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Obesity and COVID-19: an Italian snapshot

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ABSTRACT

Objective: The clinical manifestations of COVID-19 run from asymptomatic disease to severe acute respiratory syndrome. Older age and comorbidities are associated to more severe disease. A role of obesity is suspected.

Methods: We enrolled patients hospitalized in the medical COVID-19 ward with SARS-CoV-2 related pneumonia. Primary outcome of the study was to assess the relationship between the severity of COVID-19 and obesity classes according to BMI.

Results: 92 patients (61.9% males; age 70.5±13.3 years) were enrolled. Patients with overweight and obesity were younger than normal-weight patients (68.0±12.6 and 67.0±12.6 years vs. 76.1±13.0 years, $p<0.01$). A higher need for assisted ventilation beyond pure oxygen support (Invasive Mechanical Ventilation or Non-Invasive Ventilation) and a higher admission to intensive or semi-intensive care units was observed in patients with overweight and obesity ($p<0.01$ and $p < 0.05$, respectively) even after adjusting for sex, age and comorbidities ($p<0.05$ and $p<0.001$, respectively), or when patients with dementia or advanced cancer were removed from the analysis ($p<0.05$).

Conclusion: Patients with overweight and obesity admitted in a medical ward for SARS-CoV-2 related pneumonia, despite their younger age, required more frequently assisted ventilation and access to intensive or semi-intensive care units than normal weight patients.

What is known

1. COVID-19 is a respiratory disease caused by the new coronavirus SARS-CoV-2. The disease emerged in China and caused a global pandemic.
2. Clinical manifestations of COVID-19 run from asymptomatic disease to severe acute respiratory syndrome, with older age and the presence of comorbidities reported as risk factors for more severe disease.
3. A role of obesity in determining the severity of COVID-19 manifestations has been suspected, but more data about the association between obesity and COVID-19 are still needed.

What is new

1. Overweight and obesity were frequent in a cohort of patients admitted in an internal medicine ward dedicated to the care of COVID-19.
2. Patients with overweight and obesity admitted in the COVID-19 internal medicine ward for SARS-CoV-2 pneumonia were than 10 years younger than patients with normal weight.
3. Patients with overweight and obesity, despite their younger age, required more frequently assisted ventilation and they are more prone to be admitted to intensive or semi-intensive care units.
4. Patients with overweight and obesity had a higher need for non-invasive ventilation during

SARS-CoV-2 pneumonia than normal-weight patients without dementia or cancer.

What will change

1. Patients with overweight and obesity are at higher risk for more severe COVID-19, even after adjustment for age, sex and comorbidities.
2. Patients with overweight and obesity should follow very strictly prevention measures during the current pandemic disease and they need to be monitored more closely in case of infection.

INTRODUCTION

In December 2019, a new coronavirus causing a severe acute respiratory syndrome (SARS-CoV-2) emerged in Wuhan, China (1). The virus spread rapidly worldwide affecting many other countries during the first months of year 2020. In Italy, by February 15th, 2020, only 3 cases of coronavirus disease 2019 (COVID-19) were identified in people who recently traveled to China. However, on February 20th, 2020, a severe case of pneumonia due to SARS-CoV-2 was diagnosed in a young man living in northern Italy's Lombardy region, without any possibility of exposure abroad. Since then, the epidemic spread very rapidly in our country, with a total of 156.363 cases and 19.901 deaths registered up to April 13, 2020 (2).

The clinical manifestations of COVID-19 run from asymptomatic disease to severe acute respiratory infection requiring hospitalization and oxygen support, up to admission to an intensive care unit for assisted ventilation (3). Older age and the presence of comorbidities have been reported as risk factors for more severe disease and death both in China (3,4) and in Italy (5). In particular, in Chinese COVID-19 patients the prevalence of diabetes and hypertension was 20% and 30%, respectively (4,6). According to a recent meta-analysis, diabetes may not increase the risk of SARS-CoV-2 infection but can worsen its outcome (7). Diabetes and hypertension are typical complications of overweight and obesity. In addition, obesity was recognized as an independent risk factor for systemic complications from influenza during the 2009 H1N1 pandemic (8). Although obesity was not listed among the comorbidities associated to SARS-CoV-2 infection, a possible role of obesity in determining the severity of COVID-19 manifestations has been suspected (9). Very recently, a French study demonstrated a high frequency of obesity among patients admitted in intensive care unit for SARS-CoV-2 related pneumonia, with disease severity

increasing with body mass index (BMI) (10). Nonetheless, more data on this possible association are still needed.

