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- Gülsüm Oya HERGÜNSEL[1]
- Mehmet Süleyman SABAZ[2]

CORRESPONDANCE

[1] Mehmet Süleyman SABAZ

Marmara University Pendik Training and Research Hospital, Department of Anesthesiology and Reanimation , Istanbul, Turkey

Phone: +905064415710
e-mail: udmss_47@hotmail.com

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[1] Health Science University Bakırköy Dr. Sadi Konuk Training and Research Hospital, Anesthesiology and Reanimation, Istanbul, Turkey

[2] Marmara University Pendik Training and Research Hospital, Department of Anesthesiology and Reanimation , Istanbul, Turkey

RESEARCH

THE EFFECT OF OBESITY ON MORTALITY IN GERIATRIC PATIENTS FOLLOWED IN THE INTENSIVE CARE UNIT

Abstract

Introduction: This study was intended to evaluate the relationship between the presence of obesity in geriatric patients, which is becoming more and more common in the intensive care unit, with the intensive care process and mortality.

Materials and Method: In this retrospective study, data on 2,114 patients aged 65 and over who were followed in the intensive care unit between January 2013-January 2020 were obtained electronically and evaluated.

Results: Patients were divided into two groups of 1,632 (77.2%) non-obese and 482 (22.8%) obese patients. It was determined that acute kidney injury development was more common in obese patients (326; 67.6%) than non-obese patients (937; 57.4%) and obese patients required more frequent dialysis ($p < 0.05$). It was determined that obese patients required more frequent mechanical ventilator support, had higher positive end-expiratory pressure and peak pressure Work of Breathing ventilator values, and had lower compliance (34 [29–41]) ($p<0.05$). Although obese patients were given fewer daily calories than non-obese patients, their mean blood glucose was higher ($p < 0.001$). Obese patients (5.70 [2.43–12.31]) had longer intensive care durations than non-obese patients (4.41 [2.01–10.45]) ($p < 0.05$). Finally, intensive care mortality was determined to be 37.6% (181) in obese patients and 36.0% (588) in non-obese patients ($p>0.05$).

Conclusion: Obese patients' increased complication rate and duration of stay in the intensive care show that obesity increases intensive care morbidity in geriatric patients, but it has no relationship with mortality.

Keywords: Geriatrics; Aged; Obesity; Intensive Care Units; Body Mass Index; Respiration, Artificial.

INTRODUCTION

Obesity, which is defined as abnormally increased fat accumulation that may adversely affect health, is accepted as an important public health problem and has an increasing prevalence worldwide (1). In recent years, the increase in the rate of obesity in the general population has had an effect on the profile of patients admitted to the intensive care unit (ICU), resulting in an increase in the number of obese patients (2). The management of obese patients is difficult due to accompanying metabolic dysfunction, impaired glucose intolerance, and respiratory and cardiovascular diseases (3). Concerning the drugs used in treatment, especially those with lipophilic properties, drug response may be altered due to increased fat mass (4). As a result of decreased vascular access due to large body habitus and affected blood pressure measurement accuracy, the frequency of invasive procedures, such as central venous access and intra-arterial cannulation, increases, and nursing care becomes difficult (4). Previous studies on obese patients in the ICU have determined that obesity prolonged the length of stay in the ICU (5,6). However, studies examining the relationship between obesity and mortality in the ICU have yielded complicated results (5-8). Some studies reported an increase in mortality (7), while others found no difference in mortality (5). Nevertheless, some studies have revealed an obesity paradox, in which obesity is not harmful but, in fact, protective (6,8).

In recent years, a worldwide increase in obesity has been observed in the geriatric population (9). According to the estimates of the United Nations, it is predicted that the global elderly population, which was 9.0% in 2019, will increase to 11.7% in 2030 and 16% in 2050 (10). According to a study conducted in the United States, 37.5% of women over 60 and 39.4% of men over 60 were obese (9). Patients over the age of 65 constitute approximately half of the ICU admissions (11). Moreover, the ICU readmission rate and mortality risk are higher in this patient group (11). In addition to the increased prevalence of obesity in society, the increase in the number of geriatric patients has resulted in the development of a geriatric obese patient profile, which is becoming more prominent in ICUs. In geriatric patients, obesity has been associated with an increased risk of coronary heart disease due to diabetes mellitus, hypertension, dyslipidemia, and physical inactivity (12).

In addition to the rapid increase in the number of geriatric patients, the complicated results of studies investigating the mortality of obese patients may cause a paradox associated with the consequences of obesity in geriatric patients in the ICU. In order to resolved this paradox, our study is intended to determine the relationship between obesity and mortality in geriatric patients followed in an ICU in a large center and within a large sample.

MATERIALS AND METHODS

Data Center

This retrospective study was carried out in the ICU of a third-level training and research hospital in Istanbul, Turkey's most populous city.

When a patient is admitted to the ICU, after removing his or her clothes and jewellery, the patient's height and weight are measured by the nurse and recorded in the clinical decision support system. After the height and weight information is entered into the clinical decision support system, the system automatically calculates the body mass index (BMI) with the loaded algorithm and saves it in the patient file. Due to the electronic ecosystem, all bedside monitor information measured during the ICU follow-up of the patient, mechanical ventilation parameters, laboratory examination results, extracorporeal applications, and information on all infusions are transmitted from the utilized devices to the clinical decision support system.

DATA COLLECTION

The data on all patients followed up between January 2013 and January 2020 from the *EMRall-Qlin-ICUImdSoftMetavision* Clinical Decision Support System used in the ICU were obtained and evaluated through Structured Query Language (SQL) queries.

