

# The role of body mass index in postoperative complications of surgical treatment for early-stage lung cancer cases

## *Erken evre akciğer kanseri olgularının cerrahi tedavisinde beden kitle indeksinin postoperatif komplikasyonlardaki rolü*

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**Atf/Cite as:** Aydın S, Keçeci Özgür G, Akçam Tİ, et al. The role of body mass index in postoperative complications of surgical treatment for early-stage lung cancer cases. Northwestern Med J. 2023;3(1):1-8.

### ABSTRACT

**Introduction:** Body mass index is an important condition that may affect postoperative complications. Although there are studies on this subject in the literature, we aimed to reveal the relationship between body mass index and complications in lung cancer surgery more distinctly by limiting the factors that may directly affect postoperative complications such as operation type and staging.

**Methods:** Patients undergoing thoracotomy and lobectomy for early-stage primary lung cancer in our clinic between January 2014 and October 2021 were retrospectively analyzed. The demographic characteristics of the 292 patients and their body mass indexes (BMI) were grouped in line with the recommendation of the World Health Organization and analyzed in terms of postoperative complications and length of stay.

**Results:** The mean age of the cases was 61.93±0.55 (34-86) years, and the mean body mass index was 26.89±0.30 (16.44-58.27) kg/m<sup>2</sup>. The mean BMI value was 17.40 kg/m<sup>2</sup> for group 1, 22.55 kg/m<sup>2</sup> for group 2, 27.25 kg/m<sup>2</sup> for group 3, and 33.75 kg/m<sup>2</sup> for group 4. At least one complication developed in 71.4% of the cases in group 1, these values were 58.5% - 52.8% - 35.2% for group 2, group 3, and group 4, respectively. It was determined that cases with high body mass index had a lower risk of developing complications in the postoperative period (p=0.003).

**Conclusion:** We found that body mass index is a factor that can give an idea about postoperative complications, prolonged air drainage, and hemorrhage in patients for whom resection is planned due to lung cancer.

**Keywords:** Body mass index, complication, lung cancer, thoracotomy

### ÖZ

**Giriş:** Beden kitle indeksi ameliyatlardan sonraki komplikasyonları etkileyebilecek önemli bir durumdur. Literatürde bu konuda araştırmalar bulunsa da çalışmamızda farklı olarak operasyon tipi ve hastalık evresi gibi postoperatif komplikasyonları doğrudan etkileyebilecek unsurları sınırlandırarak beden kitle indeksi ile akciğer kanseri cerrahisinin komplikasyonları arasındaki ilişkiyi daha net bir şekilde ortaya koymayı amaçladık.

**Yöntem:** Kliniğimizde Ocak 2014 – Ekim 2021 tarihleri arasında erken evre primer akciğer kanseri nedeniyle torakotomi ile lobektomi uygulanan olgular retrospektif olarak incelendi. Çalışmaya dahil olan 292 hastanın demografik özellikleri ve dünya sağlık örgütünün önerisine göre gruplandırılmış beden kitle indeksleri (BKİ), postoperatif komplikasyonları ve yatış süreleri ile analiz edildi.

**Bulgular:** Olguların yaş ortalaması 61.93±0.55 (34-86) yıl, beden kitle indeksi ortalaması 26.89±0.30 (16.44-58.27) kg/m<sup>2</sup> olarak hesaplandı. Grup 1 için ortalama BKİ değerinin

**Received:** 01.12.2022

**Accepted:** 12.01.2023

**Publication date:** 01.02.2023

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17.40 kg/m<sup>2</sup>, grup 2 için 22.55 kg/m<sup>2</sup>, grup 3 için 27.25 kg/m<sup>2</sup>, grup 4 için 33.75 kg/m<sup>2</sup> olduğu saptandı. Grup 1' deki olguların %71.4' ünde en az bir komplikasyon gelişirken grup 2, grup 3 ve grup 4 için bu değerler sırasıyla %58.5 - %52.8 - %35.2 olarak bulundu. Yüksek beden kitle indeksli olguların postoperatif dönemde komplikasyon gelişimi açısından daha düşük risk taşıdığı belirlendi (p=0.003).

**Sonuç:** Akciğer kanseri sebebi ile rezeksiyon planlanan olgularda beden kitle indeksinin pos-tooperatif komplikasyonlar, uzamış hava drenajı ve hemoraji açısından fikir verebilecek bir faktör olduğunu saptadık.