In this study, we report the prevalence of overweight and obesity in Italian patients hospitalized for SARS-CoV-2 related pneumonia in an internal medicine ward entirely dedicated to COVID-19 patients during the Italian outbreak of the disease. The association between increased BMI and the severity of the disease was also evaluated.

METHODS

Study Setting

Veneto is an Italian region with about 5 million inhabitants located in the north east of the country, very close to Lombardy. Initial cases of COVID-19 in Veneto region were detected shortly after the first Italian ones and the outbreak spread rapidly, with 14.432 confirmed cases, 4.430 hospitalizations, and 800 deaths reported until April 14, 2020 (11). The burden for the Regional Health Care Service increased rapidly reaching a peak of 2.068 patients hospitalized for COVID-19 in April 1, 2020, 350 of whom in Intensive Care Units (ICUs) (11). Initially, our hospital addressed the outbreak through the beds available in the ICUs for patients requiring invasive mechanical ventilation (IMV), in a semi-intensive respiratory unit for patients requiring non-invasive assisted ventilation (NIV), and in the Infectious Disease Unit for patients requiring only oxygen support. As the number of cases increased, the Hospital reacted by increasing the number of beds in ICUs and in the semi-intensive unit and by transforming some of the Internal Medicine Units in COVID-19 wards. Our 50 beds Internal Medicine Unit (Clinica Medica 3) was transformed in a COVID-19 ward in March 14, 2020. Since then, our ward received COVID-19 patients requiring oxygen support from the Emergency Department and from the ICUs and the semi-intensive respiratory unit, in a continuous exchange of patients according to their modifying requirements for different levels of intensity of care. Discharge could occur through quarantine at home or in one of the community hospitals specifically identified by the Region. Criteria for discharge, as agreed for all the COVID-19 units of our Hospital, were the followings: oxygen saturation >93% without oxygen support in the last 48 hours; no fever in the last 48 hours;

respiratory rate < 22 acts/min; no worsening findings at chest x-ray; duration of the disease >7 days; oxygen saturation >92% during a six minutes walking test.

Study patients and data collection

For the present study, we analyzed the clinical data of all patients hospitalized in our COVID-19 ward from March 23 (when we start to collect systematically anthropometric data) to April 11, 2020. All patients were positive to an oropharyngeal swab used for a real-time reverse transcriptase–polymerase chain reaction assays specific for SARS-CoV-2 and they were diagnosed with COVID-19 pneumonia. Data were extracted from the electronic clinical documentation and patient confidentiality was protected by assigning an anonymous identification code. The following data were included in the database: sex, age, height, weight at hospital admission, BMI, days between the onset of symptoms and the hospital admission, previous comorbidities (cancer, dementia, type 2 diabetes, hypertension, cardio-vascular diseases, chronic respiratory diseases, chronic kidney diseases, chronic liver diseases, chronic inflammatory diseases), most intensive form of ventilatory support required during the hospital stay (IMV, NIV, oxygen support), most intensive setting of care required during the hospital stay (ICUs, semi-intensive respiratory unit, medical ward), death, hospital discharge (at home or in a community hospital), and duration of hospital stay.
For a further assessment of the severity of COVID-19, two additional separate indicators were considered: 1) Need for IMV at any time during the hospital stay; 2) Need for NIV at any time during the hospital stay. Patients were classified according to their BMI in three categories as normal-weight (< 25 kg/m^2), overweight (from 25 to < 30 kg/m^2) and obesity (≥ 30 kg/m^2).

Statistical analysis

All variables were tested by normal Test (Shapiro-Wilk test) and Equal Variance Test (Brown-Forsythe). One Way Analysis of Variance was used when Normality Test and Equal Variance Test have been passed (data are presented as mean values ± standard deviations). Chi-square test (or Fisher's exact test) was carried out for categorical variables and data were expressed as frequency (percentage). Different multiple logistic models were performed considering as dependent (dichotomous) variables: Assisted Ventilation (NIV+MV = 1), versus only oxygen support (= 0),

