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Is High Body Mass Index a Risk Factor for COVID-19?

Yüksek Beden Kitle İndeksi COVİD-19 için Bir Risk Faktörü Müdür?

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ABSTRACT

Objective: The aim of this study is to evaluate the relation of body mass index (BMI) with Coronavirus disease-19 (COVID-19) and its effects on the course of the disease in COVID-19 patients.

Methods: The sample of the study consists of 97 adults who applied to our hospital COVID-19 triage clinic between 01.04.2020-01.06.2020. Patients' demographic data, symptoms, thorax computed tomography results, laboratory results, body weight, height, and need for intensive care therapy and mechanical ventilation were retrospectively screened. BMI was defined as normal if it was <25.0 kg/m^2, overweight if 25.0-29.9 kg/m^2, and obese if ≥30.0 kg/m^2.

Results: It was determined that 40.2% of the individuals participating in the study were overweight and 30.9% were obese. It was observed that obese individuals had more severe symptoms such as higher fever and poorer sense of smell, and higher thoracic bilateral involvement than those with normal weight (p<0.05). Similarly, the hospitalization rates of overweight and obese individuals (82.1% and 76.7%, respectively) (p=0,051), and the dependence rate of the latter on a mechanical ventilator (17.9%) were found to be higher (p<0.05). In the logistic regression analysis, it was found that a BMI of 25.0 and above increased the rate of hospitalization by approximately 3.5 times (p<0.05).

Conclusion: It was determined that increased BMI was an important risk factor for COVID-19 and increased hospitalization rates. In societies with high obesity rates, evaluation of obesity in COVID-19 patients is important to start treatment early and reduce hospitalization rates.

Keywords: Body mass index, COVID-19, obesity

ÖZ

Amaç: Bu çalışmanın amacı Koronavirüs hastalığı-19 (COVID-19) hastalarında beden kitle indeksinin (BKİ) COVİD-19 hastalığı ile ilişkisi ve hastalık seyrine olan etkilerini değerlendirmektir.

Yöntemler: Çalışmanın örneklemini 01.04.2020-01.06.2020 tarihleri arasında hastanemiz COVİD-19 triyaj polikliniğine başvuran 97 yetişkin birey oluşturmaktadır. Hastaların demografik verileri, semptomları, toraks bilgisayarlı tomografi sonuçları, hastaneye başvuru sırasında rutinde bakılan laboratuvar sonuçları, vücut ağırlığı, boy uzunluğu, yoğun bakım tedavisi ve mekanik ventilasyona ihtiyaç duyma durumları retrospektif olarak taranmıştır. BKİ'nin <25,0 kg/m^2 olması normal, 25,0-29,9 kg/m^2 arası hafif şişman ve 30,0 kg/m^2 olması ise şişman olarak tanımlanmıştır.

Bulgular: Çalışmaya katılan bireylerin %40,2'sinin hafif şişman ve %30,9'unun ise şişman olduğu saptanmıştır. Şişman olan bireylerde ateş ve koku alma bozukluğu gibi semptomların daha fazla ve toraks bilatertal tutulumun normal bireylere göre daha yüksek olduğu görülmüştür (p<0,05). Benzer şekilde hafif şişman ve şişman bireylerin hastaneye yatış oranlarının (sırasıyla %82,1 (p=0,051) ve %76,7) ve şişman bireylerin (%17,9) mekanik ventilatöre bağlanma oranlarının daha yüksek olduğu saptanmıştır (p<0,05). Lojistik regresyon analizinde BKİ'nin 25,0 kg/m^2 ve üzeri olmasının hastaneye yatış oranlarını yaklaşık 3,5 kat artırdığı saptanmıştır (p<0,05).

