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Excessive weight as a risk factor for COVID-19 severity – A retrospective study

El exceso de peso como factor de riesgo de gravedad del COVID-19: estudio retrospectivo

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ABSTRACT

Introduction: obesity is related to cardiovascular disease (CVD) and metabolic disease, and is associated to worsening infectious conditions. In Brazil, more than 50 % of the population is overweight and the obesity prevalence is rising. Since the beginning of the coronavirus pandemic (COVID-19, coronavirus disease 2019), more than 600 million people have been infected, resulting in more than 6.5 million deaths.

Objective: this study aimed at evaluating the association between excess weight and clinical prognosis in COVID-19 patients.

Method: longitudinal and retrospective cohort study carried out in a hospital in Southern Brazil. Patients were separated into two groups: thinness/eutrophy and overweight/obesity; and demographic, clinical nutritional, biochemical and outcome data were collected from medical records.

Results: the average age was 59.3 years, 53.3 % were men and 66.3 % were overweight. The thin/eutrophic group was significantly older and had a higher prevalence of CVD and other comorbidities. The overweight group had significantly more visits to the Intensive Care Unit (ICU). Excess weight, when associated to ICU admission, increased the death risk

by 4.16 times, as well as being independently associated to longer ICU visits, the use of mechanical ventilation (MV) and invasive MV, increasing the occurrence of these outcomes by around 30 %.

Conclusion: ICU admission was significantly associated to mortality and the strength of this association depended on the presence or absence of overweight/obesity.

Keywords: COVID-19. SARS-CoV-2. Obesity. Overweight. Prognosis.

RESUMEN

Introducción: la obesidad está relacionada con enfermedades cardiovasculares (ECV) y metabólicas y se asocia con el empeoramiento de las condiciones infecciosas. En Brasil, más del 50 % de la población tiene sobrepeso y la prevalencia de la obesidad está aumentando. Desde el inicio de la pandemia de coronavirus (COVID-19, enfermedad por coronavirus 2019), más de 600 millones de personas han sido infectadas, lo que ha provocado más de 6,5 millones de muertes.

Objetivo: este estudio tuvo como objetivo evaluar la asociación entre el exceso de peso y el pronóstico clínico en pacientes con COVID-19.

Método: estudio de cohorte longitudinal y retrospectivo realizado en un hospital del Sur de Brasil. Los pacientes fueron separados en dos grupos: delgadez/eutrofia y sobrepeso/obesidad; y se recopilaron datos demográficos, nutricionales clínicos, bioquímicos y de resultados de los registros médicos.

Resultados: la edad promedio fue de 59,3 años, el 53,3 % eran hombres y el 66,3 % tenían sobrepeso. El grupo delgado/eutrófico era significativamente mayor y tenía una mayor prevalencia de ECV y otras comorbilidades. El grupo con sobrepeso tuvo significativamente más visitas a la Unidad de Cuidados Intensivos (UCI). El exceso de peso, cuando se asoció al ingreso en UCI, aumentó 4,16 veces el riesgo de muerte, además de asociarse de forma independiente con visitas más prolongadas a UCI, el uso de ventilación mecánica (VM) y VM invasiva, aumentando la ocurrencia de estos desenlaces en alrededor de un 30 %.

Conclusión: el ingreso en la UCI se asoció significativamente con la mortalidad y la fuerza de esta asociación dependió de la presencia o ausencia de sobrepeso/obesidad.

Palabras clave: COVID-19. SARS-CoV-2. Obesidad. Sobrepeso. Pronóstico.

INTRODUCTION

Since March 2020, when the World Health Organization (WHO) declared the coronavirus pandemic (COVID-19, coronavirus disease 2019), caused by the SARS-CoV-2 virus (severe acute respiratory syndrome — related to coronavirus 2), first identified in 2019 in China (1), more than 600 million people have been infected, resulting in more than 6.5 million deaths worldwide (2). Obesity is seen as a risk factor for the increased severity of COVID-19 since the pandemic beginning.

