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The impact of comorbidities and obesity on the severity of COVID-19 and risk factors for mortality: a prospective study in hospitalized patients

The impact of comorbidities and obesity on the severity of COVID-19 and risk factors for mortality: a prospective study in hospitalized patients

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KEY WORDS
Obesity; BMI; comorbidities; COVID-19; severity; mortality; risk factors

Abstract

Background- The studies of the clinical and demographic characteristics of COVID-19 patients around the world have made it possible to observe a rich semiology, which implicated obesity as a factor in the severity of COVID-19 pneumonia, and can lead to intensive care or even death. Some biomarkers have been identified as risk factors for mortality. The aim of this study was to verify obesity and the risk factors for mortality of COVID-19 infection.

Methods- This was a single-center prospective study carried out at Rouiba University Hospital, between March 19, 2020 to September 30, 2021. The clinical data were collected: age (year), BMI groups (≥ 30 and <30 kg / m2), sex, active smoking, medical history, clinical complaints, peripheral oxygen saturation (SpO2) at admission, and the length of hospital stay. A standard laboratory assessment and a chest CT without a contrast agent were performed. The prognostic was verified, and the healing, death, or transfers to intensive care were noted, and the data was analyzed.

Résultats-Our results showed an obesity rate (26.8%) and a mortality rate (5.3%) and found that obesity increases the risk of severity but not mortality in hospitalized patients. The risk factors for death from COVID-19 were the underlying chronic diseases including diabetes, COPD, renal failure and cardiovascular disease, hypoxia on admission, elevated serum LDH, CRP, and D-Dimer levels.

Conclusion-The inclusion of obesity and risk factors in therapeutic management strategies and prognostic scores will be essential to improve the prognosis of hospitalized COVID-19 patients.

1. Introduction

The SARS-CoV-2 coronavirus pneumonia outbreak was classified as a pandemic by the World Health Organization in March 2020 [1]. COVID-19 is causing extensive expressions ranging from mild upper respiratory tract symptoms to acute respiratory distress syndrome (ARDS), hypercoagulability, and cytokine storm [2]. However, the analysis of the clinical and demographic characteristics of COVID-19 patients around the world has made it possible to observe a rich semiology, which differs from one region to another and an estimated mortality rate of 3.2% [3].

Current literature suggests that complications from obesity potentially increase the severity of COVID-19, particularly in people under the age of 60 years [4]. Previous studies have shown the link between obesity as a potential aggravating factor in COVID-19 pneumonia [5] increased hospitalizations [6, 7], and the risk of invasive mechanical ventilation [8]. Various mechanisms may be involved, namely restrictive ventilatory deficit, lipotoxicity and induction of a pro-inflammatory state [9].

Other studies suggest that overweight and obese patients have a higher risk of serious illness during SARS-CoV-2 infection [10-13]. Overweight or obese patients require more frequent hospitalizations in intensive and semi-intensive care units, regardless of age. In addition, overweight and obese patients have a more frequent need for assisted ventilation due to SARS-CoV-2 pneumonia [8].

This assumes that obesity influences clinical manifestations and may contribute to disease progression and is considered potentially a prognostic factor of COVID-19 infection [14]. Algeria like the rest of the world is facing the spread of this pathology, and the first patient carrying this virus was detected on February 25, 2020. Obesity is reaching epidemic proportions in Algeria, and weighs heavily on the system of algerian health. In 2010, the TAHINA study reported a prevalence of total obesity in Algeria of 9.1% in men and 30.1% in women [15].

To effectively fight this epidemic, the algerian health authorities need to identify the risk factors for severe forms of patients hospitalized for COVID-19 [16]. Some authors have suggested that overweight and obese patients should be classified as high risk and should be minimally protected from infection and monitored more closely for SARS-CoV-2 pneumonia [10].

Symptoms of COVID-19 can include fever, cough, breathing difficulties, and organ failure. The severity of the disease can lead patients to intensive care or even death [17]. Old age, certain biomarkers such as LDH and D-Dimer have been identified as risk factors for mortality [18]. The aim of this study was to evaluate the association between obesity and the clinical, biological, CT, and prognosis profile of algerian patients hospitalized for COVID-19.