Sonuç: Artmış BKİ'nin COVİD-19 için önemli bir risk faktörü olduğu ve hastaneye yatış oranlarını artırdığı belirlenmiştir. Obezite oranlarının yüksek olduğu toplumlarda COVİD-19 hastalarının obezite açısından da değerlendirilmesi tedavinin erken başlaması ve hastaneye yatış oranlarının azaltılması açısından önemli olacağı düşünülmektedir.

Anahtar Sözcükler: Beden kitle indeksi, COVİD-19, obezite

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Introduction

Twenty-seven pneumonia cases of unknown etiology were detected on December 31, 2019, in Wuhan, China. The cause of this disease was named severe acute respiratory syndrome coronavirus (SARS-CoV-2) by the Chinese Center for Disease Control and Prevention on January 7, 2020, due to its similarity to SARS-CoV (1). The name of the disease was accepted as Coronavirus disease-19 (COVID-19) by the World Health Organization (WHO) and the COVID-19 epidemic was described as an "international public health emergency".

COVID-19 was declared as a global epidemic (pandemic) on March 11 due to the occurrence of COVID-19 in 113 more countries outside China, the spread and severity of the virus (2). Currently, according to WHO data, COVID-19 cases have been seen in 216 countries and the total number of cases is reported to be 7,094,473 (3). The first COVID-19 case in Turkey was detected on March 11, 2020. An increase in the number of cases has been observed in Turkey as in the whole world, and the total number of cases was 170,132 as of 08.06.2020 (4).

CoVs are single-stranded, positive polarity enveloped RNA viruses. The most important transmission route of COVID-19 infection is through droplets, touching surfaces containing the virus, and then touching the mucous membranes of the mouth, nose, and eyes. The contagious period of the disease is not known exactly; the average incubation period is 4-5 days but it extends up to 14 days (2). In mild cases of the disease, symptoms such as cough, fever, difficulty breathing, diarrhea, abdominal pain, taste and smell disorders, and widespread joint and muscle pain are observed; severe pneumonia and mortality can be seen in severe cases (5).

Obesity is increasing all over the world due to urbanization, economic development, and changes in lifestyle and is considered an epidemic problem. In recent years, one out of every two people is reported to be overweight or obese in industrial countries. Obesity prevalence is 34% in the US (6) and according to Turkey Nutrition and Health Survey-2010 data obesity prevalence was 30.3% in all adults in Turkey (7). Although the mechanism between obesity and COVID-19 is not known clearly, retrospective studies conducted on the influenza A virus H1N1 pandemic in 2009 emphasized that obesity was important in the course of the disease and mortality risk (8,9). Nowadays, obesity is also thought to be an important risk factor for COVID-19, and the increasing COVID-19 mortality in the United States is suggested to be due to the high prevalence of obesity in the country (10).

The increase in the consumption of refined carbohydrates, food with a high glycemic index, saturated fatty acids, processed foods, and red meat with the western-style diet, which is one of the most important causes of obesity, has a proinflammatory effect. In addition, due to insufficient intake of vitamins and minerals that act as antioxidants, antimicrobial agents cannot function adequately and the activation of macrophages is prevented (11). Secondary leptin insufficiency occurs in obesity due to leptin resistance. It is suggested that there may be susceptibility to infections in obese individuals due to the decrease in the immunomodulatory effect of leptin (12). In addition, low-level chronic inflammation caused by increased adipokines [tumor necrosis factor (TNF)-α, interleukin (IL) 6 and resistin, etc.) as a result of amyloid-A secreted by adipose tissue in obesity negatively affects the function of leukocytes and macrophages, altering the immune response and reducing the body's resistance to infections (13).

The number of studies examining the relationship between obesity and COVID-19 is limited in the literature. These studies found that increasing body mass index and obesity cause an increase in the severity of COVID-19 disease, the need for intensive care treatment, and mechanical ventilation (10,14). This study evaluates the relationship between obesity and COVID-19 disease and the effects of obesity on COVID-19 disease course in Antalya province.