Obese patients are at increased risk of contracting infectious diseases due to impaired innate and adaptive immune responses, as well as associated conditions (impaired respiratory mechanics, subcutaneous tissue homeostasis and comorbidities) which may be indirectly related to the onset and/or worsening of these conditions (3-5).

Overweight (body mass index-BMI ≥ 25 and < 30 kg/m²) and obesity (BMI ≥ 30 kg/m²) affect many people around the world. In 2016, 39 % of adults were overweight and 13 % were obese worldwide (6). Brazil, like other Western countries, has higher rates, with prevalence of 57.2 % and 22.4 % of overweight and obesity, respectively (7). Obesity is associated to heart and metabolic diseases such as cardiovascular disease (CVD) and type 2 diabetes mellitus (DM2), as well as musculoskeletal disorders and some types of cancer (6).

A recent meta-analysis (3,140,413 patients; 167 studies) found that obesity was associated to a 52 % higher risk of severe COVID-19, as well as 9 % higher mortality among patients (8).

Another meta-analysis (54 studies, 10 different countries) found a 33 % obesity prevalence among COVID-19 patients. In addition, obese individuals were 2.4 times more likely to be affected by COVID-19 (odds ratio, OR = 2.42; 95 % confidence interval, CI = 1.58-3.70) and 1.6 times more likely to progress to severe forms of the disease (OR = 1.62; 95 % CI, 1.48-1.76), with obesity being a risk factor for hospitalization, use of mechanical ventilation (MV), admission to the Intensive Care Unit (ICU) and death (OR; 95 % CI: 1.75 [1.47-2.09]; 2.24 [1.70-2.94]; 1.75 [1.38-2.22]; 1.23 [1.06-1.41]) (9).

Many studies have shown that COVID-19 patients who are overweight or obese develop a severe clinical course and that obesity is associated to an increased risk of mortality (10-13). However, most of these studies have limitations and the specific risk factors involved in the evolution of disease severity and outcomes, including mortality, are still uncertain.

Considering that Brazil is the fifth country in the world in terms of the number of COVID-19 cases, that it is among the 15 countries with the highest mortality from the disease (2) and that the Brazilian population has a prevalence of 57.2 % overweight and 22.4 % obesity (7), this study aimed at evaluating the association between excess weight and COVID-19 in clinical outcomes, hospital discharge and mortality, in patients admitted to a hospital (metropolitan region Porto Alegre city, Rio Grande do Sul state, Brazil).

METHODS

Study design

This retrospective cohort study was carried out in a hospital (metropolitan region Porto Alegre city, Rio Grande do Sul state, Brazil). Data from electronic medical records of adult patients over the age of 18, admitted from April 2020 to January 2022, with a diagnosis of COVID-19, laboratory-confirmed through the RT-PCR test (Reverse Transcription Polymerase Chain Reaction) and those with weight and height records to classify BMI, were included. Data from patients

with respiratory diseases (asthma, chronic obstructive pulmonary disease — COPD and tuberculosis), Down's Syndrome, pregnant and breastfeeding women were excluded.

The sample was calculated using the WinPEPI program (Programs for Epidemiologists for Windows) version 11.43 and based on the study by Du et al. (10). Considering a significance level of 5 %, power of 80 %, an estimated mortality rate of 8 %, and an OR of 2.68 for obese patients, a minimum total of 342 patients was defined (171 in each group): group 1 - eutrophic patients and group 2 - overweight patients.

However, after the data collection, the sample size for the eutrophic group was not reached, even after extending the collection period until January 2022. Therefore, the initial design was changed and thin patients were grouped with eutrophic patients and overweight patients were grouped with obese patients, leaving group 1 (thin and eutrophic) and group 2 (overweight and obese). This new grouping took into account the variables (outcomes): ICU, MV, invasive MV, oxygen support (O2), hemodialysis, sepsis, death and hospital discharge, in relation to nutritional status, classified as thin, eutrophic, overweight and obese.

This study was approved by Ethics Committee for Research of Universidade do Vale do Rio dos Sinos – UNISINOS, protocol number 5.048.412, December 09, 2020.