2. Pateints & methods

Study design

This study is the third part of a project analyzing clinical, biological and radiological data from algerian patients with COVID-19. The first part published, consists of a descriptive study , the second part concerned the analysis of the clinical, biological and radiological severity factors of algerian patients hospitalized for COVID-19: comparison between patients with normal and low pulsed oxygen saturation of hemoglobin (SpO2). As a large part of the methodology of this study was previously described [19, 20], only the main points of the methodology will be treated in this paper.

This was a single-center prospective study, which was carried out at Rouiba University Hospital, Algiers (Algeria) (period: March 19,2020 to september 30, 2021). Only patients with a positive diagnosis of COVID-19 [real-time PCR, antigen test [21-24] and pulmonary CT signs compatible with the infection were included in the study. Lack of BMI on admission was a non-inclusion criterion.

Data sources

The following clinical data were collected from a pre-established observation sheet and hospitalized patient records: age (year), BMI groups (≥ 30 and <30 kg / m2), sex, active smoking, notion of contact with a suspected / confirmed case of COVID-19, medical history, clinical complaints, peripheral oxygen saturation (SpO2) at admission, length of hospital stay.

Body weight was measured, height was self-reported, and indeed it was difficult to measure the height of the patients due to the clinical condition of the patients and to prevent any risk of SARSCoV-2 transmission.

Body mass index (BMI) was calculated using the usual formula (weight [kilograms] / height squared [square meters]) and categorized into five standard groups on the basis of National Heart Lung and Blood Institute criteria [25]: Insufficient BMI, <18.5 kg / m2; reference category, 18.5 kg / m2 at <25 kg / m2; overweight, 25 kg / m2 to <30 kg / m2; and obesity was defined as a BMI ≥30 kg / m2.

A standard laboratory assessment and a chest CT without a contrast agent were performed[19]. The prognostic was verified, and the healing, death, or transfers to intensive care were noted.

Statistical analysis

Quantitative and qualitative data were expressed as means ± standard deviations, and number (%), respectively. Missing data were removed from statistical analyzes [26]. Student's T-test and Pearson's Chi-square test were used to compare quantitative and qualitative data from the two groups, respectively. The results were entered using the statistica software (Statistica Kernel version 6; Stat Soft. France). A significance level <5% was retained.

3. Results

Among the 705 patients hospitalized and confirmed COVID-19, in the Department of pulmonology, 194 were excluded because anthropometric data was missing at admission. The 511 patients selected were divided into two groups: obese-group (137 patients) and non-obese group (374 patients).

Clinical profile and medical complaints

Table 1 exposes the characteristics and medical background of patients. Compared to the non-obese group, the obese-group included higher percentages of females (p<0.001), patients aged < 50 years (p=0.01), and the obese group was ~ 4-years younger (p=0.02). Included lower percentage of smokers (p=0.013), have higher percentage of hypertension (p=0.023) and have similar medical background.

Table 2 exposes the clinical complaints and physical exam' data of patients. The two groups have similar clinical complaints and similar physical exam' data (except for dyspnea: compared to the non-obese group, the obese-group included a higher percentage of patients with dyspnea, with anosmia and her with hemoptysis), and lower oxygen saturation level at admission.

Table 3 presents the biological (ESR and CRP) and hematological data of patients. The two groups had similar biological and hematological data and included similar percentage of patients having anemia, polycythemia, lymphopenia, basocythemia, hyperleukocytosis, thrombocytopenia, thrombocytosis, biological inflammatory syndrome, high CRP or ESR, but a lower level of leucopenia.

Table 4 presents the biochemical data of patients. Compared to the non-obese group, the obese-group have a higher value of LDH, a higher value of sodium, and to a lesser degree AST and creatinine.