**Anahtar kelimeler:** Akciğer kanseri, beden kitle indeksi, komplikasyon, torakotomi

## INTRODUCTION

Body mass index (BMI) is a basic parameter employed in the classification of obesity, with its widespread use from individual patient evaluation to international surveillance studies (1). It has been known that obesity has a relationship with dyslipidemia, hypertension, coronary heart disease, cerebrovascular diseases, gallbladder disease, sleep apnea, osteoarthritis, respiratory diseases, and cancers (2).

It is widely accepted that preoperative respiratory, cardiac, or metabolic comorbidities of patients increase the risk of complications in the perioperative period. Although the causality of the condition have not been fully explained, this idea has aroused interest among surgeons from different departments in investigating the preoperative characteristics that might affect postoperative complications (3,4).

Based on this idea, it has been thought that high BMI values of the cases could increase postoperative complications by affecting the complications of comorbidities in the preoperative period or could directly affect postoperative complications in patients undergoing surgical treatment. Therefore, we aimed to reveal this effect.

## MATERIALS AND METHODS

The patients who underwent lung resection for primary lung cancer in our clinic between January 2014 and October 2021 were retrospectively analyzed. To standardize the surgical technique among the patients, the cases excluded from the study are those who underwent videothoroscopic and hybrid operation, those

with a history of previous thoracic operation, the cases undergoing resection other than lobectomy, and those preoperatively used anticoagulant and antiaggregant drugs (because of the possible effect on hemorrhage complications by affecting bleeding and coagulation). To eliminate the negative effect of advanced lung cancer on BMI, only the early stage (Stage 1 and 2a) cases were included in the study. Postoperative embolism prophylaxis was administered to all patients with enoxaparin 40 mg/kg/day. Demographic characteristics, BMI values, postoperative complications, and length of hospital stays of the patients were analyzed. The patients were grouped in line with the BMI classification by World Health Organization. Accordingly, the cases with a BMI value below 18.5 kg/m<sup>2</sup> were grouped as group 1, 18.5-24.99 kg/m<sup>2</sup> as group 2, 25-29.99 kg/m<sup>2</sup> as group 3, and the cases over 30 kg/m<sup>2</sup> as group 4. Prolonged air drainage was defined as the removal of the patient's thoracic drains after the seventh postoperative day. The standardization of the hemorrhage complication is a problematic issue. Depending on factors such as the height and weight of the patient, the volume of postoperative hemorrhage that may impair hemodynamics varies. For this reason, we determined the postoperative hemorrhage complication not as the amount of drainage that occurs in the thoracic drain, but as thoracic drainage causing hemodynamic instability independent of volume, or a decrease observed in hemoglobin value below 7 g/dL independent of hemodynamic instability. The effect of the BMI and the presence of preoperative comorbidity on postoperative complications and hospital stay was investigated. The informed consent form was obtained from all patients. This study was approved by the local ethics committee (Decision Date: 27.04.2022, No: 2022/04-81).

### Statistical Analysis

IBM SPSS package program was used in the analysis of the data obtained from the study. A cross table was created for categorical data and the chi-square analysis was performed. The Shapiro-Wilk test was used to assess whether the data show normal distribution. The comparison of two groups in numerical variables, which did not show normal distribution, was made with the Mann-Whitney U test, while the comparison of more than two groups was made with the Kruskal-Wallis test. The t-test or ANOVA was used for the normally distributed variables. Receiver Operating Characteristic analysis was employed to evaluate sensitivity and specificity. The statistical significance level was taken as "0.05".

### RESULTS

Of the 292 patients in the study, 219 (75%) were male and 73 (25%) were female. The mean age of the cases was  $61.93 \pm 0.55$  (34-86) years, the mean height was  $167.27 \pm 0.47$  (143-188) centimeters (cm), and the mean weight was  $75.25 \pm 0.87$  (37-140) kilograms (kg). Based on these height and weight measurements, the mean body mass index was calculated as  $26.89 \pm 0.3$  (16.44-58.27)  $\text{kg}/\text{m}^2$ .