Sample

During the study period, 9,544 patients were admitted to the ICU. After the exclusion of 7,430 patients from the study according to the exclusion criteria, the remaining 2,114 patients constituted the study population. All patients included in the study were divided into two groups according to the BMI criteria determined by the World Health Organization, including 1,632 (77.2%) patients with a BMI <30 kg/m^2 and 482 (22.8%) patients with a BMI ≥ 30 kg/m^2.

Inclusion criteria

The study was intended to include all patients aged 65 and over who had spent more than 24 hours in intensive care.

Exclusion criteria

Patients younger than 65 (n: 4,864), those who were taken to the service within the first 24 hours after ICU admission (n: 980), those who developed mortality (n: 774), and those with missing data (n: 812) were excluded from the study.

Primary outcome

Evaluating the relationship between obesity and mortality in patients over 65 years of age who were followed in ICU was the primary aim of the study.

Secondary outcome

The secondary aims of the study were to compare patients' comorbidities at admission, primary diagnoses, calculated ICU scores, interventions, and treatments.

Ethical aspects

Before beginning the research, ethics committee approval and institutional permission were obtained from the Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (Protocol code: 2021/218; Approval no: 2021-08; Approval date: 19.04.2021).

Evaluation of data (statistical analysis)

The data collected in the study were evaluated using SPSS 22.00 software. A Shapiro-Wilk test was used to test the distribution of the numerical data. Categorical variables were expressed in terms of frequencies and percentages. Numerical variables with a normal distribution were given as means ± standard deviations, while numerical data not conforming to a normal distribution were given as medians and interquartile intervals (IQRs). An independent-samples t-test was used in comparing the numerical data, and a Mann-Whitney U-test was used when the assumptions of the t-test could not be met. The Chi-square test was used for comparing categorical variables, and Fisher's exact test was used when the conditions of the Chi-square test were not met. A Kaplan-Meier survival analysis was used to determine the association between BMI groups and 28-day mortality. It was thought that the severity of acute illness and chronic health conditions might be different in these groups of patients. In order to avoid these differences potentially affecting results and provide better randomization, patients were divided into four quartiles according to their acute physiology and chronic health evaluation (APACHE) II scores (16, 17-23, 24–29, and ≤30). Additionally, receiver operating characteristic (ROC) curves were created to determine the differences in mortality risk between patients in each quartile. A p-value <0.05 was accepted as the level of significance.

RESULTS

Table 1 shows the general characteristics of the patients, who were divided into two groups based on their BMI: non-obese and obese. Of the 2,114 patients, 1,632 (77.2%) were non-obese, and 482 (22.8%) were obese. The average age of the non-obese patients (77 [70–83]) was higher than that of the obese patients (75 [70–82]) (p <0.05). It was determined that the female gender (937; 57.4%) was more common in non-obese patients, whereas the male gender (376; 78.0%) was more common in obese patients (p <0.001). Median BMI values were 27.34 (25.39–28.69) in non-obese patients and 36.73 (33.20–41.62) in obese patients. The frequency of comorbidity was similar between groups. The frequencies of diabetes mellitus and hypertension were increased in obese patients (p <0.05). An examination of the admission diagnoses of the patients in the ICU revealed that the most common admission diagnosis in both groups was sepsis. The rate of patients diagnosed with sepsis was similar between groups. The most common sepsis source in both groups was intraabdominal sepsis. Other common diagnoses in obese patients (due to chronic obstructive pulmonary disease (COPD), pneumonia, and other causes) were pulmonary diseases (95; 19.7%), postoperative follow-up (61; 12.7%), and cerebrovascular disease (47; 9.8%). While malignancy (129; 7.9%) was more common in non-obese patients than obese patients, diagnoses of COPD (37; 7.7%), renal-metabolic diseases (42; 8.7%), and hepatic cirrhosis (8: 1.7%) were more common in obese patients than non-obese patients (p <0.05) (Table 1).

The ICU scores, interventions, and treatments of the patients are shown in Table 2. The numbers of arterial catheters applied to the groups were similar. More central venous catheters were applied to obese patients than to non-obese patients (502, 56.5%, p<0.05). There was no difference between the groups regarding the use of vasoactive drugs, antibiotics, and Total parenteral nutrition (TPN) (p>0.05). When the complications that developed in the ICU were examined, it was found that the rate of acute kidney injury (AKI) in obese patients (326; 67.6%) was higher that than in non-obese patients (937; 57.4%) (p<0.001). Obese patients (124; 25.7%) required dialysis more frequently than non-obese patients (318; 19.5%). Pressure sores were more common in obese patients (76; 15.8%) than non-obese patients (145; 8.9%) (p<0.001).

Mechanical ventilation

While 68.4% (1,191) of non-obese patients required mechanical ventilator support, this rate increased to 74.3% (358) in obese patients (p<0.05). When mechanical ventilator parameters were examined, while positive end-expiratory pressure (5.6 [5.1–6.0]), peak pressure (14 [12–16]), and Work of Breathing ventilator (WOBv) (1.16 [0.99–1.31]) values were higher in obese patients, pulmonary compliance (34 [29–41]) was lower (p<0.05). There was no difference in mean tidal volume between the groups, but tidal volume, in ml/kg adjusted for ideal weight, was higher in obese patients (p<0.001). Between the groups, FiO_2, respiratory rate per minute, and mechanical power did not differ significantly (Table 2). Mechanical ventilation duration was higher in obese patients, but this difference was not statistically significant (p>0.05).