Data collection

Data collection included nutritional data (weight, height and BMI); demographics (age and gender); clinical information (signs, symptoms, comorbidities) and outcomes (ICU, MV, invasive MV, O2 support, hemodialysis, sepsis, death and hospital discharge). BMI was calculated using the weight recorded in the medical records divided by the height squared. For adults aged 18 to 59, the WHO classification was used (14) and for elderly individuals aged 60 and over, BMI was classified according to the cut-off points proposed by PAHO (15), (Pan American Health Organization).

Thinness/eutrophy group included COVID-19 patients, aged between 18 and 59 years, classified according to the WHO (14) as thin (BMI < 18.5 kg/m²) and eutrophic (BMI ≥ 18.5 and < 25 kg/m²) and elderly patients aged 60 years and over, with low weight (BMI < 23 kg/m²) and eutrophic (BMI ≥ 23 kg/m² and < 28 kg/m²), according to PAHO (15).

Overweight/obesity group included COVID-19 patients, aged between 18 and 59, classified according to the WHO (14) as overweight (BMI ≥ 25 and < 30 kg/m²) and obese (BMI ≥ 30 kg/m²) and elderly patients aged 60 or over, with excess weight (BMI 28 to 29.9 kg/m²) and obesity (BMI ≥ 30 kg/m²), according to PAHO (15).

Statistics analysis

The data collected was coded into an Excel spreadsheet and analyzed. Quantitative variables were described by mean and standard deviation or median and interquartile range. Categorical variables were described by absolute and relative frequencies.

Means were compared using the Student’s t-test. In case of asymmetry, the Mann-Whitney test was used. Pearson's chi-square or Fisher's exact tests were used for comparing proportions.

For controlling confounding factors, the Poisson regression model was used to assess the independent prediction of overweight in the outcomes studied. The criterion for entering the multivariate model was that the variable had a *p*-value of < 0.10 in the bivariate analysis.

The significance level adopted was 5 % ($p < 0.05$) and the analyses were carried out using the SPSS program version 21.0 (SPSS, Statistical Package for Social Science) (16).

RESULTS

During the collection, 1,426 patients were diagnosed with COVID-19. Sample was made eligible by applying inclusion and exclusion criteria. In phase 1 of data collection, data from 69 children and adolescents (under 18) and 662 patients who were not hospitalized were excluded. In phase 2, 78 patients with asthma, COPD, tuberculosis and Down's syndrome and 7 pregnant women were excluded. In phase 3, data from 2 patients in palliative care, 7 with negative PCR for COVID-19, 156 without BMI or weight and height records and 6 without biochemical test records were excluded. The final sample include data from 445 patients. The sample selection and eligibility flowchart are described in figure 1.

The mean age in the total sample was 59.3 years (standard deviation, SD ± 16.3), which is different from the study by Page-Wilson et al. (17) who found a mean age of 64 years (interquartile range, IQR, 52-75) in their study of 1,109 participants with COVID-19. Iaccarino et al. (18), in a cohort of 2,378 patients with the disease, found a mean age of 68.2 years (SD ± 0.38).

Regarding the nutritional status, thinness was found in 10.1 %; $n = 45$, eutrophy in 23.6 %; $n = 105$, overweight in 18.4 %; $n = 82$ and obesity in 47.9 %; $n = 213$.

Thin/healthy group represented 33.7 % of the sample; overweight/obese group, 66.3 %. Mean BMI values for the total sample and for the thin/eutrophic and overweight/obese groups were 30.87 kg/m² ± 8.05, 23.64 kg/m² ± 2.8 and 34.55 kg/m² ± 7.33, respectively.

Overweight/obese group had a mean age of 54.1 years (SD ± 15.1 years), which was significantly younger than the lean/healthy group (69.8 years SD ± 13.4 years).

Male proportion was higher in the total sample (53.3 %), as well as in both groups, 54.2 % in the overweight/obese group and 51.3 % in the thin/eutrophic group.

Demographic data, clinical and nutritional characteristics are shown in table I.