When the comorbidities (diabetes, hypertension, arrhythmia, rheumatological diseases, migraine, etc.) in the preoperative period were examined, 204 (69.9%) patients had at least one comorbidity, while 88 (30.1%) did not have any additional disease. All cases underwent lobectomy, of these 102 had (34.9%) right upper, 15 (5.1%) middle, 63 (21.6%) right lower, 62 (21.2%) left upper, and 50 (17.1%) underwent left lower lobectomy. When evaluated in terms of primary lung cancer subtype, 164 (56.2%) patients were diagnosed with adenocarcinoma, 92 (31.5%) with squamous cell carcinoma, and 13 (4.5%) with large cell carcinoma. Other rare pathology subtypes comprised 7.9% of the patients, amounting to a total of 23 cases. In the light of

pathological examinations, 204 (69.9%) cases were determined as stage 1, and 88 (30.1%) as stage 2A.

Of all patients, 149 (51%) had at least one complication in the postoperative period. The most common complications were postoperative hemorrhage requiring volume replacement, prolonged air drainage, subcutaneous emphysema, surgical site infection, atelectasis, renal-hepatic function marker changes, and tachycardia. Prolonged air drainage, which has an important place in thoracic surgery practice, developed in 97 (33.2%) patients, while 18 (6.2%) patients underwent erythrocyte suspension replacement due to postoperative hemorrhage (Table 1). No mortality was observed in the early postoperative period.

When the BMI groups were examined; seven (2.4%) cases took place in group 1 (underweight), 106 (36.3%) cases in group 2 (normal weight), 108 (37%) cases in group 3 (overweight), and 71 (24.3%) cases in group 4 (obese). The mean BMI value was calculated as  $17.40 \pm 0.60$  (16.44-18.37)  $\text{kg}/\text{m}^2$  for group 1,  $22.55 \pm 1.54$  (18.72-24.93)  $\text{kg}/\text{m}^2$  for group 2,  $27.25 \pm 1.42$  (25.0-29.76)  $\text{kg}/\text{m}^2$  for group 3, and  $33.75 \pm 3.89$  (30.10-58.27)  $\text{kg}/\text{m}^2$  for group 4. There was only one case considered morbidly obese (with a BMI of 58.27  $\text{kg}/\text{m}^2$ ) in the population. The BMI value of all other cases was below 40  $\text{kg}/\text{m}^2$ .

**Table 1. The frequency of the complications and the total count of complicated patients (one patient can have more than one complication).**

Complications	Count	%
Prolonged air drainage	97	33.2
Postoperative bleeding	18	6.2
Atelectasis	10	3.4
Subcutaneous emphysema	15	5.1
Surgical site infection	13	4.5
Renal function abnormality	17	5.8
Hepatic function abnormality	12	4.1
Tachycardia	16	5.5
Postoperative pneumonia	16	5.5
Others	10	3.4
Total count of complicated patients	149	51

Gender, resected lung lobe, cancer subtype, and comorbidity were not found to be statistically related to complications and hospital stay in the postoperative period. The mean age of the cases with complications was  $62.64 \pm 0.79$  (34-86) years, and the cases without complications were  $61.18 \pm 0.75$  (35-81). This difference was not statistically significant ( $p=0.181$ ).

Although only early-stage cases were examined in our study, stage 1 and stage 2A cases were also compared in terms of complications. At least one complication was detected in 99 (48.5%) of the stage 1 cases, while it was found in 50 (56.8%) of the stage 2A cases. Stage was not found to be an effective factor in postoperative complications ( $p=0.194$ ).

There was no statistically significant relationship between BMI groups and postoperative hospital stay ( $p=0.125$ ). Although there was a negative correlation between the hospital stay and the numerical value of BMI in the evaluation performed without considering the groups, this correlation was of a low significance ( $p=0.006$ ) (Correlation coefficient:  $-0.162$ ). Age was not evaluated as a factor correlated with postoperative hospital stay ( $p=0.663$ ).

When the relationship between BMI groups and postoperative complications was investigated (Table 2), there was at least one complication in 71.4% of the cases in group 1, 58.5% in group 2, 52.8% in group 3, 35.2% in group 4 ( $p=0.013$ ).

The distribution of postoperative hemorrhage and prolonged air drainage complications, which have an important place in the practice of thoracic surgery, were examined based on groups. Prolonged air drainage occurred in 57.1% of the cases in group 1, 43.4% in group 2, 28.7% in group 3, and 22.5% in group 4. Hemorrhagic drainage requiring postoperative volume replacement therapy occurred in 28.6% of cases in group 1, 8.5% of the cases in group 2, and 6.5% of the cases in group 3. No patient with severe hemorrhage requiring replacement was found among group 4 cases. Accordingly, it was revealed that the riskiest group was group 1, whereas the safest group was group 4 for both conditions ( $p=0.010$ ,  $p=0.008$ , respectively).