Laboratory parameters

The laboratory parameters of the patients are given in Table 2. When blood gas values were examined, pCO_2 was higher and PH was lower in obese patients (p<0.05). In the two groups, PO_2, HCO3, and lactate levels were similar (p>0.05). Fewer daily calories could be given to obese patients (1,524 [1,382–1,697] than non-obese patients (1,652 [1,461–1,881]) (p<0.001). Despite lower calorie input, the mean

Table 1. Characteristics of patients groups and admission diagnosis.

Parameters	Non-Obese n=1632 (%77.2)	Obese n=482 (%22.8)	*P*-value
Body mass index, median (IQR) (kg/m^2)	27.34(25.39-28.69)	36.73(33.20-41.62)	
Age (year)	77(70-83)	75(70-82)	0.026
65-74	668(40.9)	219(45.4)	0.427
75-84	613(37.6)	188(39.0)	0.759
≥85	351(21.5)	75(15.6)	0.055
Gender			>0.001
Female	695(42.6)	376(78.0)	
Male	937(57.4)	106(22.0)	
Comorbidity	1512(92.6)	455(94.4)	0.184
Hypertension	839(51.4)	307(63.7)	<0.001
Diabetes	422(25.9)	190(39.4)	<0.001
Cerebrovascular disease	204(12.5)	46(9.5)	0.77
CAD	346(79.9)	87(18.0)	0.132
COPD	242(14.8)	86(17.8)	0.108
CRF	194(11.9)	73(15.1)	0.059
Malignancy	226(13.8)	54(11.2)	0.132
Hepatic disease	23(1.4)	8(1.7)	0.668
Psychiatric disorder	13(0.8)	6(1.2)	0.360
Dementia	147(9.0)	34(7.1)	0.178
Other	121(7.4)	32(6.6)	0.564
Admission diagnosis			
Cerebrovascular disease	210(12.9)	47(9.8)	0.066
Cardiac	111(6.8)	34(7.1)	0.847
Pulmonary	266(16.3)	95(19.7)	0.080
Pneumonia	160(9.8)	43(8.9)	0.563
COPD	73(4.5)	37(7.7)	0.005
Pulmonary, Other	33(2.0)	15(3.1)	0.158
Renal-metabolic	96(5.9)	42(8.7)	0.027
Hepatic cirrhosis	11(0.7)	8(1.7)	0.044
Trauma	38(2.3)	15(3.1)	0.334

Sepsis	455(27.9)	136(28.2)	0.885
Pneumosepsis	96(5.9)	20(4.1)	0.142
İntra- abdominal sepsis	217(13.3)	75(15.6)	0.206
Urosepsis	50(3.1)	14(2.9)	0.858
Sepsis, other	92(5.6)	27(5.6)	0.976
Malignancy	129(7.9)	18(3.7)	0.002
Postoperative	220(13.5)	64(13.3)	0.909
GIB-Hemorrhage	54(3.3)	8(1.7)	0.059
Other	42(2.6)	15(3.1)	0.420

CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; CRF, chronic renal failure; GIB: gastrointestinal bleeding; IQR: inter quartile range.

blood sugar of obese patients (156 [131–193]) was higher than that of non-obese patients (144 [121–176]) (p <0.001). Other laboratory parameters were found to be similar, except that obese patients had higher white blood cells (WBCs), and non-obese patients had higher procalcitonin levels.

ICU duration and mortality

Obese patients (5.70 [2.43–12.31]) had longer ICU stays than non-obese patients (4.41 [2.01–10.45]) (p <0.05). When 28-day mortality was examined via Kaplan-Meier survival analysis, it was determined that there was no difference between the groups (Log-rank: p=0.191) (Figure 1). Also, ICU mortality was determined to be 37.6% (181) in obese patients and 36.0% (588) in non-obese patients (p>0.05). In the subgroup analysis performed according to the admission diagnoses of the patients, there was no difference in mortality between the groups with any admission diagnosis (Table 3). Considering that the clinical weights of the patients may differ and this may affect the mortality data, the patients were divided into four quartiles according to APACHE II score. Thereby, patients with similar disease severity were grouped together. In order to determine the relationship between BMI and mortality, an ROC analysis, including patients in the four APACHE II groups, was performed. No significant relationship was found between BMI and mortality in any of the groups, regardless of disease severity (Figure 2).

DISCUSSION

As a result of this study, which investigated the effect of obesity on mortality in geriatric ICU patients, it was determined that the mortality rate of obese patients was similar to that of non-obese patients. Mortality was found to be similar between the groups in the subgroup analyses for all admission diagnoses. Even when geriatric patients with similar disease severity were grouped, obesity had no effect on mortality. An attempt to find a BMI cut-off value that would affect mortality was unsuccessful. The paradox that associates obesity with better survival in geriatric patients in the ICU could not be statistically confirmed. The results of previous studies investigating the ICU mortality of obese patients contradict one another. While ICU mortality has been shown to be lower in obese patients in some studies (5), no difference in mortality was observed in other studies (6), and obesity was even found to cause higher mortality in one subgroup of obese patients (13). In another study, obesity was

Table 2. Scores, interventions, mechanical ventilator values, blood parameters and treatments during the ICU stay.