As for the signs and symptoms during hospitalization, the overweight/obese group had significantly more dyspnea (77.3 % vs. 56.7 %, $p < 0.001$), headache (20 % vs. 10.7 %, $p = 0.019$), ageusia (6.4 % vs. 0.7 %, $p = 0.011$) and anosmia (5.4 % and 0 %, $p = 0.008$) when compared to the lean/healthy group.

With regard to comorbidities, systemic arterial hypertension (SAH) was the most prevalent (61.3 %), when considering the total sample, followed by DM2 (39.8 %), other diseases (25.1 %), CVD (17.5 %), chronic renal disease-CRD (3.6 %), cancer (2.5 %), immunosuppression (1.1 %) and liver disease (0.9 %). Patients in the lean/healthy group had a

significantly higher prevalence of CVD (25.3 % vs. 13.6 %, $p = 0.003$) and other comorbidities (32.7 % vs. 21.4 %, $p = 0.013$) when compared to those in the overweight/obese group.

In terms of outcomes, a total of 49 % of patients were admitted to the ICU, 56.4 % used MV, 40.9 % invasive MV and 72.8 % required O2 support, 18.2 % required hemodialysis and 13.2 % had sepsis. In addition, 57.1 % of patients were discharged from hospital and 39.1 % died during hospitalization.

Overweight /obese group had significantly more ICU visits ($p = 0.045$) when compared to those in the lean/eutrophic group. There was a statistically significant association between the outcomes (discharge, death and transfers) and overweight/obesity ($p = 0.018$) and, after analyzing the adjusted residuals, a higher proportion of deaths was observed in patients with thinness/eutrophy when compared to those in the overweight/obesity group (46.7 % vs. 35.3 %). However, in the multivariate analysis, which assessed whether excess weight was an independent factor associated to the outcomes, adjusting for age, dyspnea, CVD and other diseases, a 9 % increase in the risk of death was observed in the overweight/obese group, although this number was not significant. Furthermore, overweight/obesity was an independent risk factor associated to ICU, the use of MV and invasive MV, increasing the occurrence of these outcomes by around 30 %.

As for clinical complications, the thin/healthy group required more hemodialysis, while the overweight/obese group had more sepsis, although there were no significant differences. The data related to nutritional status and the outcomes studied are shown in table II.

Although excess weight did not prove to be an independent factor in the occurrence of mortality, it did interact with ICU admission. ICU admission was significantly associated to mortality, with 65.6 % of patients admitted to the ICU dying and only 13.7 % of those who did not go to the ICU having this outcome ($p < 0.001$). The strength of this association depended on the presence or absence of excess weight ($p < 0.001$), with patients who were overweight/obese and went to the ICU having a 4.16 times greater risk of death compared to those who were not overweight and went to the ICU (RR = 4.16; 95 % CI: 1.87-9.25).

Table III and figure 2 show the data about the assessment of overweight/obesity as an independent factor associated to the outcomes studied.

DISCUSSION

This study showed that excess weight was an independent risk factor associated to the need for ICU care ($p = 0.044$), MV ($p = 0.014$) and invasive MV ($p = 0.042$), supporting the findings of other previously published studies (19,11,20). In a cohort study of 684 patients hospitalized with COVID-19, 73 % of them were classified as overweight and obese and had a significantly 2- and 2.4-times higher risk of intubation, respectively (12). Hendren et al. (11), in a multicenter study in the United States (7,606 COVID-19 patients) found that the higher the degree of obesity, the greater the risk of using MV. In addition, obese individuals had a higher risk of thrombosis and the need for hemodialysis. Another study also found that severe obesity (BMI ≥ 35 kg/m^2), age, male gender and smoking were significant predictors of an increased need

for oxygenation (13). When observing COVID-19 patients, Lighter et al. (20) found that younger individuals (< 60 years old) who were obese grades I and II had a 1.8 and 3.6 times greater risk of ICU admission, respectively, compared to non-obese individuals. However, Albarrán-Sánchez et al. (22) found no differences in the risk ratio for the use of MV or for ICU admission by BMI category.