considered as the most intensive ventilation; Semi-Intensive Care Unit (SEMI) plus Intensive Care Unit (ICUs) versus Medical Ward (SEMI+ICUs = 1, Medical Ward = 0); death (=1) versus no death (=0). We analyzed two models (A and B) for each dependent variable. In model A we included as independent variables obesity categories (overweight and obesity, ≥25 Kg/m^2, versus normal weight, BMI < 25 Kg/m^2), age (years) and sex (male =1, female = 2); in model B, comorbidities were entered as independent variables beyond obesity categories, age and sex. The small sample size included in this study precluded the analysis of the role of each baseline comorbidities as independent predictor of outcomes in multiple logistic regression. Thus, we chose to analyze the presence of comorbidities resulting statistically different among the three population according BMI (respiratory chronic diseases and dementia), and type 2 diabetes, suggested to be a negative prognostic factor for SARS-CoV-2 infection outcome (7). A p-value level < 0.05 was considered significant. All statistical analyses were performed with the Systat Software SigmaPlot v.14.

RESULTS

A total of 92 patients stayed at least one day in the COVID-19 medical ward from March 23 to April 11, 2020. At the end of this study period, 50 patients (54.4%) had been discharged from the hospital (36 at home and 14 in a community hospital), 12 (13.0%) died and 30 (32.6%) were still hospitalized in our ward or in other departments of the hospital (ICU, semi-intensive respiratory unit or Infectious Disease Unit). Mean total duration of the hospital staying was 14.6 ± 8.6 days (range 3-41 days) for patients discharged from the hospital and 10.8 ± 10.4 days (range 1-33 days) for the patients who died during hospitalization. The baseline characteristics, the clinical data during hospitalization and the outcomes of the patients are reported in **Table 1**. The patients were predominantly males (61.9%), and their mean age was 70.5 ± 13.3 years (range: 40 to 96 years). Baseline comorbidities burden was relevant. Assisted ventilation (NIV + IMV) beyond pure oxygen support was used in 34 patients (37.0%), with 9 patients requiring IMV and 25 patients NIV. A total of 35 patients (38.0%) were treated during hospitalization in more intensive settings than the internal medicine COVID-19 ward, with 16 patients requiring admission to an ICU and 19 patients requiring admission to the semi-intensive respiratory unit.

Mean BMI in our study population was 27.2 ± 4.6 kg/m^2 (range: 17.7 to 40.8 kg/m^2). Distribution

into the three BMI classes was: 32 patients (34.8%) normal-weight, 31 (33.7%) overweight and 29 (31.5%) affected by obesity. Only one patient had severe obesity (BMI ≥40 kg/m^2) and was included in the obesity class. The baseline characteristics, the clinical data during hospitalization and the outcomes of the patients in the three BMI classes are compared in **Table 2**. Male gender was more prevalent in patients with overweight and obesity than in normal-weight patients ($p<0.05$). Normal-weight patients were more than 10 years older than patients with higher BMI ($p<0.01$) and 43.7% of them had dementia, with a statistically significant different from the other two subgroups ($p<0.001$). Furthermore, the presence of respiratory chronic diseases displayed a strong difference among the three classes ($p<0.01$) with obesity category showing the most prevalence. Assisted ventilation (NIV + IMV) beyond pure oxygen support was used in 15.6% of normal-weight patients, in 54.8% of patients with overweight and in 41.4% of patients with obesity ($p<0.01$), with most of the difference being linked to an increased use of NIV ($p<0.05$). More intensive settings (ICUs or semi-intensive respiratory unit) than the internal medicine COVID-19 ward was requested by 18.7% of patients in the normal-weight group, by 54.8% of patients in the overweight group and by 41.3% of patients with obesity ($p<0.05$). Death rate was significantly higher in the normal-weight group (31.2%) than in patients with overweight (no deaths) or obesity (6.9%) ($p<0.001$).

Thus, with the aim to analyze the most intensive ventilatory support, the most intensive setting and the mortality, adjusting the differences among the BMI categories, we developed multiple logistic regression models (**Table 3**). We analyzed two models (A and B) for each dependent dichotomous variable. In model A we included as independent variables obesity categories (overweight and obesity, ≥25 Kg/m^2, versus normal weight, BMI < 25 Kg/m^2), age and sex; in model B, comorbidities were entered as independent variables beyond obesity categories, age and sex. The association of the BMI categories with the need of Assisted Ventilation (NIV+IMV) as the most intensive ventilation versus only oxygen support remained statistically significant ($p<0.05$; OR 4.19; IC95% 1.36-12.89) in a multiple regression analysis in which age and sex were entered as independent variables (model A). Interestingly, when also comorbidities were included (model B), BMI categories continued to be significant ($p<0.05$; OR 3.62; IC95% 1.09-11.97). The differences among the most intensive setting (SEMI+ICUs versus medical ward) were confirmed also in model A ($p<0.001$; OR 11.65; IC95% 3.88-34.96) and model B ($p<0.001$; OR 12.46; IC95% 3.48-44.54).

