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Obesity and the Risk of Early Admission to the Intensive Care Unit in COVID-19 Patients: A Retrospective Cohort Study

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1. ABSTRACT

1.1. Introduction: Obesity is a significant risk factor for severe complications in COVID-19 patients. However, its relationship with admission to the Intensive Care Unit (ICU) remains inadequately explored. This study aims to determine the association between obesity and early ICU admission in COVID-19 patients.

1.2. Objective: To evaluate the association between obesity and the risk of early ICU admission in hospitalized COVID-19 patients, aiming to enhance understanding of the factors influencing the clinical progression of the disease and the development of severe complications.

1.3. Patients and Methods: An ambispective cohort observational study was conducted on COVID-19 patients treated between March 2020 and September 2021 at a tertiary-level hospital in Santander, Colombia. Patients were classified as obese according to the BMI ($\geq$ 30 kg/m^2). The association between obesity and ICU admission was analyzed using Kaplan-Meier and Cox regression models.

1.4. Results: A total of 734 patients were included; 53.81% were male, with a mean age of 60.77 years (SD: 15.20). Of these, 28.34% had a BMI $\geq$ 30 kg/m^2, and 24.8% required ICU admission. The 22-day survival rate was 67%. Obesity had a Hazard Ratio (HR) of 1.51 [95% CI 1.11 - 2.06], and male sex had an HR of 1.71 [95% CI 1.26 - 2.32].

1.5. Conclusion: Obesity is related to an increased probability of ICU hospitalization and therefore worse adverse outcomes; findings that correlate with the outcomes of this group of patients in other viral respiratory infections. These finding emphasize the need for targeted preventive and management strategies to reduce burden of disease.

1.6. Keywords: Obesity; COVID-19; Intensive care unit; Survival analysis; Risk factors

2. INTRODUCTION

The COVID-19 pandemic, triggered by the SARS-CoV-2 virus [1], has posed an unprecedented challenge to global public health, with a devastating impact in terms of morbidity and mortality [2]. Over time, alarming death tolls have been recorded worldwide, with mortality rates varying widely across different regions and populations, reaching figures close to 120 per 100,000 people [3]. This disease has highlighted various risk factors that contribute to poorer outcomes in infected patients [4-6]. Among these factors, obesity has emerged as a significant concern [1,4].

Obesity is not only associated with an increased risk of developing chronic diseases such as diabetes and cardiovascular diseases, but it has also been shown to increase susceptibility to severe complications in COVID-19 patients [7-9]. This is presumably due to the inflammatory component of obesity and a previously described syndemic relationship [10]. Despite advances in understanding this association, the link between obesity and the clinical course of the disease in the Colombian population, particularly regarding admission to the Intensive Care Unit (ICU), has yet to be fully established [11].

Some studies have explored the association between obesity and the severity of COVID-19 infection, focusing on the influence of obesity on systemic inflammatory response [12], immune dysfunction, and predisposition to metabolic diseases [13]. Despite these advances, the specific relationship between obesity and ICU admission remains an area requiring further investigation [13,14].

It is essential to understand how obesity may contribute to the likelihood of ICU admission in individuals with Non-Communicable Chronic Diseases (NCDs), especially in the context of clinical management of COVID-19 patients [15]. Early identification of these risk factors is crucial for improving early detection and guiding more effective management strategies [16]. Therefore, this study aimed to evaluate the association between obesity and early ICU admission in hospitalized COVID-19 patients, with the goal of contributing to a better understanding of the factors influencing the disease's prognosis.

3. MATERIALS AND METHODS

An ambispective cohort study was conducted at a tertiary level hospital in Santander, Colombia, between March 29, 2020, and September 27, 2021. The metropolitan area is made up of Floridablanca, Girón, Piedecuesta, and Bucaramanga, with approximately 1,224,257 habitants. The study included all patients ≥ 18 years old, admitted to the ER with respiratory suggestive symptoms and a positive RT-PCR for COVID-19. The following patients were excluded:

- Those who arrived at the ER without *vital* signs or who underwent triage/pre-admission but died before being admitted and evaluated by a doctor
- Those who were diagnosed post-mortem
- Patients with incomplete medical histories
- Those who declined to participate; and
- Those who could not be contacted

3.1. Procedures

Baseline characteristics of the entire cohort and a detailed description of the procedures were previously published [17]. Trained physicians made electronic medical record review and telephonic interviews for patients who were still alive; in those patients who had passed away, only electronic medical record was used to gather data. Limesurvey were used for data managing to reduce missing entries and enable real-time data validation [18]. Recollected variables include sociodemographic characteristics, clinical factors, smoking status, need for hospitalization, and received treatments.