Table 5 presents the CTs' data of patients, length of hospitalization and patients' issues.The two groups have radiological data without significant differences, except for the CT extension of more than 75% more marked in the obese group. The two groups have a similar duration of hospitalization also have an equal frequency of death and include identical percentages of patients transferred to intensive care.

Table 6 exposes the characteristics, and factors associated with in-hospital mortality. Compared to the survivor group, the non-survivor group had higher percentages of men (55.6% vs 47.7%), older ages (69.2 vs 55.4, p<0.0001) and more comorbidities; heart disease (37.0 vs 11.2, p<0.0001), hypertension (44.4 vs 32.4, p=0.197), diabetes (59.3 vs 24.0, p<0.0001), COPD (11.1 vs 1.2, p=0.0001), and chronic kidney disease (11.5 vs 1.5, p0.0003), but the same percentage of asthma (3.7 vs 5.6, p=0.678).

The non-survivor group included a higher frequency of dyspnea (84.6 vs 49.4, p=0.0008) and a lower level of saturation (72.8 vs 91.2, p<0.0001). Based on the biological profile, the non-survivor group included a higher level of polynuclear neutrophils (p=0.004), LDH (0.009), and C-reactive protein (p=0.017), and a higher number of patients with D-dimers greater than 1600 ng/ml (p=0.03) and a higher level of kaliemia(p=0.017). On the other hand, the same group included more patients with an extent of lesions between 50 and 75% (p=0.004), and greater than 75% (p=0.032).

Table 1. Characteristics and medical background of patients

		Total sample (n=511)	G1: BMI ≥ 30 kg/m^2 (n=137)	G2: BMI < 30 kg/m^2 n=374	p
Characteristics					
Sex (female)		265 (51.9)	87 (64)	178 (47)	<0.001**
Age ≥ 50 years		335 (65.6)	258 (57)	77 (69)	0.010**
Age (years)		56±15	53±14	57±16	0.002*
Height (m)		1.68±0.09	1.66±0.09	1.69±0.09	0.045*
Weight (kg)		79±15	93±13	74±11	<0.001*
BMI (kg/m2)		27.8±4.8	33.7±3.5	25.7±3.2	<0.001*
Corpulence Status	Underweight	11 (2)	-	11 (3)	-
	Normal weight	126 (25)	-	126 (34)	-
	Overweight	237 (46)	-	237 (63)	-
	Obesity level-1	101 (20)	101 (74)	-	-
	Obesity level-2	28 (5)	28 (21)	-	-
	Obesity level-3	8 (2)	8 (6)	-	-
Smokers		69 (14)	10 (8)	59 (16)	0.013*
Contact with a suspected/confirmed case of Covid-19		263(52)	71 (52)	192 (52)	0.530
Medical background					
Arterial hypertension		169 (33)	56 (41)	113 (30)	0.023*
Mellitus diabetes		132 (26)	35 (26)	97 (26)	0.929
Chronic respiratory disease and allergy		56 (11)	12 (9)	44 (12)	0.348
COPD		9 (2)	1 (1)	8 (2)	0.284
Asthma		28 (5)	8 (6)	20 (5)	0.829
Heart diseases		64 (13)	17 (12)	47 (13)	0.962
Thyroid diseases		46 (9)	17 (13)	29 (8)	0.093
Cancer		14 (3)	2 (1)	12 (3)	0.292

G: group. BMI: body mass index. Quantitative and categorical data were expressed as mean±standard deviation and number (%), respectively.
P (probability): p< 0.05 (*Student Test, **Two sided Chi-2): G1 vs. G2.