A cut-off value was investigated for the preoperative estimation of patients likely to develop postoperative complications. For this purpose, Receiver Operating Characteristic (ROC) analysis was performed on the BMI numerical value, but no significant value was found.

**Table 2. Complication rates according to BMI groups.**

		Complication Presence	Complication Absence	Total	
Count		5	2	7	
BMI group	1	% within BMI group	71,4%	28,6%	100,0%
		% within Complication	3,4%	1,4%	2,4%
	Count		62	44	106
	2	% within BMI group	58,5%	41,5%	100,0%
		% within Complication	41,6%	30,8%	36,3%
	Count		57	51	108
	3	% within BMI group	52,8%	47,2%	100,0%
		% within Complication	38,3%	35,7%	37,0%
Count		25	46	71	
4	% within BMI group	35,2%	64,8%	100,0%	
	% within Complication	16,8%	32,2%	24,3%	
Count		149	143	292	
Total	% within BMI group	51,0%	49,0%	100,0%	
	% within Complication	100,0%	100,0%	100,0%	

BMI; body mass index.

## DISCUSSION

Lung cancer is the leading cause of cancer-related death. Surgical treatment is recommended for stage I, II, and selected IIIA cases in the treatment of non-small cell lung cancer. The procedures that can be applied can be listed as wedge resection, segmentectomy, lobectomy, and pneumonectomy. Wedge resection is known to be less risky than major resection methods in terms of postoperative complications. The mortality of pneumonectomy has been reported to be 6-8% (5). It is possible to report different morbidity rates for each resection procedure. In our study, we only used data regarding lung cancer cases that underwent lobectomy and limited the type of resection as an important variable that could affect the results, thereby aiming to reveal the effect of BMI on the results more clearly. We believe that the lack of a significant relationship between the lung lobe resected and postoperative complication rates reinforces this effect.

In a study investigating the difference between the videothoroscopic approach and thoracotomy for lobectomy operation, it was reported that patients who underwent thoracotomy and lobectomy were at higher risk in terms of postoperative complications and their length of hospital stay was longer in the postoperative period (6). To minimize the effect of this variable on the results, we included only the data regarding lung cancer cases operated by thoracotomy.

There are different studies available in the literature explaining the relationship between comorbidities in the preoperative period and postoperative complications. In a study containing a data set of 1,154 cases and investigating the relationship between cardiovascular diseases and postoperative complications in lung cancer patients, it was emphasized that cardiovascular diseases were not associated with postoperative complications or long-term results of surgery (7). This is a detailed study focusing on such various complications as cardiac complications, pneumonia, prolonged air drainage, atelectasis,

and bronchopleural fistula, but this data set comprises cases from all different lung cancer stages. On the other hand, another study on the same subject with a data set of 400 cases emphasized that the risk of postoperative complications increased with the age of the patients, comorbidities, and the size of the surgical procedures (8). However, this study included patients in different stages. There are similar studies in the literature, and these two studies can be considered as an explanation for the lack of consensus on this issue yet. Considering that disease stage may be a major determinant in terms of postoperative complications, we found it appropriate to include only the data of early-stage patients in our study. Accordingly, we did not detect preoperative comorbidity as a determining factor for postoperative complications in our limited patient population.

In a study containing the data set of 822 cases operated for various indications such as malignancy, emphysema, chest wall tumor, and pneumothorax; BMI values were used in the analysis of postoperative complications, mortality rates, and hospital stays of the cases. This study, which had similar BMI groups to our study, found no statistically significant difference between the four BMI groups in terms of postoperative mortality, although it was stated that the mortality rate was slightly higher in cases with low BMI compared to the others. It was also stated that obese patients had a longer hospital stay, and obese and underweight patients were more prone to complications compared to the normal-weight group (9).

In a study containing the data set of 1,311 cases diagnosed with lung cancer, no statistically significant relationship was found between BMI groups and postoperative hospital stay and complications. In this study, it was determined that the patients who lost weight prior to the operation had a longer hospital stay and underweight cases were riskier in terms of postoperative mortality (10). On the other hand, 122 patients who underwent wedge resection,



lobectomy, or pneumonectomy were enrolled in a study examining patients who underwent lung resection after neoadjuvant therapy for non-small cell lung cancer, which was carried out with the aim of revealing the risk factors of this combined therapy. While the BMI value of the cases without postoperative pulmonary complications was found to be  $24.8 \pm 3.1$ , it was  $22.3 \pm 3.6$  for the cases with complications and the significance of this effect was statistically proven. In the study, preoperative carbon monoxide diffusion capacity, smoking, and preoperative comorbidities were defined as independent factors like BMI, aiming to predict the cases that could have pulmonary complications in light of these data. In our study, no factor other than BMI was found to be significant on postoperative complications (11).