The statistically significant differences of death rate among BMI classes disappeared in model A in which the effects of sex and age were taken into account, with age being the only factor associated to death ($p<0.01$; OR 1.21; IC95% 1.05-1.39). When we included comorbidities, age stopped to be linked to mortality.

IMV was requested at any time during the hospital stay in 9 patients (9.8%) and NIV in 34 (37.0%). The proportion of patients who required IMV or NIV at any time during the hospital stay according to BMI classes is reported in **Figure 1A**. No significant differences were observed in the proportion of patients requiring IMV (6.2% in normal-weight patients, 16.1% in patients with overweight and 6.9% in patients with obesity). The proportion of patients requiring NIV at any time during the hospital stay was lower in normal-weight patients (15.6%) than in patients with overweight (54.8%) or obesity (41.4%) ($p<0.01$). The proportion of patients receiving some form of assisted ventilation in the normal-weight group could be lowered by the high prevalence in this group of frail elderly patients with dementia or advanced cancer, in which intensive ventilatory support was deemed not appropriate, and that died in the medical COVID-19 ward. Therefore, we repeated this analysis removing 22 patients with dementia or advanced cancer (**Figure 1B**). No deaths were reported in this subgroup. In this subgroup, no differences were observed in the proportion of patients receiving IMV between the three BMI classes (14.3%, 17.2%, and 8.7%, respectively) whereas the prevalence of patients receiving NIV remained lower in normal-weight patients (28.6%) than in patients with overweight (55.2%) or obesity (43.5%) ($p<0.05$).

DISCUSSION

In this descriptive cross-sectional study, we illustrated the baseline characteristics, the clinical data and the outcomes of a cohort of patients hospitalized with a diagnosis of SARS-CoV-2 related pneumonia in a dedicated medical ward of a large University Hospital located in the Veneto Region, Italy. The cohort was an unselected group of patients representing the real life situation of patients hospitalized in our ward. Obesity and overweight were present in two thirds of patients. Patients with overweight and obesity were younger than patients with normal weight, they required more frequently respiratory support beyond simple oxygen (IMV and NIV), and they were more frequently admitted to ICUs and semi-intensive respiratory unit. Older normal-weight patients were more frequently affected by dementia and they had a higher mortality rate. The need

for assisted ventilation and an increased admission to ICUs and SEMI remained more prevalent in patients with overweight and obesity than in normal weight patients after adjustment for age, sex and comorbidities. In particular, NIV use was demonstrated to be lower in normal-weight patients, even though patients with dementia or advanced cancer were removed from the analysis.

The prevalence of overweight and obesity in patients hospitalized for SARS-CoV-2 related pneumonia was 65.2% (33.7% for overweight and 31.5% for obesity, respectively). The last reported prevalence of overweight and obesity in adults 18-69 years old in the Veneto Region was 40.0% (30.4% for overweight and 9.6% for obesity), with a progressive increase in prevalence when age increases (12). According to these epidemiologic data, age-adjusted expected prevalence of overweight and obesity in our sample would be 39.6% and 15.3%, respectively (chi-square expected vs observed prevalence = 6.8285; $p<0.05$). Therefore, obesity, in particular, seems over-represented in our COVID-19 group of patients than in the general population of our Region. However, the small sample included in our study limits the reliability of this observation. In a single French center, obesity was significantly more prevalent among 124 patients admitted in intensive care for SARS-CoV-2 than in historical controls admitted for no SARS-CoV-2 related respiratory distress (47.6% vs 25.2%) (10).