Table 2. Clinical complaints and physical exam' data of patients

	Total sample (n=511)	G1: BMI ≥ 30 kg/m^2 (n=137)	G2: BMI < 30 kg/m^2 n=374	p
Clinical complaints				
Fever	398 (78)	114 (83)	284 (77)	0.344
Cough	385 (75)	107 (79)	278 (74)	0.293
Dyspnea	261 (51)	84 (62)	177 (47)	0.004*
Hemoptysis	14 (3)	7 (5)	7 (2)	0.046*
Sore throat	132 (26)	36 (26)	96 (26)	0.867
Ageusia	190 (37)	59 (43)	131 (35)	0.071
Anosmia	176 (35)	60 (44)	116 (31)	0.007*
Abdominal pain	94 (18)	32 (23)	62 (16)	0.071
Vomiting and / or nausea	119 (23)	36 (26)	83 (22)	0.306
Diarrhea	195 (38)	61 (45)	134 (36)	0.060
Myalgia	303 (59)	90 (66)	213 (57)	0.056
Headache	283 (55)	83 (61)	200 (53)	0.122
Skin lesion	19 (4)	3 (2)	16 (4)	0.280
Asthenia	413 (81)	114 (84)	299 (80)	0.294
Anorexia	300 (59)	89 (65)	211 (56)	0.062
Chest pain	142 (28)	39 (29)	103 (27)	0.752
Eye burn	35 (7)	10 (7)	25 (7)	0.770
Fear of heights	117 (23)	33 (24)	84 (22)	0.629
Rhinorrhea	27 (5)	11 (8)	16 (4)	0.084
Physical exam' data				
Temperature at admission	37.3±0.9	37.4±0.9	37.2±0.9	0.318
Respiratory rate (cpm)	24±8	25±10	23±7	0.051
Heart rate (cpm)	90±16	91±15	89±16	0.176
Oxy-sat (%) at admission	90±10	88±11	91±9	0.004*
Fever (temperature ≥ 37,5°C)	117 (39.4%)	38 (46.91%)	79 (36.57%)	0.105
Tachypnea (respiratory rate > 20 cpm)	210 (60)	60 (69)	150 (57)	0.045*
Tachycardia (heart rate ≥100)	84 (18)	24 (21)	60 (17)	0.419
Bradycardia (heart rate ≤ 60)	8 (2)	1 (1)	7 (2)	0.408
Low oxy-sat (< 92%) at admission	315 (62)	69 (50)	246 (66)	0.002*

G: group. BMI: body mass index. Quantitative and categorical data were expressed as mean±standard deviation and number (%), respectively.
P (probability): p< 0.05 (*Student Test, **Two sided Chi-2): G1 vs. G2.

Table 3. Hematological, ESR and CRP data of patients					
		Total sample (n=511)	G1: BMI ≥ 30 kg/m^2 (n=136)	G2: BMI < 30 kg/m^2 n=375	p
Quantitative data					
Hemoglobin (g/dl)		12.9±1.7	12.8±1.6	12.9±1.8	0.601
Leukocytes (103/mm3)		7995±3931	7910±3429	8026±4102	0.779
Leucocyte count	NPN (103/mm3)	5961±3603	5781±3158	6009±3744	0.627
	EPN (103/mm3)	41±78	30±57	45±84	0.084
	BPN (103/mm3)	131±130	139±137	138±131	0.416
	Lymphocytes (103/mm3)	1184±728	1228±751	1168±743	0.430
	Monocytes (103/mm3)	666±541	688±648	657±514	0.606
Platelets (103/mm3)		262±104	266±118	261±101	0.660
ESR (1st h) (mm)		65±37	68±39	64±37	0.386
CRP (mg/L)		55±59	57±59	53±59	0.656
Patients' profile					
Anemia		154 (35)	36 (31)	118 (37)	0.255
Polycythemia		4 (1)	0 (0)	4 (1)	0.227
Leukopenia		44 (10)	6 (5)	38 (12)	0.040*
Lymphopenia		204 (47)	51 (44)	153 (48)	0.435
Basocythemia		128 (30)	38 (34)	90 (29)	0.335
Hyperleukocytosis		103 (23)	28 (24)	75 (23)	0.886
Thrombocytopenia		50 (11)	13 (11)	37 (12)	0.898
Thrombocytosis		26 (6)	9 (7)	17 (5)	0.352
High CRP		248 (63)	66 (63)	182 (63)	0.932
High ESR (1st h)		263 (82)	66 (81)	197 (82)	0.836
Biological inflammatory syndrome		358 (83)	92 (80)	266 (84)	0.377

BPN: basophilic polynuclear. BMI: body mass index. CRP: C-reactive protein. EPN: eosinophilic polynuclear. ESR: erythrocyte sedimentation rate. G: group. NPN: neutrophilic polynuclear. Quantitative and categorical data were expressed as mean±standard deviation and number (%), respectively.
P (probability): p< 0.05 (*Student Test, **Two sided Chi-2): G1 vs. G2.