Parameters	Non-Obese n=1632 (%77.2) median (IQR)	Obese n=482 (%22.8) median (IQR)	P-value
APACHE 2	23(17-29)	24(17-29)	0.586
APACHE 4	80(58-110)	82(57-118)	0.565
SAPS 3	50(42-58)	49(42-59)	0.951
SOFA	6(3-9)	6(3-10)	0.760
TISS	20(15-26)	22(16-27)	0.171
GCS	9(5-13)	10(6-13)	0.595
RASS	-1(-4-0)	-1(-4-0)	0.624
Interventions			
Arterial catheter	1159(71.0)	344(71.4)	0.881
Central catheter	846(51.8)	284(58.9)	0.006
MV	1116(68.4)	358(74.3)	0.013
Tracheostomy	294(18.0)	88(18.3)	0.903
Dialysis	318(19.5)	124(25.7)	0.003
Treatments			
Nutrition (kcal/day)	1652(1461-1881)	1524(1382-1697)	<0.001
TPN	569(34.9)	172(35.7)	0.740
Antibiotics	1452(89.0)	432(89.6)	0.684
Vasoactive agents	1016(62.3)	303(62.9)	0.809
Mechanical ventilation			
FiO_2 (%)	42(40-47)	43(40-48)	0.082
PEEP (cmH_2O)	5.3(5.1-5.9)	5.6(5.1-6.0)	<0.001
P peak (cmH_2O)	14(12-16)	15(13-17)	<0.001
Tidal Volume	479(422-546)	477(423-531)	0.433
Tidal Volume (ml/kg)	6.56(5.84-7.43)	6.92(6.18-7.73)	<0.001
Respiratory rate (min)	19(16-21)	19(16-22)	0.682
Compliance (ml/cmH_2O)	37(31-48)	34(29-41)	<0.001
WOBv (j/L)	1.06(0.90-1.21)	1.16(0.99-1.31)	<0.001
Mechanical power (J/mien)	9.30(7.76-10.78)	9.29(7.73-10.87)	0.737
Blood gas			
PH	7.40(7.32-7.44)	7.38(7.30-7.43)	0.005

PO_2 (mmHg)	87.1(64.7-109.1)	84.4(63.3-106.7)	0.166
PCO_2 (mmHg)	40.6(35.8-46.6)	42.9(38.0-49.8)	<0.001
HCO_3 (mEq/L)	24.3(20.8-27.7)	24.4(20.6-28.2)	0.608
Lactate (mmol/L)	1.78(1.33-3.11)	1.89(1.41-3.31)	0.068
Laboratory			
Glucose (mg/dl)	144(121-176)	156(131-193)	<0.001
Hemoglobin (g/dl)	9.64(8.71-10.96)	9.57(8.63-10.91)	0.174
Hematocrit (%)	30.26(27.19-34.09)	29.79(27.19-33.90)	0.437
Platelet ($x10^9$/L)	206(148-275)	218(160-287)	0.039
White blood cell ($x10^9$/L)	12,35(9.30-16.19)	13.54(10.09-17.28)	<0.001
CRP (mg/L)	1.84(0.28-4.99)	2.11(1.01-5.15)	0.191
Procalcitonin (ug/L)	0.93(0.40-4.52)	0.72(0.35-3.35)	0.033
INR	1.20(1.07-1.43)	1.21(1.08-1.43)	0.715
APTT (sec)	32.3(27.0-41.5)	31.2(26.0-40.2)	0.066
AST (U/L)	31(20-57)	31(21-63)	0.490
ALT (U/L)	19(11-37)	20(13-40)	0.063
Creatinine (mg/dl)	0.70(0.47-1.08)	0.76(0.48-1.06)	0.630
Albümine (mg/dl)	2.80(2.33-3.30)	2.90(2.41-3.34)	0.105
Sodium (mmol/L)	139(136-143)	139(136-142)	0.305
Chlorine (mmol/L)	103(99-107)	103(99-107)	0.142
Potassium (mmol/L)	4.1(3.7-4.5)	4.0(3.7-4.4)	0.607
Magnesium (mg/dl)	1.98(1.80-2.19)	1.95(1.77-2.17)	0.057
Complications			
AKI	937(57.4)	326(67.6)	<0.001
Pressure sores	145(8.9)	76(15.8)	<0.001
MV (day)	5.27(2.24-11.99)	5.29(2.48-13.81)	0.298
LOS ICU (day)	4.41(2.01-10.45)	5.70(2.43-12-31)	0.003
28-day mortality	549 (33.6)	162 (33.6)	0.990
ICU mortality	588(36.0)	181(37.6)	0.542

APACHE: acute physiology and chronic health evaluation; SAPS: simplified acute physiology; SOFA: sequential organ failure assessment; TISS: therapeutic intervention scoring system; GCS: glascow coma score; RASS: Richmond Agitation and Sedation Scale; MV: mechanic ventilation; TPN: total parenteral nutrition; FiO_2: fraction of inspired oxygen; PEEP: positive end-expiratory pressure; WOBv: work of breathing ventilator; PCO2: partial pressure of carbon dioxide; PO2: partial pressure of oxygen; HCO_3: bicarbonate; CRP: C-reactive protein; INR: international normalized ratio; APTT: activated partial thromboplastin time; AST: aspartate aminotransferase; ALT: alanine aminotransferase; AKI: acute kidney injury; LOS: length of stay; ICU: intensive care unit; IQR: inter quartile range.