Method

This study includes 19-83 years old adults (n=97) who were admitted to the COVID-19 triage outpatient clinic of a state hospital between 01.04.2020 and 01.06.2020 and had quantitative real-time PCR (reverse transcriptase polymerase chain reaction) test positivity in nasopharyngeal swab samples.

Demographic data of the patients, symptoms at hospital admission, thorax computed tomography (CT), routine laboratory test results at admission (leukocyte, platelet, hemoglobin, ferritin, etc.), need for intensive care unit (ICU) and mechanical ventilation, and duration of treatment at hospital and ICU were retrospectively scanned from the hospital data processing system. In order to determine the obesity status of the patients, height and body weight information were obtained from nurse observation forms and body mass index (BMI) was calculated with the formula [body weight (kg)/height (m^2)]. WHO criteria were used in body mass index classification; BMI of individuals below 25.0 kg/m^2 was considered normal, between 25.0-29.0 kg/m^2 as overweight, and 30.0 kg/m^2 and above as obese (15).

Before starting the study, permission was obtained from the Ministry of Health COVID-19 Scientific Research Platform Commission (project number: 2020-05-25T14_00_01); the study was also examined by the Health Sciences University Antalya Training and Research Hospital Ethics Committee, and approval was obtained on 03.06.2020 (decision number: 7-7)

Statistical Analysis

SPSS (Statistical Package for Social Sciences) Windows 22.0 package program was used for all statistical analyzes. For statistical significance, $p<0.05$ was accepted. Descriptive statistics were presented with frequency, percentage, mean ($\bar{X}$), standard deviation (SD), median, and interquartile range (IQR) values. Fisher's Exact Test or Pearson's chi-square test was used in the analysis of the relationships between categorical variables. Kruskal Wallis test was used for nonparametric comparison

Table 1. General characteristics of patients according to body mass index classification

	BMI			
	<25.0 kg/m² normal	25.0-29.9 kg/m² overweight	≥30.0 kg/m² obese	p
Gender, n (%)				
Male	13 (25.5)	20 (39.2)	18 (35.3)	0.640
Female	15 (31.1)	19 (42.2)	12 (26.7)	
Age, median (IQR)	47 (39-60)	39 (30-47)	52 (43-65.5)	0.002
Comorbidity, n (%)				
Hypertension	3 (11.1)	7 (17.9)	12(42.9)	0.012
Coronary artery disease	1 (3.7)	1 (2.6)	2 (7.1)	0.648
COPD	1 (3.7)	-	4 (14.3)	0.099
Asthma	-	5 (12.8)	2 (7.1)	0.149
Diabetes mellitus	2 (7.4)	4 (10.3)	9 (32.1)	0.019
Chronic kidney disease	-	-	1 (3.6)	0.304
Cancer	3 (11.1)	1 (2.6)	1 (3.6)	0.279

BMI: Body mass index, COPD: Choronic obstructive pulmonary disease, IQR: Inter quantile range

of biochemical findings of individuals according to BMI classification, and the ANOVA test was used when the assumption of normal distribution was confirmed. The effect of body mass index being normal (<25.0 kg/m²) or overweight/obese (25.0 kg/m²) on hospitalization, intensive care unit, and mechanical ventilator requirement was examined by logistic regression analysis. Hosmer-Lemeshow test was used for model fitness.

Results

Among the individuals (n=97) participating in the study, 52.6% (n=51) were men and 47.4% (n=46) were women. 40.2% of the individuals participating in the study were overweight, 30.9% were obese, and there was no difference between men and women according to BMI classification (p>0.05). The mean age of the participants was 48.4±15.0 years, the median age of the overweight group was 39 years and the obese group was 52 years.

The evaluation of the participants according to their accompanying diseases revealed that hypertension and diabetes were significantly higher in individuals with overweight and obesity compared to individuals with normal BMI (p<0.05).