Table 4. Biochemical data of patients					
		Total sample (n=511)	G1: BMI ≥ 30 kg/m^2 (n=137)	G2: BMI < 30 kg/m^2 n=374	p
Quantitative data					
Kidney function	Urea (g/L)	0.43±0.31	0.45±0.37	0.42±0.28	0.301
	Creatinine (mg/L)	11.81±10.28	13.27±16.16	11.29±7.07	0.072
Liver function	ASAT (UI/L)	44.80±30.99	49.39±34.54	43.06±29.54	0.039
	ALAT (UI/L)	40.86±39.31	43.08±35.68	40.80±41.52	0.601
	ALP (UI/L)	168.19±60.06	161.67±51.11	171.02±61.14	0.156
Serum electrolytes	Potassium (mmol/l)	3.90±0.48	3.82±0.53	3.92±0.46	0.063
	Sodium (mmol/l)	136.83±4.67	137.70±4.38	136.53±4.73	0.032*
Prothrombin level (%)		84.73±15.41	86.82±15.43	84.54±14.27	0.221
CPK (UI/L)		164.78±317.53	205.56±333.20	142.71±323.20	0.753
LDH (UI/L)		555.42±305.72	647.61±371.44	527.05±277.06	0.001*

ALAT: alanine amino-transferase. ALP: alkaline phosphatase. ASAT: aspartate amino-transferase. BMI: body mass index. CPK: creatine phosphokinase. G: group. LDH: lactico-dehydrogenase. Quantitative and categorical data were expressed as mean±standard deviation and number (%), respectively.
P (probability): p< 0.05 (*Student Test, **Two sided Chi-2): G1 vs. G2.

Table 5. Computed tomography scan data of patients, length of hospitalization, issues of patients				
	Total sample (n=511)	G1: BMI ≥ 30 kg/m^2 (n=137)	G2: BMI < 30 kg/m^2 n=374	p
Radiological signs				
ground-glass	455 (94)	128 (98)	327 (93)	0. 078
nodular ground-glass	239 (50)	72 (55)	167 (48)	0.158
diffuse ground-glass opacity	334 (69)	89 (68)	245 (70)	0. 778
crazy paving	169 (35)	44 (34)	125 (36)	0. 664
condensation	258 (54)	71 (54)	187 (53)	0. 860
CT extension of lésions				
<10%	106 (22)	25 (19)	81 (23)	0.327
10-25%	87 (18)	23 (17)	64 (18)	0.834
25-50%	138 (28)	36 (27)	102 (29)	0.683
50-75%	83 (17)	28 (21)	55 (15)	0.153
>75%	11 (2)	8(6)	3 (1)	<0.001
Length of hospitalization, issues of patients				
Hospital stay (day)	10.1±6.5	10.0±6.6	10.4± 6.2	0.605
Transfer to an intensive care-unit	49 (9.6)	16 (11.7)	33 (8.8)	0.332
Death	27 (5.3)	20 (5.3)	7 (5.1)	0.915

BMI: body mass index. G: group. Data were expressed as number (%). p (probability): p< 0.05 (* Two sided Chi-2): G1 vs. G2.