Since the pandemic beginning, several studies have shown a higher risk of mortality in obese individuals (10-13). In our study, after multivariate analysis, although excess weight was not an independent risk factor for mortality, when associated to ICU admission, the risk of death increased 4.16 times in this condition. Supporting this finding, this group also had significantly more ICU visits ($p = 0.045$). A retrospective, multicenter study carried out in Brazil by Paravidino et al. (21), evaluated the association between obesity and mortality, according to age groups, based on the analysis of data from 8,183 COVID-19 patients admitted to an ICU. The results showed that patients with severe obesity had an increased risk of mortality (RR = 1.21; 95 % CI: 1.03-1.43) when compared to eutrophic or overweight individuals, supporting the findings of the study by Page-Wilson et al. (17), in which the chances of death were higher among individuals with a BMI ≥ 40 kg/m² (OR, 2.05; 95 % CI, 1.04-4.04).

On the other hand, Paravidino et al. (21) found that among patients aged ≥ 60 years, mild/moderate obesity was associated to a reduced risk of mortality (RR = 0.87; 95 % CI: 0.78-0.97). Singh et al. (8), in a systematic review with meta-analysis (167 studies, 3,140,413 patients) showed, as the main result, an association between obesity and an increased risk of COVID-19 severity, ICU admission or the need for invasive MV (RR = 1.52; 95 % CI: 1.41-1.63), as well as mortality (RR = 1.09, 95 % CI: 1.02-1.16).

The high number of overweight/obese patients found in this study ($n = 295$; 66.3 %) supports the results of the Vigitel 2021 study, where Porto Alegre city was classified as the fourth Brazilian capital with the highest overweight prevalence (62.16 %) and the fifth highest with obesity (22.6 %) among adults (7). In other studies, including COVID-19 patients, carried out in the United States and Mexico, similar prevalence was found for overweight and obesity, as in the studies by Page-Wilson et al. (17), with 1,019 patients, by Albarrán-Sánchez et al. (22), with 608 participants and by Palaiodimos et al. (13), with 200 individuals, showing prevalence of overweight and obesity of 75.2 %, 78.3 % and 81 %, respectively. An American multicenter cohort of 7,606 patients found an overweight/obesity prevalence of 73 %, significantly represented by individuals under the age of 50 and with grade III obesity (11).

In this study, SAH and DM2 were the most frequent comorbidities and there were no significant differences between the thin/healthy and overweight/obese groups. A higher frequency of these comorbidities has also been found in other cohort studies (13,17).

Albarrán-Sánchez et al. (22) (608 patients) showed that patients with at least one of the comorbidities (obesity, DM2 and SAH) had a significantly higher risk of mortality (OR, 1.786; 95 % CI, 1.165-2.73). In a meta-analysis (30 studies, 6,560 COVID-19 patients), hypertension was associated to increased mortality, progression to severe disease, severe acute respiratory syndrome and ICU admission.

These results seem to be related to the higher expression of angiotensin-converting enzyme (ACE-2) in hypertensive patients, due to the associated genetic polymorphism and the use of ACE inhibitors or angiotensin receptor blockers, which could increase the susceptibility and severity of the disease (23).

In our study, the thin/eutrophic group had a higher CVD prevalence and other diseases when compared to the overweight/obese group. Although high BMI is an important risk factor for the occurrence of chronic noncommunicable diseases (NCDs) (6), especially CVDs, it is possible that this finding could be justified by the older average age of the thin/obese group (69.8 vs. 54 years old), since older individuals tend to have more comorbidities.

Although there is evidence that high BMI values are associated to higher mortality and disease severity in COVID-19 patients, this index cannot distinguish between visceral and subcutaneous fat.

Pranata et al. (24) in a systematic review and meta-analysis (5 studies, 539 patients), investigated the association between visceral adiposity, subcutaneous fat and severe forms of COVID-19, based on data obtained by abdominal computed tomography of the areas of visceral, subcutaneous and total fat. Results showed that visceral fat area was associated to severe forms of COVID-19 (OR, 1.9; 95 % CI, 1.1 - 2.2; I^2: 49.3 %), when compared to subcutaneous adiposity.