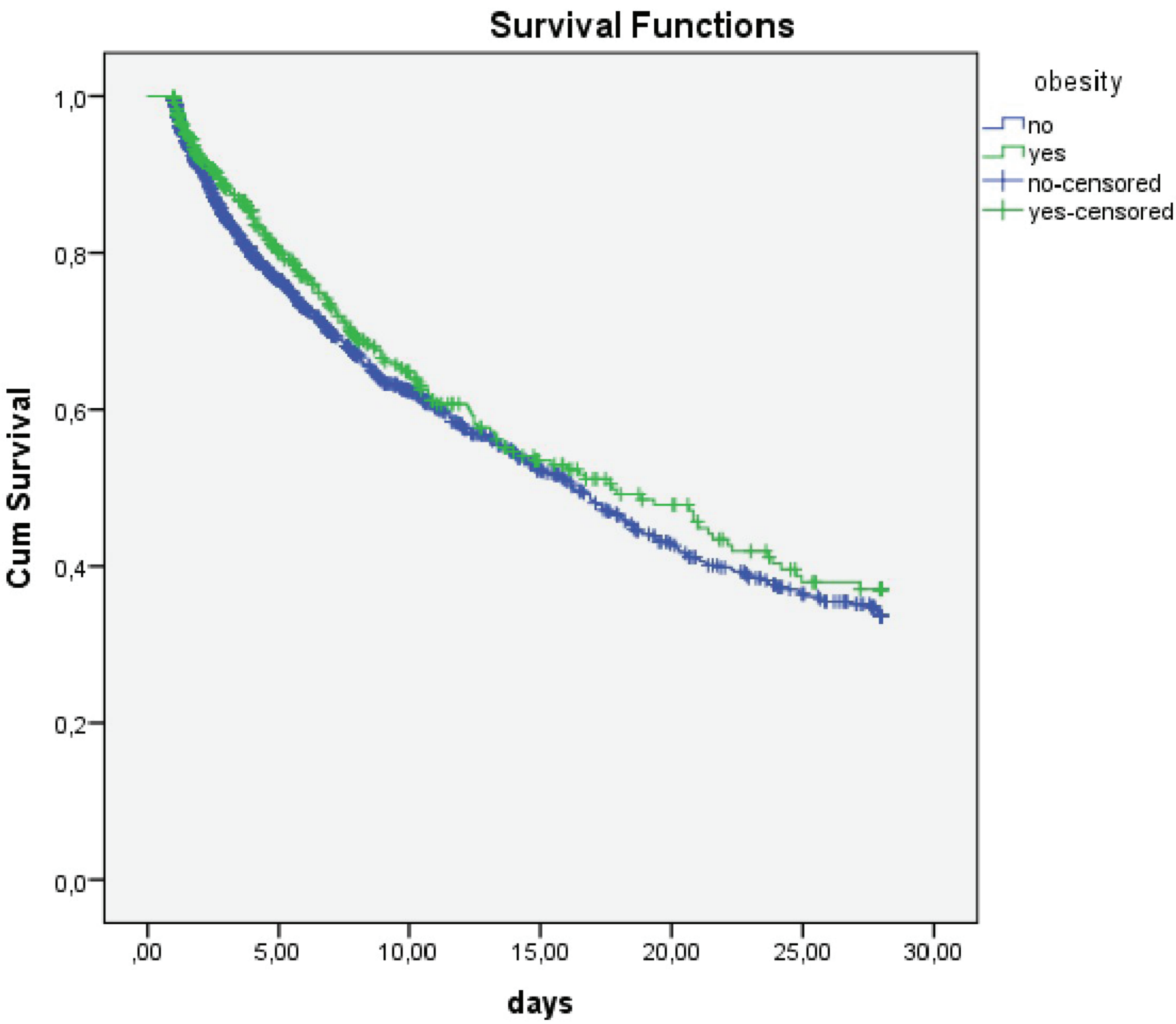
Table 3. Mortality rates of the groups according to the diagnosis of ICU admission.

Admission diagnosis	Non-Obese n=1632 (%77.2)	Obese n=482 (%22.8)	P-value
Cerebrovascular disease	61(29.0)	10(21.3)	0.281
Cardiac	42(37.8)	19(55.9)	0.062
Pulmonary	96(36.1)	35(36.8)	0.896
Pneumonia	66(41.3)	20(46.5)	0.535
COPD	19(26.0)	8(21.6)	0.612
Pulmonary, Other	11(33.3)	7 (46.7)	0.326
Renal-metabolic	39(40.6)	21(50)	0.307
Hepatic cirrhosis	7(63.6)	5(62.5)	0.663*
Trauma	11(28.9)	4(26.7)	0.577*
Sepsis	210(46.2)	65(47.8)	0.736
Pneumosepsis	41(42.7)	7(35)	0.524
Intra-abdominal sepsis	102(47.0)	33(44.0)	0.653
Urosepsis	15(30.0)	5(35.7)	0.683
Sepsis, other	52(56.5)	20(74.1)	0.101
Malignancy	40(31.0)	8(44.4)	0.255
Postoperative	38(17.3)	5(7.8)	0.063
GIB-Hemorrhage	29(53.7)	2(25.0)	0.128*
28-day mortality	549 (33.6)	162 (33.6)	0.990
ICU mortality	588(36.0)	181(37.6)	0.542

COPD: chronic obstructive pulmonary disease; GIB: gastrointestinal bleeding. *Fisher exact test