Table 6. Factors associated with in-hospital mortality				
Parameters at admission	Overall (N=511)	Survivors (N = 484)	Non-survivors (N = 27)	p
BMI, mean ± SD, kg/m2	27.83±4.82	27.85± 4.74	27.34 ± 6.11	0.589
Age years	56.2± 15.5	55.4 ±15.2	69.2 ±14.8	<0.0001*
Sex (male)	48.1(246)	47.7 (231)	55.6(15)	0.429
Smokers	13.9 (69)	13.4 (63)	23.1 (6)	0.166
Comorbidities				
Heart disease	12.5 (64)	11.2 (54)	37.0 (10)	<0.0001*
Hypertension	33.1 (169)	32.4 (157)	44.4 (12)	0.197
Diabetes mellitus	25.8 (132)	24.0 (116)	59.3 (16)	<0.0001*
Asthma	5.5 (28)	5.6 (27)	3.7(1)	0.678
COPD	1.8 (9)	1.2 (6)	11.1(3)	0.0001*
Chronic kidney disease	2 (10)	1.5 (7)	11.5 (3)	0.0003*
Symptoms				
Cough	75.5 (385)	75.0 (363)	84.6 (22)	0.268
Dyspnea	51.2 (261)	49.4 (239)	84.6 (22)	0.0008*
SpO2 >92%	61.8 (315)	64.3 (311)	15.4(4)	<0.0001*
Air ambient Oxy-sat (%)	90.3 ±9.6	91.2 ± 8.01	72.8± 17.1	<0.0001
Hemoglobin (g/l)	12.86± 1.75	12.9 ±1.7	12.4 ± 2.1	0.162
Polynuclear neutrophils (/mm3)	5961± 3603	5845 ±3557	7898 ±3879	0.004*
Lymphocytes (/mm3)	1184 ±729	1187 ±724	1134 ±816	0.719
ESR (1st hour) (mm)	65.3 ±37.6	65.2± 37.9	67.0 ±31.2	0.850
C-reactive protein (mg/l)	54.5 ±59.0	52.9 ±57.8	82.5± 72.1	0.017*
LDH level (u/l)	555.4 ±305.7	547.0 ±294.4	738.4 ±466.3	0.009*
D-dimers >1600 ng/ml	25.7 (75)	24.0 (64)	44.0 (11)	0.03*
Kaliemia (mmol/l)	3.90± 0.47	3.87 ±0.46	4.15± 0.70	0.017*
Natremia (mmol/l)	136.8 ± 4.67	136.7± 4.64	138.6 ±5.01	0.092
CT extent of COVID-19				
<10%	21.6 (106)	22.3 (104)	8.7 (2)	0.147
10-25%	17.8 (87)	18.2 (85)	8.7 (2)	0.245
25-50%	28.2 (138)	28.1 (131)	30.4 (7)	0.904
50-75%	16.9 (83)	15.8 (74)	39.1 (9)	0.004*
>75%	2.2 (11)	1.9 (9)	8.7 (2)	0.032*
Length of stay in the hospital (day)	10.1 ±6.5	10.0±6.2	11.1±9.9	0.332
Quantitative and categorical data were expressed as mean±standard deviation and number (%), respectively. p (probability) : p< 0.05 (*Student Test)				

Discussion

A few studies were available in the North African environment to assess the risk factors of dying during hospitalizations of patients with COVID-19. Our results could give a model to evaluate risk and use it at convenience in acute care settings.

In this study, we collected data from 511 cases of COVID-19. The cohort was a random group of patients representing the real situation of patients hospitalized in our department with 26.8% of obese patients, although obesity represents according to the Tahina study [15] 21.24% of the algerian population. In a large New York study of patients hospitalized for COVID-19, 41.7% had a body mass index (BMI)> 30 kg / m^2 and 19.0% a BMI> 35 kg / m^2[27]. Analysis of the data by BMI identified 2 groups with an average BMI of (33.7 vs 25.7) in the whole sample, and of (33.8 vs 25.8) in subjects less than 50 years old. In our study, the obese vs. non-obese group had higher percentages of women and patients under the age of 50 y. Comparable results were found in an Italian study, where the relationship between obesity and COVID-19 does not appear evident in the general population, on the other hand it was particularly clear in the youngest subjects [28].

In our study of patients under 50 infected with COVID-19, BMI was similar to the mean BMI of the entire sample, while in other studies in patients of under 50 years infected with SARS-CoV-2, the average BMI was higher, and this index seemed to decrease with age in COVID-19 patients [29-31]. The results suggest that obesity may be more prominent in young patients with COVID-19.