The patients with overweight and obesity admitted in our COVID-19 internal medicine ward for SARS-CoV-2 related pneumonia were 10 years younger than patients with normal weight admitted in the same ward with the same diagnosis and in the same period. In a recent pre-publication report, Petrilli et al. reported that age and obesity were among the most important risk markers for having symptoms severe enough to warrant hospitalization in 4.103 patients with COVID-19 in New York City (13). In our study, patients with overweight and obesity, despite their younger age, required more frequently assisted respiratory support and they were more prone to be admitted to intensive or semi-intensive care unit. The association with an increased need of assisted ventilation and a greater admission in ICUs and SEMI remained significant even after adjustment for age, sex and comorbidities. Moreover, patients with overweight and obesity required more frequently NIV even if compared to normal-weight patients without dementia or cancer. Our results are consistent with the findings of the French study, in which the proportion of patients who required IMV increased with BMI categories, and it was greatest in patients with BMI >35kg/m^2 (10).

In our study, death rate was higher in normal-weight patients than in patients with overweight or obesity. This difference was totally explained by a difference in age, as confirmed by the regression model in which the effect of BMI categories was adjusted by age. Most of the deaths observed in this group occurred indeed in very old frail elderly patients with disability and multiple comorbidities, including dementia and cancer. When we included the presence of dementia in the regression model, we did not find a significant difference, even though the role of the age disappeared, probably due to the small size of our cohort. Frailty is a strong predictor of short-term survival in older adults with or without comorbidities (14). We can suggest that the normal weight observed in this subgroup might be considered an indirect marker of sarcopenia and/or undernourishment in a setting of increased requirements linked to the presence of a severe acute inflammatory status. In Italy, more than 50% of the deaths related to the SARS-CoV-2 epidemic occurred in patients >80 years old (15). Adequacy of nutritional support might be a crucial aspect in the subgroup of older patients with dementia or cancer hospitalized for COVID-19 (16).

Patients with overweight and obesity enrolled in our study are mostly represented by middle-aged men. The constraint of the clinical work in a confined ward precluded an assessment of fat distribution, but we can speculate that majority of these patients were affected by visceral obesity. Currently, the mechanisms linking overweight and obesity to a more severe SARS-CoV-2 related pneumonia remain speculative. Obesity is associated to sleep apnea syndrome and to a restrictive ventilatory pattern, as well as to surfactant dysfunction, which might contribute to severe acute respiratory syndrome during COVID-19 (16). Moreover, patients with central obesity and insulin resistance, as well as patients with type 2 diabetes, are frequently characterized by a chronic state of low grade inflammation, with increased levels of interleukin 6 (IL-6) and other pro-inflammatory cytokines. This chronic activation of the inflammatory pathways could induce an impaired immune-response and an increased susceptibility to infections (7). Recent reports suggest that the pro-coagulant pattern of patients with severe COVID-19 may justify the high rate of thromboembolic complications and pulmonary embolism during the course of the disease (18). We cannot exclude that overweight and obesity could explain a more severe COVID-19 considering that obesity *per se* is characterized by a disturbed haemostatic balance with increased coagulation and impaired fibrinolysis which could trigger thrombosis (19). In our study, we did

not observe a worsening of the severity of COVID-19 with the increase in BMI class (obesity versus overweight). This could be attributed to a protective effect of more severe obesity ("obesity paradox"), or to the fact that the association between overweight and obesity and severity of SARS-CoV-2 related pneumonia could be mediated by factors not related to BMI. Further studies may contribute to a better understanding of the mechanisms explaining the link between visceral obesity and COVID-19 complications.

Our study presents several limitations. Our sample was relatively small and heterogeneous, limiting the power of the study ~~and precluding a more sophisticated statistical analysis~~. In particular, we were not able to analyze if each obesity-related comorbidity influences the association between overweight and obesity and the severity of COVID-19. This is clearly a very relevant question that would require larger sample. On the other hand, we tried to test the presence of three important comorbidities in our population (respiratory chronic diseases, type 2 diabetes and dementia), even though we know the not large meaningful of the results. Moreover, the study was centered on patients admitted to a dedicated internal medicine ward and this probably excluded some patients with the most severe manifestations of SARS-CoV-2 infection. However, our ward works in strict contact with ICUs and the semi-intensive respiratory unit and many of our cases were represented by patients originally admitted to more intensive clinical setting and then transferred to our ward after stabilization and partial recovery. Therefore, our sample covers the full spectrum of disease severity and provide some information about the characteristics of patients with less severe disease not included in previous studies limited to an intensive care setting (10).