Prolonged air drainage, one of the complications specific to thoracic surgery, has always been the subject of research in the literature. Thoracic surgeons have developed various scales to predict patients expected to have prolonged air drainage. In the majority of these studies, BMI has also been included as a part of the scales or investigated in terms of being effective (12,13). In a study aiming to identify the patients who might develop prolonged air drainage, BMI value was determined as a risk factor in parallel with the previous studies. Prolonged postoperative air drainage in the patient group with low BMI was attributed to poor nutritional status and inadequate wound healing. The low incidence of prolonged air drainage in obese patients is also supported by the assumption that this group has low tidal volume, increased respiratory rate, and decreased respiratory system compliance (14). In our study, in accordance with the literature, the incidence of prolonged air drainage was found to be high in cases with low BMI and it was observed that it decreased as BMI increased.

In a study conducted in 2022, investigating the effect of BMI in patients who underwent videothoracoscopic lobectomy operation, it was emphasized that the operational time increased in overweight and obese patients, whereas

postoperative pulmonary complications were surprisingly less common in overweight patients, which was found to be statistically significant. It was also stated that as the BMI value shifted from overweight to obese, only the length of hospital stay and the risk of renal function test abnormality increased, while leaving other complications unaffected. In fact, it was shown that the risk of prolonged air drainage decreased as the BMI value was close to the obesity range. It has been reported that extreme BMI values, whether low or high, are prone to complications (15).

The belief that obesity poses a risk factor for postoperative complications has changed with the increase in studies on this subject, evolving into a belief that obese cases suffer fewer complications in the postoperative period, which is called the obesity paradox (16). In a meta-analysis that included 25 studies examining the postoperative effects of BMI, it was stated that high BMI values had positive effects on early postoperative outcomes and survival in patients with lung cancer, thus confirming the existence of the obesity paradox (17). As stated in the limitations of this meta-analysis study, other diseases such as preoperative diabetes or hypertension in patients may affect the effect of obesity on complications. For this reason, we believe that there is a need for further studies in which the variables to affect postoperative complications are narrowed as much as possible.

Although we intend to make our study specific by limiting variables such as disease stage, surgical procedure, and resection size, the impact of patient characteristics on postoperative complications, survival, and long-term outcomes is a broad topic. Kavurmacı et al. considered preoperative factors affecting atrial fibrillation, an important complication in thoracic surgery practice, and developed a scoring method (18). To this end, conditions such as age, preoperative cardiac diseases, chronic obstructive pulmonary disease, presence of other comorbidities, and resection size were scored to determine patients with a high risk of developing atrial

fibrillation in the postoperative period. We think that with the increase in the number of such studies on important and selected postoperative complications in the practice of thoracic surgery, we can better understand the factors affecting postoperative complications and can reduce the length and cost of hospitalization periods in the postoperative period in the future.

The main limitation of our study is that it was single-centered. We think that multicenter studies on limited patient populations will be an important step toward confirming the hypothesis in question. Since there was only one morbidly obese patient in our study, we could not share detailed information for group 4. In addition, due to the limited surgical applications in morbidly obese patients, information about the complication rates of this group is limited. Increasing the number of patients or multicenter studies will ensure better information sharing about morbidly obese cases.

## CONCLUSION

As a result, we found a lower rate of complications after lung cancer operations in the patient population with high BMI. We also determined that comorbidities were not effective on complications, and BMI or additional diseases did not affect the length of hospital stay. Based on these results, BMI value should be considered as a parameter that can give an idea about the postoperative results in the preoperative evaluation of patients with lung cancer. In addition, patients with low BMI should be evaluated in terms of preoperative nutrition program and rehabilitation, and in terms of intraoperative measures to prevent complications such as prolonged air drainage and hemorrhage.

**Ethics Committee Approval:** The study protocol was approved by the Buca Seydi Demirsoy Training and Research Hospital Non-Interventional Research Ethics Committee (27.04.2022 / 2022/04-81).

**Conflict of Interest:** The authors have declared that they have no conflict of interest.

**Funding:** The authors have declared that they have not received any financial support.

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