significance. ASA: American Society of Anesthesiologists, BMI: Body mass index, ICU: Intensive care unit, CCI: Charlson Comorbidity index, DVT: Deep vein thrombosis, VTE: Venous thromboembolism, HR: Hazard ratio, CI: Confidence intervals

of complications (22) and mortality (23,24) is significantly lower in obese patients as an obesity paradox. In addition to obesity, it has been shown that the risk of postoperative complications is higher in patients with high ASA and CCI, long operative time and preoperative respiratory disorders (25-29). In our study, it has been shown that the ASA scores of the patients are high, CCI scores increase as BMI increases (p<0.05), the operation time is longer (p<0.05) and the need for ICU hospitalization is higher, supporting the literature. These scores and associated comorbid diseases explain the relationship between scores and postoperative complications as obesity rises. From the preoperative period, these two scores must predict the postoperative outcome. In our study, while the increase in CCI score was associated with the length of hospital stay (p<0.05), the same correlation was not found in the ASA score. We think that this may be due to the study population being limited to ASA-II and III patients. There are studies in the literature supporting the prognostic importance of CCI in terms of postoperative complications. Our study results were in agreement with the results of previous studies in predicting the postoperative outcome of obesity and CCI by cross-sectional design (30,31). A study of patients undergoing radical cystectomy found that demographic factors and comorbidity indices such as ASA, BMI, and CCI had poor discriminating ability for adverse events (sepsis, wound infection, hospitalization, and prolonged hospital stay) (32). The ASA independently estimated the duration of surgery, length of hospital stay, and hospital cost in a study of total knee arthroplasty patients; BMI has been associated

Table 3. Parameters related to the length of hospital stay and complication development time

Variables	Duration of stay in hospital		Complication onset time	
	r	p	r	p
Age	0.327	0.019*	0.083	0.352
BMI	0.336	0.007*	-0.328	0.013*
ASA score	0.178	0.403	-0.315	0.016*
CCI score	0.345	0.002*	0.117	0.449
Duration of operation	0.315	0.020*	0.107	0.496
Duration of anesthesia	0.304	0.030*	0.106	0.503

*p<0.05 shows statistical significance. ASA: American Society of Anesthesiologists, BMI: Body mass index, CCI: Charlson Comorbidity index

with intraoperative time (33). According to the findings of this study, there is no statistically significant increase in postoperative intensive care admissions as we approach the morbidly obese group. However, as one progresses from the normal BMI group to the obese and morbidly obese groups, the hospitalization rate in the postoperative ICU increases by 4.3, 11.9, and 15.0 percent, respectively. As a result, it is expected that increasing the number of patients in the groups will result in statistical significance. In our study, the factors affecting the length of hospital stay were found to be age, BMI, CCI score, and operation time. In direct proportion to the increase in these factors, the length of stay in the hospital also increased.

Study Limitations

The number of patients in the groups was insufficient because of the retrospective nature of the presented study. Furthermore, whether the patients' operations were performed laparoscopically or openly may have affected postoperative complications and hospital stay, but this was not investigated in our study.

CONCLUSION

Obesity increases the risk of postoperative complications such as wound infection, sepsis, acute renal damage, evisceration, and hospital stay in patients who have had endometrial cancer surgery. Obesity is an effective risk factor for developing endometrial cancer, and it is associated with a poor postoperative outcome in patients who have this cancer and have undergone surgery. Furthermore, in our study, ASA and CCI scores were linked to postoperative complications. Simultaneously, the CCI score was linked to the length of hospital stay. The fact that these scores, which are widely used in routine practice, provide us with information about patients' postoperative outcomes from the preoperative period emphasizes the importance of these scores once more.

ETHICS

Ethics Committee Approval: Bakırköy Dr. Sadi Konuk Training and Research Hospital Ethics Committee approval was obtained (proctocol no:2020/221, date: 08.06.2020).

Informed Consent: This was a retrospective study.

Authorship Contributions

Surgical and Medical Practices: G.Ö.Y, G.S., Concept: G.Ö.Y., G.S., F.T., D.A., Design: G.Ö.Y., G.S., F.T., D.A., Data Collection or Processing: D.A., Literature Search: G.S., F.T., Writing: G.Ö.Y., G.S., F.T., D.A.

Conflict of interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Wyatt SB, Winters KP, Dubbert PM. Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. Am J Med Sci 2006;331:166-74.
2. Sabaz MS, Aşar S, Sertçakacılar G, Sabaz N, Çukurova Z, Hergünsel GO. The effect of body mass index on the development of acute kidney injury and mortality in intensive care unit: is obesity paradox valid? Ren Fail 2021;43:543-55.
3. Kaaks R, Lukanova A, Kurzer MS. Obesity, endogenous hormones, and endometrial cancer risk: a synthetic review. Cancer Epidemiol Biomarkers Prev 2002;11:1531-43.
4. Schmandt RE, Iglesias DA, Co NN, Lu KH. Understanding obesity and endometrial cancer risk: opportunities for prevention. Am J Obstet Gynecol 2011;205:518-25.
5. Giede C, Le T, Power P; SOGC-GOC-SCC POLICY AND PRACTICE GUIDELINES COMMITTEE; SPECIAL CONTRIBUTORS. The role of surgery in endometrial cancer. J Obstet Gynaecol Can 2013;35:370-1.
6. Flancbaum L, Choban PS. Surgical implications of obesity. Annu Rev Med 1998;49:215-34.
7. Doyle SL, Lysaght J, Reynolds JV. Obesity and post-operative complications in patients undergoing non-bariatric surgery. Obes Rev 2010;11:875-86.
8. Ortiz VE, Kwo J. Obesity: physiologic changes and implications for preoperative management. BMC Anesthesiol 2015;15:97.
9. Smith NA, Martin G, Marginson B. Preoperative assessment and prehabilitation in patients with obesity undergoing non-bariatric surgery: A systematic review. J Clin Anesth 2022;78:110676.
10. American Society of Anesthesiologists. ASA Physical Status Classification System. Available from: https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system.
11. Hergünsel GO, Sabaz MS. The effect of obesity on mortality in geriatric patients followed in the intensive care unit. Turkish Journal of Geriatrics 2021;24:315-29.

12. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373-83.
13. Sabaz MS, Aşar S. Association of Charlson Comorbidity and Pneumonia Severity Indices with Mortality in Patients with Coronavirus Disease-2019 in the Intensive Care Unit.Turk J Intensive Care 2021;19:33-41.
14. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992;45:613-9.
15. Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali WA. New ICD-10 version of the Charlson comorbidity index predicted in-hospital mortality. J Clin Epidemiol 2004;57:1288-94.
16. Wang MY, Green BA, Shah S, Vanni S, Levi AD. Complications associated with lumbar stenosis surgery in patients older than 75 years of age. Neurosurg Focus 2003;14:e7.
17. Arrigo RT, Kalanithi P, Cheng I, Alamin T, Carragee EJ, Mindea SA, et al. Charlson score is a robust predictor of 30-day complications following spinal metastasis surgery. Spine (Phila Pa 1976) 2011;36:E1274-80.
18. Afolabi HA, Zakariya Zb, Ahmed Shokri AB, Mohammad Hasim MNB, Vinayak R, Afolabi-Owolabi OT, et al. The relationship between obesity and other medical comorbidities. Obesity Medicine 2020;17:100164.
19. Khaodhiar L, McCowen KC, Blackburn GL. Obesity and its comorbid conditions. Clin Cornerstone 1999;2:17-31.
20. Anderson JW, Konz EC. Obesity and disease management: effects of weight loss on comorbid conditions. Obes Res 2001;9 Suppl 4:326S-34S.
21. Bamgbade OA, Rutter TW, Nafiu OO, Dorje P. Postoperative complications in obese and nonobese patients. World J Surg 2007;31:556-60; discussion 561.
22. Tjeertes EK, Hoeks SE, Beks SB, Valentijn TM, Hoofwijk AG, Stolker RJ. Obesity--a risk factor for postoperative complications in general surgery? BMC Anesthesiol 2015;15:112.
23. Mullen JT, Moorman DW, Davenport DL. The obesity paradox: body mass index and outcomes in patients undergoing nonbariatric general surgery. Ann Surg 2009;250:166-72.
24. Valentijn TM, Galal W, Hoeks SE, van Gestel YR, Verhagen HJ, Stolker RJ. Impact of obesity on postoperative and long-term outcomes in a general surgery population: a retrospective cohort study. World J Surg 2013;37:2561-8.
25. Maradit Kremers H, Visscher SL, Kremers WK, Naessens JM, Lewallen DG. Obesity increases length of stay and direct medical costs in total hip arthroplasty. Clin Orthop Relat Res 2014;472:1232-9.
26. Bradley BM, Griffiths SN, Stewart KJ, Higgins GA, Hockings M, Isaac DL. The effect of obesity and increasing age on operative time and length of stay in primary hip and knee arthroplasty. J Arthroplasty 2014;29:1906-10.
27. Terada T, Johnson JA, Norris C, Padwal R, Qiu W, Sharma AM, et al. Severe Obesity Is Associated With Increased Risk of Early Complications and Extended Length of Stay Following Coronary Artery Bypass Grafting Surgery. J Am Heart Assoc 2016;5:e003282.
28. Poelemeijer YQM, Lijftogt N, Detering R, Fiocco M, Tollenaar RAEM, Wouters MWJM. Obesity as a determinant of perioperative and postoperative outcome in patients following colorectal cancer surgery: A population-based study (2009-2016). Eur J Surg Oncol 2018;44:1849-57.
29. Shinonara K, Ugawa R, Arataki S, Nakahara S, Takeuchi K. Charlson comorbidity index is predictive of postoperative clinical outcome after single-level posterior lumbar interbody fusion surgery. J Orthop Surg Res 2021;16:235.
30. Cannata F, Laudisio A, Ambrosio L, Vadala G, Russo F, Zampogna B, et al. The Association of Body Mass Index with Surgical Time Is Mediated by Comorbidity in Patients Undergoing Total Hip Arthroplasty. J Clin Med 2021;10:5600.
31. Nuttall M, van der Meulen J, Emberton M. Charlson scores based on ICD-10 administrative data were valid in assessing comorbidity in patients undergoing urological cancer surgery. J Clin Epidemiol 2006;59:265-73.
32. Meng X, Press B, Renson A, Wysock JS, Taneja SS, Huang WC, et al. Discriminative Ability of Commonly Used Indexes to Predict Adverse Outcomes After Radical Cystectomy: Comparison of Demographic Data, American Society of Anesthesiologists, Modified Charlson Comorbidity Index, and Modified Frailty Index. Clin Genitourin Cancer 2018;16:e843-50.
33. Hinton ZW, Fletcher AN, Ryan SP, Wu CJ, Bolognesi MP, Seyler TM. Body Mass Index, American Society of Anesthesiologists Score, and Elixhauser Comorbidity Index Predict Cost and Delay of Care During Total Knee Arthroplasty. J Arthroplasty 2021;36:1621-5.