In conclusion, our study and other available evidences suggest that patients with overweight and obesity have a higher risk of more severe clinical symptoms during SARS-CoV-2 infection. Patients with overweight and obesity require more frequently hospitalization (13), and we showed a greater admission in intensive and semi-intensive care units, independent by age. Furthermore, patients with overweight and obesity present a more frequent need of assisted ventilation during SARS-CoV-2 related pneumonia, as demonstrated in our study, and more frequently need IMV when in the ICUs (10). Finally, we could suggest that patients with overweight and obesity should be considered in a higher risk class and therefore be protected at most from infection and monitored more closely in case of SARS-CoV-2 related pneumonia.

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Data sharing statement: The original data source used for this study is not publicly available, since they are part of the personal clinical documentation of the individual patients enrolled in the study and they are protected by Italian privacy protection laws. An anonymized electronica database specific for this study is stored and locked in our center and available upon request.

Conflict of Interest: The authors declare no conflict of interest.

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Table 1. Baseline characteristics, clinical data during hospitalization and outcomes in 92 patients hospitalized for SARS-CoV-2 related pneumonia in a COVID-19 medical ward.

Demographics and anthropometry		
Male sex	57 (61.9%)	
Age, years	70.5 ± 13.3	Range: 40 – 96
BMI, kg/m^2	27.2 ± 4.6	Range: 17.7 – 40.8
Baseline comorbidities		
Type 2 diabetes	28 (30.4%)	
Hypertension	59 (64.1%)	
Cardio-Vascular Diseases	29 (31.5%)	
Respiratory Chronic Diseases	12 (13.0%)	
Renal Chronic Diseases	5 (5.4%)	
Liver Chronic Diseases	5 (5.4%)	
Inflammatory Chronic Diseases	6 (6.7%)	
Cancer	12 (13.0%)	
Dementia	17 (18.5%)	
Most intensive ventilatory support		
Invasive Mechanical Ventilation	9 (9.8%)	
Non-Invasive Ventilation	25 (27.7%)	
Oxygen support	58 (63.0%)	
Most intensive setting of care		
Intensive Care Units	16 (17.4%)	
Semi-intensive respiratory unit	19 (20.6%)	
Medical ward	57 (70.0%)	
Outcome		
Death	12 (13.0%)	

Hospital discharge	50 (54.4%)

Data are presented as mean ± standard deviations for continuous variable and as frequency (percentage) for categorical variables. BMI: Body Mass Index.

Table 2. Baseline characteristics, clinical data during hospitalization and outcomes in 92 patients hospitalized for SARS-CoV-2 related pneumonia in a COVID-19 medical ward according to BMI classes.

	NORMAL (n = 32)	**OVERWEIGHT (n = 31)**	**OBESITY (n = 29)**	**p**
Demographics and anthropometry				
Male sex	53.1 %	61.3 %	72.4 %	< 0.05
Age, years	76.1 ± 13.0	68.0 ± 12.6	67.0 ± 12.6	< 0.01
BMI, kg/m^2	22.3 ± 1.9	27.4 ± 1.5	32.4 ± 2.6	< 0.001
Baseline comorbidities				
Type 2 diabetes	28.1 %	25.8 %	37.9 %	0.300
Hypertension	56.2 %	67.7 %	69.0 %	0.513
Cardio-Vascular Diseases	31.2 %	29.0 %	34.5 %	0.901
Respiratory Chronic Diseases	6.2 %	3.2 %	31.0 %	< 0.01
Renal Chronic Diseases	12.5 %	6.4 %	0 %	0.142
Liver Chronic Diseases	3.1 %	9.7 %	3.4 %	0.440
Inflammatory Chronic Diseases	9.4 %	9.7 %	0 %	0.228
Cancer	18.7 %	6.4 %	13.8 %	0.346
Dementia	43.7 %	0 %	10.3 %	< 0.001
Most intensive ventilatory support				
Invasive Mechanical Ventilation (IMV)	6.2 %	16.1 %	6.9 %	0.343
Non-Invasive Ventilation (NIV)	10.3 %	38.7 %	34.5 %	<0.05
Oxygen support	84.5 %	45.2 %	58.6 %	<0.01
Assisted ventilation (NIV + IMV)	15.6%	54.8%	41.4%	<0.01
Most intensive setting of care				
Intensive Care Units (ICUs)	6.2 %	22.6 %	24.1 %	0.119

Semi-intensive Unit (SEMI)	12.5 %	32.2 %	17.2 %	0.132
Medical ward	81.3 %	48.2 %	58.6 %	<0.05
ICUs+ SEMI	18.7%	54.8%	41.3%	<0.05
Outcome				
Death	31.2 %	0 %	6.9 %	<0.001
Hospital discharge	43.7 %	64.5 %	55.2 %	<0.001

Data are presented as mean ± standard deviations for continuous variable and percentage for categorical variables. A p-value level < 0.05 was considered significant. BMI: Body Mass Index.