Table 2 summarizes the initial symptoms, hospitalization, ICU, and mechanical ventilation needs of the individuals classified according to their BMI. Fever and impairment in olfaction were more common in obese individuals while the frequency of other symptoms was similar among the groups (p<0.05). Thorax CT results demonstrated that bilateral involvement in the thorax was more in overweight and obese individuals, and this difference was statistically significant (p<0.05). The hospitalization rate was higher in overweight and obese individuals (82.1% and 76.7%; respectively) (p=0.051) and obese individuals required mechanical ventilators more frequently (17.9%) (p<0.05). Although modestly significant statistically, one of every five obese individuals required ICU treatment and this rate was higher than normal weight or overweight individuals (p=0.051).

The evaluation of routine biochemical findings of the individuals revealed that platelet levels of overweight individuals were lower than the individuals with normal BMI. Although the levels of IL-6 increased as the BMI of individuals increased (p<0.05), there was no difference between other biochemical findings according to BMI groups (Table 3).

Table 4 shows logistic regression analysis of the relationship between being normal and overweight/obese and BMI, hospitalization, intensive care unit admission, and the need to use a mechanical ventilator. A BMI value of 25.0 kg/m² and above increased hospital admission rate approximately 3.5 times (odds ratio 3.494, 95% confidence interval 1.285-9.505, p<0.05).

Discussion

Changing dietary habits and increasing body fat tissue in recent years cause leptin resistance and inflammation, therefore, the immune response of obese individuals changes, and the body's resistance against infections decreases (11-13). Obesity prevalence is an important public health problem that is rapidly increasing in Turkey as well as in the whole World (7). Centers for Disease Control and Prevention (CDC) reports that individuals with asthma, chronic lung disease, diabetes, heart disease, and chronic kidney disease are in the risk group for many diseases. Obesity may be an important risk factor for COVID-19 disease as it plays a key role in the pathogenesis of these diseases (diabetes, heart diseases, asthma, etc.) specified by the CDC (16). In this study from Antalya, Turkey, more than half of adult patients detected to have COVID-19 positivity with real-time PCR were overweight or obese and a higher body mass index increased COVID-19 disease risk. In Shenzen, China, among 383 adult patients admitted within the first two months of the pandemic, 32% were overweight and 10.7% were obese (17). A study from the US found that among 5,700 COVID-19 cases 41.7% were obese and 19% were morbidly obese (18). In addition, two studies from China to determine the relationship between obesity and

Table 2. Symptoms, hospitalization, need to intensive care and mechanical ventilator according to the classification of body mass index

	BMI			
	<25.0 kg/m² normal	25.0-29.9 kg/m² overweight	≥30.0 kg/m² obese	p
Symptoms, n (%)				
Fever	17 (63.0)	32 (82.1)	25 (89.3)	0.047
Cough	11 (40.7)	22 (56.4)	16 (57.1)	0.373
Respiratory distress	6 (22.2)	7 (17.9)	10 (35.7)	0.236
Back pain	3 (11.1)	3 (7.7)	1 (3.6)	0.566
Muscle/joint pain	6 (22.2)	13 (33.3)	7 (25.0)	0.570
Headache	3 (11.1)	8 (20.5)	2 (7.1)	0.262
Sore throat	4 (14.8)	5 (12.8)	4 (14.3)	0.970
Diarrhea	-	2 (5.1)	2 (7.1)	0.397
Vomitting	-	3 (2.6)	4 (3.6)	0.637
Stomachache	-	2 (5.1)	2 (7.1)	0.397
Taste dysfunction	4 (14.8)	9 (23.1)	9 (32.1)	0.316
Smell dysfunction	-	5 (12.8)	6 (21.4)	0.045
Thorax CT, n (%)				
Unilateral involvement	6 (20.7)	12 (30.8)	8 (26.7)	0.032
Bilateral involvement	7 (24.1)	20 (51.3)	18 (60.0)	
No finding	16 (55.2)	7 (17.9)	4 (13.3)	
Hopitalization, n (%)	15 (55.6)	32 (82.1)	23 (76.7)	0.056
Hopitalization (day), Median (IQR)	6 (4-11)	6.5 (5-12.5)	8 (5-14)	0.364
Mortality, n (%)	2 (7.4)	3 (7.7)	4 (13.3)	0.134
Need ICU care, n (%)	2 (7.4)	5 (12.8)	6 (21.4)	0.051
Length of stay ICU (day), Median (IQR)	10 (8-10)	14 (9-19.5)	14.5 (11-20.5)	0.380
Need mechanical ventilator, n (%)	1 (3.7)	2 (5.1)	5 (17.9)	0.034
Mechanical ventilation (day), Median (IQR)	7	14 (8-14)	15 (7-23)	0.481