This finding can be explained by chronic low-grade inflammation, which affects innate and adaptive immune responses, respiratory function and pulmonary perfusion, in addition to the metabolic and vascular complications caused by obesity (25). In addition, SARS-CoV-2 has a high affinity for the host cell's ACE-2, which is essential for infection.

In addition to being found in heart, kidney and lung tissues, ACE-2 is highly expressed in adipose tissue (4). Although there are few experimental studies to explain the effect of weight loss on reducing subcutaneous adipose ACE-2 expression, the positive impact of targeted weight loss on improving insulin sensitivity is already well known, a situation that may be relevant in the context of the negative regulation of ACE-2 by SARS-CoV-2 (26).

In this study, the overweight/obese group had a mean age of 54.1 years (SD ± 15.1 years), which was significantly younger than the lean/eutrophic group (69.8 years, SD ± 13.4 years). This same finding was found by Page-Wilson et al. (17), the overweight/obese group was younger when compared to those with a BMI < 25 kg/m². We also found no significant difference between genders.

Raeisi et al. (9), in their meta-analysis (54 studies), found that the association between obesity and all outcomes was not affected by gender or age. Iaccarino et al. (18) study (2,378 COVID-19 patients) showed that the main predictors of ICU admission were male gender, obesity, hypertension and chronic renal disease ($p < 0.05$ for all variables).

This study has some limitations, such as: 24 % of the medical records did not contain patients' weight and height, reducing the total sample and BMI data, probably due to a reduction in the number of nutritional assessments carried out in hospitals, especially at the start of the COVID-19 pandemic; the low number of patients classified as eutrophic, which made it impossible to follow the initial design, which was to compare outcomes between eutrophic patients and those who were overweight/obese.

Perhaps collecting data from a larger number of patients would have made it possible to reach the expected sample of eutrophic patients and thus better assess the outcomes in both groups. Furthermore, although BMI is a widely used marker due to its low cost and practicality in hospitals, its isolated assessment is limited since this parameter does not take into account visceral and subcutaneous fat.

CONCLUSION

Although overweight did not prove to be an independent risk factor for mortality, it was associated to longer ICU stays, MV and invasive MV, increasing the occurrence of these outcomes by around 30 %. ICU admission was significantly associated to mortality and the strength of this association depended on the presence or absence of overweight/obesity.

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Table I. Patient demographics and clinical characteristics.

Variables	**Total Sample (*n* = 445; 100 %)**	**Thin/Eutrophic (*n* = 150; 33.7 %)**	**Overweight/Obesity (*n* = 295; 66.3 %)**	***p***
Demographic and clinical data				
Age (years) – mean ± SD	59.3 ± 16.3	*69.8 ± 13.4*	*54.1 ± 15.1*	*< 0.001**
Gender – *n* (%)				0.631†
Male	237 (53.3)	77 (51.3)	160 (54.2)	
Signals and symptoms – n (%)				
Dyspnea	313 (70.3)	*85 (56.7)*	*228 (77.3)*	*< 0.001†*
Tachypnea	8 (1.8)	3 (2.0)	5 (1.7)	1.000‡
Anorexia	51 (11.5)	23 (15.3)	28 (9.5)	0.095†
Dry cough	192 (43.1)	58 (38.7)	134 (45.4)	0.208†
Fatigue	125 (28.1)	38 (25.3)	87 (29.5)	0.417†
Expectoration	13 (2.9)	3 (2.0)	10 (3.4)	0.557†
Diarrhea	39 (8.8)	10 (6.7)	29 (9.8)	0.348†
Myalgia	118 (26.5)	33 (22.0)	85 (28.8)	0.154†
Nausea	35 (7.9)	8 (5.3)	27 (9.2)	0.219†
Headache	75 (16.9)	*16 (10.7)*	*59 (20.0)*	*0.019†*
Dysphagia	5 (1.1)	2 (1.3)	3 (1.0)	1.000‡
Odynophagia	2 (0.4)	1 (0.7)	1 (0.3)	1.000‡
Hypotension	6 (1.3)	4 (2.7)	2 (0.7)	0.186‡
Ageusia	20 (4.5)	*1 (0.7)*	*19 (6.4)*	*0.011†*
Anosmia	16 (3.6)	*0 (0.0)*	*16 (5.4)*	*0.008†*
Comorbidities – n (%)				
DM1	5 (1.1)	1 (0.7)	4 (1.4)	0.667†
DM2	177 (39.8)	67 (44.7)	110 (37.3)	0.161*
SAH	273 (61.3)	94 (62.7)	179 (60.7)	0.761†
CVD	78 (17.5)	*38 (25.3)*	*40 (13.6)*	*0.003†*
CRD	16 (3.6)	8 (5.3)	8 (2.7)	0.256†
Hepatic Disease	4 (0.9)	2 (1.3)	2 (0.7)	0.606‡
Immunosuppression	5 (1.1)	3 (2.0)	2 (0.7)	0.341‡
Cancer	11 (2.5)	6 (4.0)	5 (1.7)	0.194‡
Others	112 (25.2)	*49 (32.7)*	*63 (21.4)*	*0.013†*