The comorbidities in the high BMI group were particularly less pronounced in the cohort of patients under 50 years, with fewer underlying illnesses such as hypertension, metabolic disease, diabetes and dysthyroidism, contrary to some studies already reported [6, 9, 32, 33].

The literature data precise that the effect of obesity on COVID-19 was independent of comorbidities, such as hypertension, and diabetes. This suggests an important pathophysiological link between a high level of adiposity and a poor prognosis of COVID-19 disease [11, 29, 34], according to Gao et al. [35], obesity has tripled the risk of worsening COVID-19. Obesity induces T cell depletion through constant low-grade inflammation, which alters the immune response and reduces its ability to confront the virus from the host [35, 36]. obesity may also interfere with the activation of immune cells [37]. Deng et al [38], have suggested in young patients, that visceral, hepatic, epicardial, and perirenal adiposity may predict the COVID-19 severity.

On analysis of chest imaging, we found that the distribution of lung lesions was slightly different between obese and non-obese patients. The cases of obesity also manifested a higher proportion of specific opacity in ground glass (98% against 93%). Lung damage involvement was slightly more extensive in obese patients, this difference becomes more pronounced, especially for CT lesions greater than 50%. Similar results have been described in the literature [14, 39].

On analysis of chest imaging, we found that the distribution of lung lesions was slightly different between obese and non-obese patients. The cases of obesity also manifested a higher proportion of specific opacity in ground glass (98% against 93%). Lung damage involvement was slightly more extensive in obese patients, this difference becomes more pronounced, especially for CT lesions greater than 50%. Similar results have been described in the literature [14, 39]. Indeed, obesity is the result of abnormal energy metabolism, which in turn lead to stress and tissue dysfunction [40, 41]. In our study, obese patients showed a slightly high rate of CRP and erythrocytic sedimentation levels than those who were not obese table 3, these markers of inflammation influence the progression and poor prognosis of COVID-19 disease.

Obesity provides a chronic environment for disease pathogenesis and is characterized by a low-inflammatory condition, which can lead to the production of depleted immune cells, and the body becomes more vulnerable to infections [8, 42, 43]. The excessive immune response to SARS-CoV-2 is the main reason for the severe forms of illness and the mortality of patients. The CRP was slightly higher in obese COVID-19 patients compared to non-obese patients in previous studies [44, 45]. In addition, significantly higher levels of LDH and hypernatremia in obese patients are associated with a slight, less pronounced elevation of transaminases mainly AST and hypokalaemia Table 4. BMI, ALAT and ASAT were independently and inversely associated with being discharged from hospital in time for these patients. One study found that obesity and abnormal liver function predispose patients with COVID-19 to prolonged hospitalization [46], in our study we found the same trend with more patients staying longer than 10 days among obese subjects and subjects with a high ALT level.

In our study, kalaemia was slightly greater in the group of obese patients (3.82 vs 3.92); sodium disorder, particularly hyponatremia, is a common occurrence in hospitalized patients with COVID-19 in a Chinese study, and is associated with a higher risk of serious illness and increased hospital mortality [47]. However, in our study, we found an association between hypernatremia, hospitalization duration, and mortality, table 6.

Indeed, the high prevalence of hypokalemia in patients with COVID-19 in Mediterranean studies suggests the presence of a disruption in the activity of the renin-angiotensin system due to severe infection of SARS-CoV-2 [48]. Additionally, this sensitive biomarker may reflect the progression of COVID-19. Hypokalaemia has been shown to be independently associated with the need for invasive mechanical ventilation [49]. Obesity can disrupt immune responses, making obese patients susceptible to infections, both bacterial and viral [50]. This increased risk had already been described for infections with the influenza virus,[50] with a longer duration of contagiousness in obese people compared to that in non-obese [49].

In our study, the mean hospital stay was similar to 10 days vs. 10.4 days, in fact, the hospital stay was the same in previous studies [33]. In our work, obese patients had lower oxygen saturation on admission (88% vs 91%).