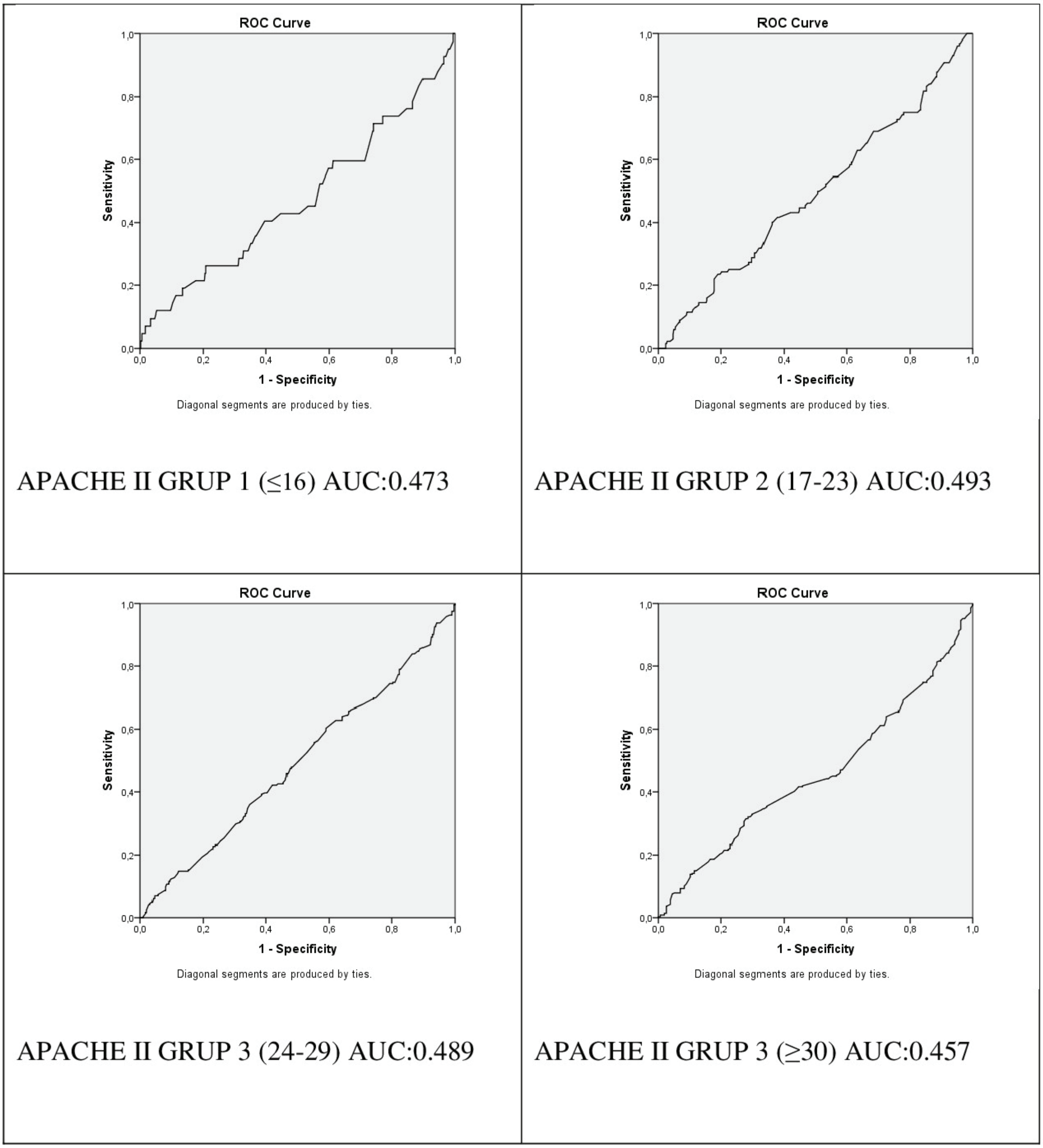
associated with a decrease in mortality in ICU patients, but no reduction in mortality was found in geriatric obese patients in the same study (14). In a meta-analysis evaluating 32 studies conducted between 1990 and 2013, in which 197,940 adults aged 65 and over were included, it was determined that the relationship between BMI and mortality formed a "U" shaped curve (15). With age, the curve shifts to the right and becomes flat. This change in the curve causes the standard BMI cut-off points to differ in older adults as compared to younger populations. These confusing results can be explained by the use of arbitrary obesity definitions, such as BMI> 28 and BMI> 31, in some studies; differences in comorbidity burden between obese and non-obese patients; and most importantly, the absence of a single obese patient phenotype. An obesity condition in which adults with dysmetabolic obesity, in which an increase in waist circumference is prominent, die at a younger age and those with a less metabolically active fat mass survive into older age may reflect the absence of this disease rather than representing a healthy state. Therefore, obesity may not have clear negative effects on the geriatric population. The causes of this reversed epidemiological situation, which is called the obesity paradox, are not entirely clear (16). An increased energy reserve that can be consumed during disease can be useful in the "geriatric" population, where many acute and chronic diseases are normal, and adipose tissue

Figure 1. Kaplan-Meier analysis performed to determine the relationship between 28-day survival and obesity (Log rank: p=0.191)



can act as a storage site for harmful metabolites in the circulation (16). Our study, in which higher blood glucose levels were detected in obese patients than non-obese patients despite their lower calorie input, supports this idea. In addition, the fact that BMI measurement does not take into account the distribution of fat in the body or lean muscle mass may cause an incorrect obesity assessment. Neck reduction due to osteoporosis, which is common with age, may cause an increase in BMI, and while a patient with all the risks of metabolic and clinical obesity due to an increase in visceral fat mass may not be defined as obese, a patient with increased muscle mass and a preserved visceral fat ratio can be defined as obese. Therefore, even the BMI values used in the determination of obesity can cause these complex results.

Figure 2. Receiver operating characteristic (ROC) analysis curves of body mass index and mortality according to four different APACHE groups.