SD: standard deviation; CVD: cardiovascular disease; CRD: chronic renal disease; SAH: systemic arterial hypertension.

**Student t-test*; †Pearson's chi-square test; ‡Fisher exact test. Source: authors.

Table II. Nutritional status and outcomes studied

Variables	**Total sample (*n* = 445; 100 %)**	**Thin/Eutrophic (*n* = 150; 33.7 %)**	**Overweight/Obesity (*n* = 295; 66.3 %)**	***p***
ICU care – n (%)	*218 (49.0)*	*63 (42.0)*	*155 (52.5)*	*0.045**
MV / O2				
MV – *n* (%)	251 (56.4)	78 (52.0)	173 (58.6)	0.217*
Invasive MV – *n* (%)	182 (40.9)	53 (35.3)	129 (43.7)	0.109*
O2 – *n* (%)	324 (72.8)	110 (73.3)	214 (72.5)	0.949*
Clinical complications – n (%)				
Hemodialysis	81 (18.2)	29 (19.3)	52 (17.6)	0.756*
Sepsis	58 (13.0)	18 (12.0)	40 (13.6)	0.754*
Outcomes – n (%)				*0.018**
Discharge	254 (57.1)	78 (52.0)	176 (59.7)	
Death	174 (39.1)	70 (46.7)	104 (35.3)	
Transfer	17 (3.8)	2 (1.3)	15 (5.1)	

*Chi-square test, # statistically significant association by the adjusted residuals test at 5 % significance level. Source: authors.

Table III. Overweight/Obesity and study outcomes

Variables	**Overweight/Obesity**	***p***
	RR (95 % CI)*	
ICU care	*1.28 (1.01-1.62)*	*0.044*
MV / O2		
MV	*1.28 (1.05-1.57)*	*0.014*
Invasive MV	*1.33 (1.01-1.74)*	*0.042*
O2	0.91 (0.79-1.04)	0.154
Clinical complications		
Hemodialysis	1.31 (0.82-2.11)	0.258
Sepsis	1.32 (0.74-2.34)	0.352
Primary outcome		
Death	1.09 (0.85-1.39)	0.485

*Adjusted for age, dyspnea, CVD and other diseases. Multivariate Poisson regression analysis. Source: authors.