We found no higher mortality or transfer rate to the intensive care unit for obese patients compared to those who were not obese in our sample (5,3 vs 5,1) for mortality, (11,7 vs 8,8) for transfer to the intensive care units. Identical results with a BMI were not found to be an independent predictor of mortality [51]. However in previous viral pandemics, it has been shown that obesity, especially severe obesity (BMI> 40 kg / m2), is associated with an increased risk of hospitalization, admission to intensive care and death [52, 53].

A systematic review and meta-analysis of 22 studies showed that obesity was associated with a poor prognosis for SARS-CoV-2 infection, marked by more cases of severe COVID-19, admission to intensive care, recourse to mechanical ventilation and rapid progression of the disease, especially in younger subjects (OR 3.30 vs 1.72). However, this meta-analysis did not find an association between obesity and hospital mortality [29].

Current literature suggests an association between obesity and increased mortality in patients with COVID-19 pneumonia in the general population, particularly in younger patients [10, 13]. However, a lower BMI ≤ 25 was associated with a decrease in the need for mechanical ventilation [13]. Obesity was significantly associated with a greater likelihood of death, and a higher percentage of death (32.61%) was noted in obesity classes II and III (BMI ≥35 Kg/m2)[63]. Group class I (BMI 18.5–24.9 Kg/m2) had the lowest percentage of death [54]. Group classI (BMI 18.5–24.9 Kg/m2) had the least percentage of meeting the primary endpoint [54]. Severe obesity is a relevant risk factor for COVID-19 severity and hospitalization in young adults, similar to that of aging patients [55]. Higher BMI in early adulthood was associated with severe COVID-19 many years later with a risk increase starting already at BMI ≥22.5 [56].

Studies show that having a BMI ≥ 30 kg/m2 is a significant risk factor in COVID-19 morbidity and mortality [57].

Comparing the survivor group with the non-survivor group in Table 6, the latter had higher percentages of males, older ages, and more comorbidities (heart disease, hypertension, diabetes, COPD, and chronic kidney disease, but the same percentage of asthma), the results were found by Kyoung Min Kim [58]. The non-survivor group had a higher frequency of dyspnea and a lower level of oxygen saturation. Based on the biological profile, the non-survivor group included a higher level of neutrophil polynuclear, LDH, and C-reactive protein, and a higher number of patients with D-dimer greater than 1600 ng/ml, which indicated that D-dimer could be an early marker to improve the management of COVID-19 patients[59]. In fact, hospital mortality was significantly higher in patients with high neutrophil count, lower lymphocyte count, elevated CRP, and D-dimer ≥ 2.0 µg/ml than those who had D-dimer < 2.0 µg/ml on admission [60]. On the other hand, the same group included more patients with an CT extent of lesions greater than 50%. The risk of mortality for COVID-19 patients could be evaluated using a lung CT-scan extent cut off [61].

Strengths and limitations

The strength of this study is prospective study included a single center with the same team of investigators, over 18 months, in a pulmonology Department. There were some limitations to the current study. First, our study cannot be considered exhaustive, and might be possible other factors that affect COVID-19 mortality, is the retrieval of clinical data was difficult for severely ill patients.

In summary, obesity contributes to clinical manifestations and can influence the progression and prognosis of COVID-19, with an accumulated risk of serious complications for obese subjects. Our cohort showed an obesity rate (26.8%) and a mortality rate (5.3%), and warned that obesity increases the risk of severity but not mortality in hospitalized patients for COVID-19. Therefore, the inclusion of obesity in prognostic scores and therapeutic management strategy will be essential to improve the prognosis of hospitalized patients with COVID-19. Risk factors for death from COVID-19 were a history of underlying chronic diseases including diabetes, COPD, renal failure and cardiovascular disease, hypoxia on admission, elevated serum LDH, CRP and D.Dimer linked to the survival status of COVID-19 patients.

Further studies are needed to assess the association between age, obesity, fragility, and clinical outcome in adults with COVID-19 disease.

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