The physiology of obesity and its comorbidities are similar to those of aging and age-related diseases. Obesity and aging share a similar phenotypical structure that can be defined by disruptions in genomic integrity, mitochondrial dysfunction, a weakened immune system, increased intracellular macromolecule accumulation, susceptibility to systemic inflammation, and changes in the composition of the body and tissues (17). Also, both obesity and aging are associated with comorbidities, including diabetes mellitus, cardiovascular diseases, and some types of cancer (18). Our research results found that the prevalence of diabetes mellitus and hypertension increased in the obese geriatric population, in accordance with the literature. Obesity and aging are characterized by the deterioration of homeostasis as a result of a gradual decrease in the function of various organs (19). The increased production of reactive oxygen species (ROS), which contributes to aging and obesity, causes oxidative damage and, eventually, DNA damage, which leads to telomere shortening and cell death (20). The resulting DNA damage plays a role in all pathologies associated with obesity and aging.

In our study, it was determined that geriatric obese patients required mechanical ventilation more frequently, but the duration of mechanical ventilation was similar to that observed for non-obese patients. Previous studies investigating the relationship between obesity and MV duration in patients have yielded controversial results (2,21). While the duration of mechanical ventilation was longer in obese patients than non-obese patients in one study (2), no such difference was found in another similar study (21). Our research results show that obese patients had higher ventilation pressures and lower compliance. These results are consistent with previous research. Although obese patients are ventilated with higher pressures on mechanical ventilators, they tend to have a lower functional residual capacity and lung volume due to the changes in respiratory mechanics caused by increased adipose tissue surrounding the chest wall (22). The decreased compliance found in obese patients can be explained by the fact that the mass burden of obesity makes the lungs more susceptible to atelectasis or increased alveolar wall tension due to the disrupted harmony between the lung and chest wall. Increased intra-abdominal pressure due to visceral fat accumulation in the abdominal area may cause an increase in respiratory workload. In addition, studies have determined that obese patients produce more carbon dioxide (23). This may explain the increased respiratory workload as well. In addition to the increased workload caused by obesity, clinicians may be hesitant to admit geriatric obese patients to the ICU and attach them to a mechanical ventilator due to the muscle weakness seen in the geriatric population. However, studies have shown that the results of the use of mechanical ventilators in the geriatric patient group are comparable to those of non-geriatric patients and that ICU admission should not be denied to geriatric patients (24).

In our study, the ICU follow-up duration was found to be significantly longer in obese geriatric patients as compared to non-obese geriatric patients. Similar studies report that obesity increases the duration of ICU stay (5,6). In a meta-analysis of 23 studies, a trend toward an increase in ICU stay in obese patients was detected (6). In another meta-analysis of 14 studies, obesity was found to be associated with increased ICU length of stay and duration of mechanical ventilation (5). However, there are studies that claim the opposite and find the average ICU duration of obese patients to be similar to that of non-obese patients (8). This may be explained by the fact that obese patients have different phenotypes. There is not a single standardized obese patient profile in the ICU. Patients vary in terms of obesity class and comorbid disease burden. Also, some clinicians tend to think that obese patients may have worse outcomes. Therefore, the increased acceptance of obese patients who can be treated more easily in the intensive care unit and are not very critical may shorten ICU follow-up duration. On the other hand, vascular access problems are common in obese patients, and the frequency of using central catheters has increased in obese patients, as shown in our study. This may lead to infection development and catheter-related complications, prolonging the duration of ICU stay. In addition, increased AKI and pressure sore incidence in obese patients may have prolonged the duration of the ICU. Previous studies have shown that the prevalence of AKI in obese patients followed in the ICU is higher than in non-obese critically ill patients, and the frequency of AKI in critically ill patients increases with BMI (25). Although the pathophysiology of the development of increased AKI in obesity is not fully understood, increased renal blood flow and glomerular filtration rate due to changes in renal hemodynamics may lead to an increase in the filtration fraction, resulting in increased susceptibility to injury. Obese ICU patients are at risk for increased intra-abdominal pressure, which can cause renal dysfunction due to both poor arterial perfusion and venous occlusion (25). As determined in this study in obese patients, the effects of more common comorbid diseases on kidney physiology should not be ignored. Another factor that may contribute to the effect of obesity on AKI is the difficulty in assessing intravascular volume status and determining adequate fluid therapy or vasoactive drug dose. In addition, providing nursing care to obese patients is more difficult than providing care to normal-weight patients due to obese patients' high body weight and large body surface area. The difficulty involved in position changes for these patients creates the risk of pressure sores and lacerations of the skin. The disruption of the protective skin barrier may prolong stays in the ICU by increasing complications such as infection or bleeding in obese patients (4).

The strengths of the study are that it has a large sample and all the data is obtained from the clinical decision support system with electronic queries for preventing data misses and human errors. There are some limitations of the study. First, having a single-center population prevents the generalization of the results despite the geographical diversity of the patients. The retrospective study design may create confounding factors and a risk of bias. In addition, the absence of data such as waist circumference or waist-hip ratio, to support the definition of obesity, may have affected the accuracy of the groups created according to BMI. The lack of registration of IV fluids and diuretic treatments used before ICU admission may have affected the BMI data by changing the weights of the patients measured in the ICU. Long-term follow-up results of patients who survived in the ICU could not be evaluated due to lack of data. There is a need for well-designed, randomized prospective studies that include geriatric obese patients at the center of the study in order to better understand the effect of obesity on the geriatric population in the ICU.