3.2. Statistical Analysis

Qualitative variables were described using absolute and relative frequencies, while quantitative variables were analyzed using measures of central tendency and dispersion. Normality was assessed using the Shapiro-Francia test. The chi-square test was applied to categorical variables, and the U-Mann–Whitney test was used for continuous variables to identify potential differences between patients who required ICU admission and those who did not.

For the bivariate analysis concerning ICU admission, a Kaplan-Meier survival curve was constructed, and a Log-Rank test was performed to estimate differences in survival between independent variables. A Cox proportional hazards model was then developed, reporting Hazard Ratios (HR) with their corresponding 95% confidence intervals. The proportionality assumption of the model was tested using the Schoenfeld and Martingale tests. A significance level of 5% was considered. All analyses were conducted using R statistical software, version 4.4.1 GUI 1.80 Big Sur Intel build.

3.3. Sample Size

We determined the sample size based on the findings of a study by Díaz JJS, et al. [19], which reported an HR of 1.47 for ICU admission. A 95% confidence level and 80% power were considered, requiring a total of 191 patients per study group.

3.4. Ethical Considerations

This study received ethical approval from the Ethics and Research Committee of the Fundación Oftalmológica de Santander (reference REC: 08892/2023) and was classified as risk-free research according to Resolution 8430 of 1993. The study was conducted in accordance with the principles of the Declaration of Helsinki, and all participants provided informed consent.

4. RESULTS

A total of 734 patients were included in the study, of whom 28.34% had a Body Mass Index (BMI) of 30 kg/m^2 or higher, classifying them as obese. Among the participants, 53.81% were male, with a mean age of 60.77 years (SD: 5.20). The median age was 63 years for normal-weight or overweight patients, and 59 years for obese patients (Table 1).

A higher incidence of Cardiovascular Disease (CVD), such as heart failure (4.77%) and stroke (2.45%), was observed in obese patients compared to non-obese patients. Additionally, diabetes mellitus was more prevalent among obese patients (26.44%) compared to non-obese patients (21.48%).

Obese patients had a mean BMI of 30.0 kg/m^2, whereas non-obese patients had a mean BMI of 24.4 kg/m^2. The median length of hospital stay was similar in both groups, with 8 days for each. During the 45-day follow-up

period, 24.8% of patients required ICU admission. Kaplan-Meier survival analysis revealed a 67% survival rate at 22 days from the onset of symptoms and a 54.1% survival rate at 27 days (Figure 1).

In the bivariate analysis of ICU admission, significant differences were observed in comorbidity variables (Table 2). Obese patients were found to have a significantly higher risk of ICU admission, with a Hazard Ratio (HR) of 1.51 (95% CI: 1.11 - 2.06), compared to those with a BMI <30 kg/m^2. Additionally, male gender was also significantly associated with ICU admission, with an HR of 1.71 (95% CI: 1.26 - 2.32).

Table 1: Sociodemographic Characteristics.

Variables n (%)	No ICU Requirement	ICU Requirement		p value
	552 (75.20%)	182 (24.80%)	734 (100%)	
Median Age (IQR)	61 (72-51)	61.5 (71-50)	61 (71-51)	0.655
Women	273 (49.46)	66 (36.26)	339 (46.19)	0.002
Men	279 (50.54)	116 (63.74)	395 (53.81)	
Ischemic Heart Disease	35 (6.34)	11 (6.04)	46 (6.27)	0.886
Heart Failure	31 (5.89)	4 (1.92)	35 (4.77)	0.023
Stroke	16 (2.90)	2 (1.10)	18 (2.45)	0.173
COPD	37 (6.70)	5 (2.75)	42 (5.72)	0.046
Diabetes	127 (23.01)	41 (22.53)	168 (22.89)	0.894
Dyslipidemia	130 (23.55)	31 (17.03)	161 (21.93)	0.065
Hypothyroidism	95 (17.21)	29 (15.93)	124(16.89)	0.69
Hypertension	245(46.58)	108 (51.92)	353 (48.09)	0.192
Rheumatic Disease	22 (3.99)	6 (3.30)	28 (3.81)	0.674
Chronic Kidney Disease	41 (7.43)	18(9.89)	59 (8.04)	0.289
Obesity	146 (26.45)	62 (34.07)	208 (28.34)	0.048
Median Charlson Comorbidity Score (IQR)	2 (4-1)	2 (4-1)	2 (4-1)	0.571
Median Length of Hospital Stay (IQR)	6 (9-4)	25 (65-13)	8 (5-13)	<0.001

P-value of the Chi2, or Mann Whitney U test.

Table 2: Bivariate Analysis Log Rank Independent Variables.