BMI: Body mass index, ICU: Intensive care unit, CT: Computed tomography, IQR: Inter quantile range

Table 3. Biochemical parameters of patients

BMI				
Biochemical parameters	<25.0 kg/m² normal	25.0-29.9 kg/m² overweight	≥30 kg/m² obese	p
	X ± SD	X ± SD	X ± SD	
Leukocyte (10³mm³)	6600.0±2724.1	6345.9±3070.9	5910.1±2209.1	0.656
Platelet (10³mm³)	271608.7±90995.3	220729.7±76162.3	230465.9±85958.9	0.023
Hemoglobin (g/dL)	13.2±2.0	13.4±1.5	112.8±2.2	0.442
Lymphocyte (10³mm³)	1508.7±822.9	1442.5±668.1	1321.4±565.9	0.607
N/L ratio	3.8±3.4	3.3±2.4	5.0±6.3	0.593
Ferritin (µg/L)	242.0±636.1	217.9±322.1	231.7±193.7	0.980
D-dimer	275.8±253.5	407.3±1206.5	262.6±274.9	0.788
Interleukin-6	17.4±31.7	25.9±28.4	70.9±53.8	0.014
C-reactive protein (mg/L)	33.3±71.1	36.8±50.1	56.1±81.8	0.455

BMI: Body mass index, N/L ratio: Neutrophil/lymphocyte ratio, SD: Standard deviation

COVID-19 found that the disease severity increased with higher BMI values in COVID-19 cases (17-19). In obese individuals, abdominal fat causes an increase in pleural pressure, a decrease in functional residual capacity, and expiratory reserve volume

Table 4. Logistic regression analysis of the relationship between normal and overweight/obesity according to body mass index for hospitalization, need to intensive unit care and a mechanical ventilator

	Odds ratio	95% CI	p
Hospitalization	3.494	1.285-9.505	0.014
Nedd to intensive unit care	1.188	0.122-11.550	0.882
Need to mechanical ventilator	2.196	0.102-47.126	0.615

CI: Confidence interval

(20). In retrospective studies conducted on the influenza A virus H1N1 pandemic, an increase in body weight caused pneumonia and severe lung infections (8,21). This study demonstrated that fever which is an upper respiratory infection symptom was more frequent in obese individuals and bilateral thoracic involvement was present in more than half of overweight and obese individuals which suggests that there was an association between obesity and disease severity. Other studies have also reported that obese individuals had more fever and cough symptoms compared to individuals with normal BMI (10,16).