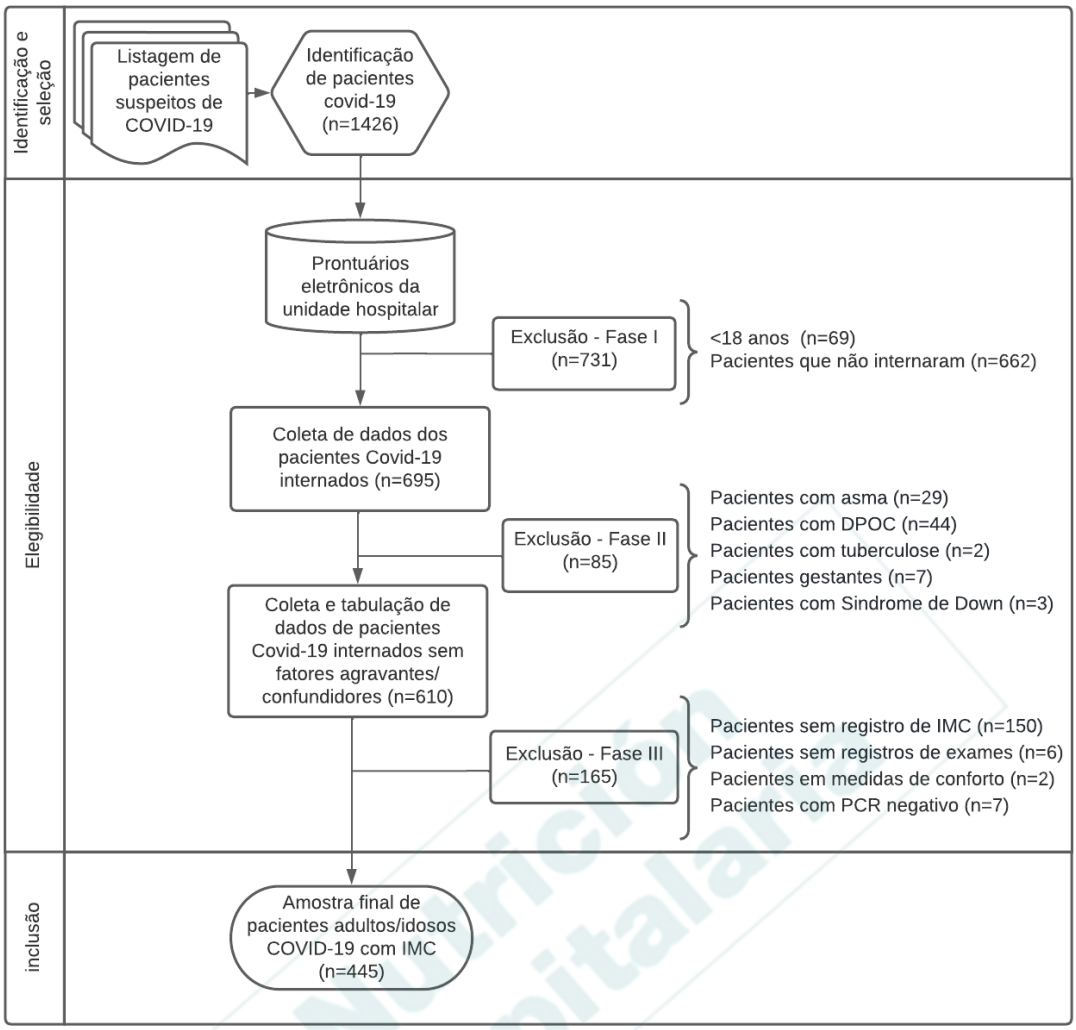

Figure 1. Sample selection and eligibility flowchart (source: authors).

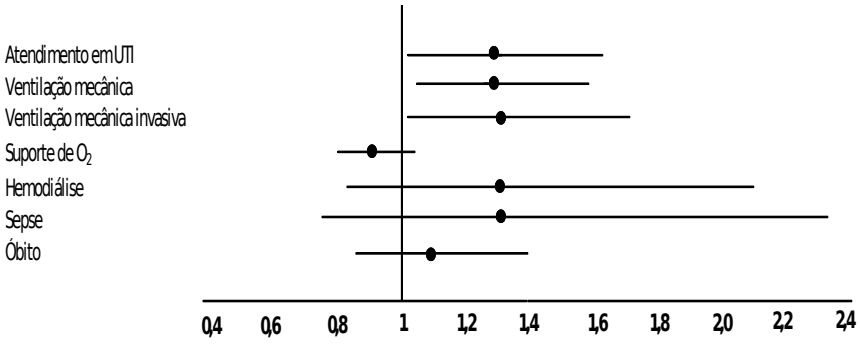

Figure 2. Adjusted relative risk of overweight as an independent factor associated with the outcomes studied (adjusted for age, dyspnea, CVD and other diseases. Multivariate Poisson regression analysis. Source: authors).