Variable	P
Age	0.8819
Sex	**0.0011**
Ischemic cardiovascular disease	0.7545
Heart failure	0.577
Cerebrovascular Accident (CVA)	0.1979

Peripheral vascular disease	0.1184
Chronic Obstructive Pulmonary Disease (COPD)	**0.0333**
Asthma	0.1339
Diabetes	0.8336
Obesity	**0.0043**
Dyslipidemia	0.0699
Hypothyroidism	0.3850
Arterial hypertension	0.8338
Rheumatic diseases	0.5649
Cancer	0.6616
Chronic Renal Disease (CRD)	0.4086
Hepatopathy	0.7189
Cirrhosis	0.4409
Neurological disease	0.0574

P Value from the Log Rank Test.

Abbreviations: ICU - Intensive Care Unit; BMI - Body Mass Index; NCDs- Non-Communicable Diseases; CVA; Stroke

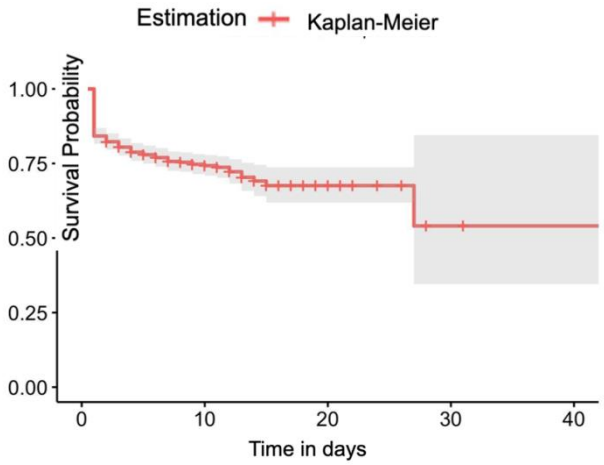

Figure 1S: Survival Curve.

5. DISCUSSION

Our ambispective cohort study provides detailed insight into the relationship between obesity and the risk of early admission to the Intensive Care Unit (ICU) in patients with COVID-19. We found that 28.34% of the patients were obese, a figure that aligns with previous studies conducted in Colombia and other Latin American regions, which have also reported a similar prevalence of obesity among COVID-19 patients [20,21].

In addition to the increased risk of ICU admission in obese patients, our study revealed that obese patients had a higher prevalence of comorbidities, such as cardiovascular diseases and diabetes mellitus, compared to those with a BMI <30 kg/m^2. This finding is consistent with the existing literature that has identified obesity as an

important risk factor for the development of severe complications and other chronic non-communicable diseases [22,23].

Most obese patients in our study were men, an observation that underscores the importance of considering gender as an additional risk factor in disease progression among COVID-19 patients [24]. Previous epidemiological studies have suggested that men may have a different immune response to viral infections, as well as a higher prevalence of comorbidities that could increase the risk of severe disease [25].

Another significant finding from our study was the association between obesity and earlier ICU admission. Obese patients showed a tendency to require intensive care more rapidly during the illness, highlighting the importance of close monitoring and appropriate management for this patient population [26]. Furthermore, this result emphasizes the need for specific preventive and management strategies for obese patients to reduce the burden on intensive care units and improve clinical outcomes [26,27].

These findings are consistent with the literature that identified obesity as a significant risk factor for the severity of viral respiratory infections, including influenza, Respiratory Syncytial Virus (RSV), and parainfluenza. Additionally, studies have shown that obese individuals not only have a higher predisposition to develop respiratory infections but also experience a prolonged duration of infection, severe clinical presentations, and poorer outcomes, suggesting greater disease burden in this group of patients [28]. In a ambispective study on influenza conducted in Detroit, obese patients were found to have a significantly higher likelihood of requiring hospitalization and experiencing prolonged hospital stays compared to non-obese individuals; moreover, although obese patients showed fewer obvious signs of pulmonary involvement, such as wheezing and hypoxia, this not implies less disease severity, as five of the six deaths in the study were recorded among individuals with obesity [29].

These findings underscore the need for a comprehensive and careful approach to managing viral respiratory infections in obese patients due to their higher risk of adverse outcomes. It is important to note that the interaction between obesity and factors such as physical activity and dietary patterns may influence susceptibility and severity of these infections, as well as a deregulated immune response. This highlights the need for comprehensive and tailored management for this high-risk population [28].

6. CONCLUSION

Our study provides a significant contribution to understanding the relationship between obesity and the severity of COVID-19. Our results demonstrate that obesity is strongly associated with an increased risk of early admission to the Intensive Care Unit (ICU) and a higher risk of morbidity and mortality; findings that were consistent with the known clinical course of other viral respiratory infections.

These findings underscore the need to develop preventive and management strategies, as well as timely, focused and multidisciplinary care approach, for obese patients with viral respiratory infections, aiming to reduce the augmented burden of disease in this group.

However, it is crucial to recognize the limitations of our study, which include its ambispective design and its conduct at a single center, potentially limiting the generalizability of the results. Therefore, further prospective

and multicenter studies are required to validate these findings and to explore in more depth the underlying mechanisms of this association.

7. FUNDING

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