In a study conducted in the USA, compared to individuals with a BMI <30 kg/m^2, the risk of hospitalization of individuals diagnosed with COVID-19 and with a BMI of 30-40 kg/m^2 was 4.3 times, and in those with a BMI ≥40 kg/m^2 was 6.2 times higher (10). Gao et al. (22) demonstrated that among hospitalized COVID-19 cases, obese individuals had longer hospital stays compared to non-obese individuals [median 23 (IQR: 17-30) and 18 (IQR: 13-24) days, respectively; p<0.05]. In the USA, 1428 COVID-19 cases admitted to hospital between 01 and 30 March 2020 were screened from the COVID-19-Associated Hospitalization Surveillance Network [COVID-NET] system. 90% of these cases had one or more comorbidities and 48.3% were obese (23). In this study, although the hospitalization rates of overweight and obese individuals were high, they were modestly significant. Logistic regression analysis in which individuals were classified as normal weight (BMI <25.0 kg/m^2) and overweight/obese (≥25.0 kg/m^2), BMI ≥25.0 kg/m^2 increased the rate of hospitalization approximately 3.5 times (odds ratio 3.494; 95% confidence interval 1.285-9.505, p<0.05). Knowing the risk for hospitalization is extremely important to start early treatment and estimate the need for hospital beds and personnel (10). Since obesity is an important factor affecting hospitalization status in COVID-19 cases, it should be evaluated in COVID-19 patients.

In a study conducted in England, which is one of the countries with high mortality due to the new type of coronavirus, 72% of the individuals receiving treatment in the intensive care unit due to COVID-19 were overweight or obese. Among 196 individuals participating in the study, 32% had BMI between 25-30 kg/m^2, 33% between 30-40 kg/m^2, and 7% 40 kg/m^2 and above (24). In a study conducted in the USA, individuals with BMI <30 kg/m^2 needed less ICU treatment compared to individuals with BMI 30 kg/m^2 and above (p<0.001) (25). In a similar study conducted in France (n=124), 48% of COVID-19 cases treated in the intensive care unit were obese (BMI >30.0 kg/m^2) and 28% were first degree obese (BMI >35.0 kg/m^2). An evaluation independent from age, diabetes, and hypertension mechanic ventilator requirement of COVID-19 cases increased with increasing BMI (p<0.050). In addition, the study found that individuals with first-degree obesity (BMI 30.0-35.0 kg/m^2) had a 7.36 times higher rate of mechanical ventilator requirement than individuals with normal body weight (26). In this study, although the number of patients who needed intensive care treatment was quite low (n=13), the number of overweight and obese individuals who needed intensive care treatment was higher than those with normal body weight (p=0.051). A small sample size may be responsible for modest statistical significance.

Biochemical findings such as lymphocyte, CRP, IL-6, and D-dimer evaluated at the time of admission to the hospital in COVID-19 cases were associated with the severity of the disease (10). Studies have demonstrated that as the severity of COVID-19 disease increases, the number of lymphocytes decreases, and the levels of CRP, IL-6, and D-Dimer increase (10,18). The increase in adipose tissue in obesity causes an increase in the levels of some proinflammatory markers [IL-6, (TNF-α), and CRP]. Therefore, obesity is considered a low-level chronic inflammatory condition (13). Increasing inflammation in obese individuals can also increase the severity of COVID-19 disease (18). In this study, higher IL-6 levels of obese individuals are thought to affect the severity and prognosis of the disease.

Study Limitations

This study has several limitations. The small sample size and the fact that it is a cross-sectional retrospective study are the most important limitations. In addition, since this was a retrospective study, the smoking status of the patients was not questioned. Smoking is also an important factor that can increase the severity and complications of COVID-19 disease.

Conclusion

In conclusion, this study found that increased BMI is an important risk factor for COVID-19 which increases hospitalization rates. Obesity rates are increasing day by day in Turkey. In societies with high obesity rates, evaluating obesity in COVID-19 patients is important for early initiation of treatment and reduction of hospitalization rates.

Ethics

Ethics Committee Approval: University of Health Sciences Turkey Antalya Health Application and Research Center (decision no: 7/7).

Informed Consent: Retrospective study.

Peer-review: Externally peer reviewed.

Authorship Contributions

Concept: A.S.K., M.T., N.S.K., Design: A.S.K., M.T., N.S.K., Data Collection or Processing: M.T., N.S.K., Analysis or

Interpretation: A.S.K., M.T., N.S.K., LiteratureSearch: A.S.K., M.T., N.S.K., Writing: A.S.K., M.T., N.S.K.

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