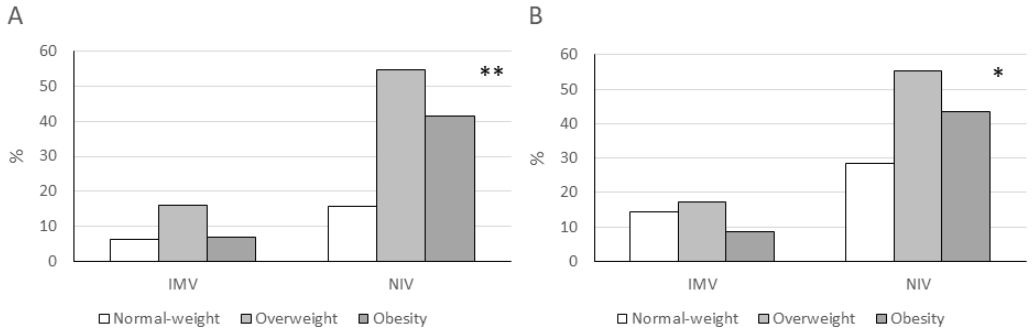
Table 3. Different multiple logistic regression models considering as dependent variables: Assisted Ventilation [Non-Invasive Ventilation (NIV) plus Invasive Mechanic Ventilation (IMV)], versus only oxygen support (NIV+IMV = 1, only oxygen support = 0), considered as the most intensive ventilation; Semi-Intensive Care Unit (SEMI) plus Intensive Care Units (ICUs) versus Medical Ward (SEMI+ICUs = 1, Medical Ward = 0); death (=1) versus no death (=0). We analyzed two models (A and B) for each dependent variable. A p-value level < 0.05* was considered significant. BMI: Body Mass Index.

independent variables		dependent (dichotomous) variables					
		NIV+IMV vs only oxygen		SEMI+ ICUs vs medical ward		death vs no death	
		p	OR (IC 95%)	p	OR (IC 95%)	p	OR (IC 95%)
Model A	BMI categories ≥25 Kg/m² vs <25 Kg/m²	0.012*	4.19 (1.36-12.89)	<0.001*	11.65 (3.88-34.96)	0.204	0.27 (0.03-2.05)
	age (years)	0.091	0.97 (0.93-1)	0.180	0.97 (0.93-1.01)	0.007*	1.21 (1.05-1.39)
	sex (male =1, female =2)	0.682	1.22 (0.47-3.17)	0.240	0.54 (0.19-1.52)	0.346	2.51 (0.37-16.94)
Model B	BMI categories ≥25 Kg/m² vs <25 Kg/m²	0.035*	3.62 (1.09-11.97)	<0.001*	12.46 (3.48-44.54)	0.375	0.26 (0.01-5.20)
	age (years)	0.246	0.98 (0.94-1.02)	0.110	0.96 (0.92-1.01)	0.182	1.11 (0.95-1.29)
	sex (male =1, female =2)	0.604	1.29 (0.49-3.42)	0.278	0.56 (0.19-1.61)	0.334	3.49 (0.28-43.98)

	Respiratory Chronic Diseases vs no	0.580	1.48 (0.37-5.88)	0.111	4.86 (0.69-33.96)	0.157	9.8 (0.41-230.38)
	Type 2 Diabetes vs no	0.332	0.59 (0.2-1.71)	0.784	0.84 (0.25-2.81)	0.553	2.06 (0.19-22.44)
	Dementia vs no	0.394	0.45 (0.07-2.79)	0.584	0.84 (0.25-2.81)	0.059	15.81 (0.9-277.43)

FIGURE LEGEND

Figure 1. Proportion of patients who required invasive mechanical ventilation (IMV) or non-invasive assisted ventilation (NIV) at any time during the hospital stay according to BMI classes. Data were calculated in all patients (panel A) and in patients without cancer and/or dementia only (panel B). Statistical analysis was performed with Chi-squared test (**$p<0.01$, *$p<0.05$).



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