CONCLUSION

It was determined that obesity does not make a difference in ICU mortality for geriatric patients. The obesity paradox in the ICU is supported by the lack of a difference in mortality when patients are grouped by admission diagnosis and disease severity. According to our results, obesity increases ICU morbidity in geriatric patients, but it is not associated with mortality. In an environment with limited resources, the careful selection of geriatric patients to be admitted to the ICU is important, and obese geriatric patients may have positive outcomes.

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REFERENCES

1. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999-2008. JAMA 2010;303 (3): 235-41. (PMID: 20071471)
2. Robinson MK, Mogensen KM, Casey JD, et al. The relationship among obesity, nutritional status, and mortality in the critically ill. Crit Care Med 2015;43 (1): 87-100. (PMID: 25289931)
3. Porter Starr KN, McDonald SR, Weidner JA, Bales CW. Challenges in the Management of Geriatric Obesity in High Risk Populations. Nutrients 2016;8 (5): 262. (PMID: 27153084)
4. Winkelman C, Maloney B, Kloos J. The impact of obesity on critical care resource use and outcomes. Crit Care Nurs Clin North Am 2009;21 (3): 403-22. (PMID: 19840718)
5. Akinnusi ME, Pineda LA, El Solh AA. Effect of obesity on intensive care morbidity and mortality: a meta-analysis. Crit Care Med 2008;36 (1): 151-8. (PMID: 18007266)
6. Oliveros H, Villamor E. Obesity and mortality in critically ill adults: a systematic review and meta-analysis. Obesity (Silver Spring). 2008;16 (3): 515-21. (PMID: 18239602)
7. Goulenok C, Monchi M, Chiche JD, Mira JP, Dhainaut JF, Cariou A. Influence of overweight on ICU mortality: a prospective study. Chest 2004;125 (4): 1441-5. (PMID: 15078757)
8. Ni YN, Luo J, Yu H, et al. Can body mass index predict clinical outcomes for patients with acute lung injury/acute respiratory distress syndrome? A meta-analysis. Crit Care 2017;21 (1): 36. (PMID: 28222804)
9. Flegal KM, Kruszon-Moran D, Carroll MD, Fryar CD, Ogden CL. Trends in Obesity Among Adults in the United States, 2005 to 2014. JAMA 2016;315 (21): 2284-91. (PMID: 27272580)
10. United-Nations Department of economic and social affairs. Population Division. World Population ageing 2019. Published by the United Nations; 2020. [Internet]. Available from: https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Report.pdf. Accessed: 01.05.2021.
11. Demirkıran H, Uzunoglu M, Erdivanlı B, et al. Prevalence and clinical features of chronic critical illness in the elderly population in Turkey. Turkish Journal of Geriatrics 2020;23 (4): 501-508. (DOI: 10.31086 / tjgeri.2020.188).
12. Amarya S., Singh K., Sabharwal M. Health consequences of obesity in the elderly. J. Clin Gerontol Geriatr 2014;5: 63–67. (DOI: 10.1016/j.jcgg.2014.01.004).
13. Falagas ME, Athanasoulia AP, Peppas G, Karageorgopoulos DE. Effect of body mass index on the outcome of infections: a systematic review. Obes Rev 2009;10 (3): 280-9. (PMID: 19243518)
14. Trivedi V, Jean RE, Genese F, et al. Impact of Obesity on Outcomes in a Multiethnic Cohort of Medical Intensive Care Unit Patients. J Intensive Care Med 2018;33 (2): 97-103. (PMID: 27139008)
15. Winter JE, MacInnis RJ, Wattanapenpaiboon N, Nowson CA. BMI and all-cause mortality in older adults: a meta-analysis. Am J Clin Nutr 2014;99 (4): 875-90. (PMID: 24452240)
16. Oga EA, Eseyin OR. The Obesity Paradox and Heart Failure: A Systematic Review of a Decade of Evidence. J Obes 2016;2016: 9040248. (PMID: 26904277)
17. Tam BT, Morais JA, Santosa S. Obesity and ageing: Two sides of the same coin. Obes Rev 2020;21 (4): e12991. (PMID: 32020741)
18. Haslam DW, James WP. Obesity. Lancet 2005;366 (9492): 1197-209. (PMID: 16198769)
19. Barzilai N, Huffman DM, Muzumdar RH, Bartke A. The critical role of metabolic pathways in aging. Diabetes 2012;61 (6): 1315-22. (PMID: 22618766)
20. Lee HC, Wei YH. Oxidative stress, mitochondrial DNA mutation, and apoptosis in aging. Exp Biol Med (Maywood) 2007;232 (5): 592-606. (PMID: 17463155)
21. Duane TM, Dechert T, Aboutanos MB, Malhotra AK, Ivatury RR. Obesity and outcomes after blunt trauma. J Trauma 2006;61 (5): 1218-21. (PMID: 17099532)
22. Salome CM, King GG, Berend N. Physiology of obesity and effects on lung function. J Appl Physiol (1985) 2010;108 (1): 206-11. (PMID: 19875713)

23. De Jong A, Chanques G, Jaber S. Mechanical ventilation in obese ICU patients: from intubation to extubation. Crit Care 2017;21 (1): 63. (PMID: 28320439)

24. Añon JM, Gómez-Tello V, González-Higueras E, et al. Prognosis of elderly patients subjected to mechanical ventilation in the ICU. Med Intensiva 2013;37 (3): 149-55. (in Spanish) (PMID: 22592112)

25. Schiffl H. Obesity and the Survival of Critically Ill Patients with Acute Kidney Injury: A Paradox within the Paradox? Kidney Dis (Basel). 2020;6 (1): 13-21. (PMID: 32021870)