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Prevalence of Comorbidities and their Impact on COVID-19 Outcomes: An Observational Study during Early Outbreak in Lebanon

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1. Background

In December 2019, clusters of pneumonia of unknown origin broke out in Wuhan, China. The infectious agent was later identified as severe acute respiratory syndrome coronavirus 2(SARS-CoV-2), a new coronavirus that was not previously seen in humans, and belongs to the same genera of viruses that have previously caused severe acute respiratory syndrome (SARS) and Middle East Respiratory Syndrome (MERS) disease outbreaks [1-3]. The World Health Organization (WHO) first considered SARS-CoV-2 infection, or Coronavirus disease 2019 (COVID-19), as a public health emergency of international concern on 30 January 2020, and then officially declared it a pandemic on 11 March 2020 [4]. By mid-May 2020, there were more than 4 million confirmed cases of COVID-19 and almost 300 thousand deaths reported worldwide [5]. In Lebanon, the first case of COVID-19 was confirmed on February 21, 2020. By mid-May 2020, there were 891 cases and 26 deaths reported in Lebanon, but the transmission was still within "clusters of cases" and the country had not yet entered the "community transmission" phase [5,6].

The clinical presentation of COVID-19 is widely variable, ranging from asymptomatic infection, mild upper respiratory symptoms, to severe viral pneumonia leading to acute respiratory distress syndrome (ARDS), and even death. Typical initial symptoms of infection include fever, cough, and dyspnea [7, 8].

Ever since its emergence, clinical and epidemiological data on COVID-19 suggested that some comorbidities are associated with a higher risk of contracting the disease, and are correlated with an increased risk of severe disease, disease complications, and poor outcomes, including death. Older age, diabetes, hypertension, obesity, and cardiovascular disease (CVD) were considered as risk factors of particular interest in COVID-19 studies, which was supported by numerous observations since early outbreak [9-13].

In Lebanon, non-communicable diseases (NCDs) present a major health challenge. In 2018, the WHO reported that NCDs are estimated to account for 91% of all deaths in Lebanon: 47% due to CVD, 16% due to cancers, 4% due to chronic respiratory diseases, and 5% due to diabetes [14].

While different countries have reported variable case-fatality rates and disease patterns [5], epidemiological studies on COVID-19 are still lacking in Lebanon. The aim of our study was to describe epidemiological and clinical characteristics of patients presenting with COVID-19 in Lebanon during early outbreak, and to explore the association of baseline risk factors and comorbidities with COVID-19 disease course and outcomes.

2. Methods

Study design and setting

This was a retrospective observational single-center study that included 150 patients admitted to Rafik Hariri University Hospital (RHUH) with newly diagnosed SARS-CoV-2 infections starting February 21, 2020. RHUH is the largest Lebanese public hospital located in Beirut, and until the end of data collection, it was the main central hospital in Lebanon receiving most COVID-19 cases. Data was collected between March 15 and May 15, 2020.

A database for COVID-19 patients was created once the first patient was admitted to RHUH. We randomly selected 150 patients newly diagnosed with COVID-19, regardless of age, gender, or disease severity, to be included in the study. Patients were considered as SARS-CoV-2-positive based on the result of real-time polymerase chain reaction (RT-PCR)

tests performed on respiratory samples at the study center. Patients visited the center if they had any symptom (dyspnea, cough, fever), were coming from travel from a high COVID-19 prevalence country, or suspected infection based on contact with a confirmed case.

At the beginning of the national outbreak, and to limit the spread of the infection, all confirmed cases were hospitalized as a form of quarantine, regardless if patients actually required in-patient care, i.e. even if they were asymptomatic or had mild symptoms.

Data collected

Data collected from patients' medical records included: demographic and anthropometric characteristics (age, gender, body mass index [BMI]), comorbidities and potential risk factors (CVD, chronic lung disease, chronic kidney disease, chronic liver disease, chronic neurological disorder, malignant neoplasm, obesity, hypertension, diabetes, smoking), signs and symptoms upon admission (fever, cough, dyspnea, other), clinical characteristics and complications (intensive care unit [ICU]/regular floor admission, need for mechanical ventilation (intubation), developing viral pneumonitis, bacterial pneumonia, ARDS, congestive heart failure [CHF], cardiac arrhythmia, cardiac ischemia, cardiac arrest, acute renal injury, liver dysfunction, hyperglycemia, hypoglycemia), and disease outcomes (length of hospital stay, RT-PCR status upon discharge, disease cure [defined as having 2 consecutive negative PCRs], time to conversion [time from first positive PCR till 2 consecutive negatives], death, disease severity). Data was collected from standard forms that were completed upon admission. Comorbidities were determined based on patients' self-report. Patients were discharged if they had 2 consecutive negative PCRs or if they were completely asymptomatic with an available place to be quarantined. If discharged while positive, patients presented for a follow-up PCR to ensure that the PCR test result became negative.

The study was approved by the Institutional Review Board of RHUH and all study data were anonymized and de-identified.

Statistical analyses

All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. No formal sample size calculation was performed since the study was done during the early outbreak period in Lebanon. At time of data collection, our sample size was considered to be sufficient, considering its representativeness of the national patient population.

All statistical tests were two-sided; p-values <0.05 were considered as statistically significant. No missing data was imputed.

Continuous variables were presented as means and standard deviations while categorical variables were presented as frequencies and percentages.

Comparison of means of continuous variables between 2 independent groups was done using Student's t-test for normally distributed data, while Mann-Whitney U test was used for data that did not meet the assumptions of a normal distribution.

Pearson chi-square or Fischer's exact tests were used for comparisons between proportions as appropriate.

Normality in distribution was tested by graphical and numerical methods. Histogram plots and Skewness/Kurtosis tests were computed for each variable. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine whether the variable had a normal distribution.

Selected risk factors (age, obesity, CVD, hypertension, diabetes, and smoking) were evaluated for possible association with clinical characteristics and as well as disease outcomes in the sample of COVID-19 patients.

3. Results

Patient demographics

A total of 150 patients were enrolled in the study. Mean age was 45.87 ±20.03 years, with 64 patients (42.67%) being 50 years or older [age range 5 – 88 years]. Most patients were male (60.67%). Thirty patients were smokers (20%) (Table 1).

Table 1: Baseline characteristics and disease symptoms, course, and outcomes in COVID-19 patients

Baseline Characteristics		
Age (years) n=150	Mean ± SD	45.87±20.03
Age Category n=150	<50 years	86 (57.33%)
	≥50 years	64 (42.67%)
Gender n=150	Male	91 (60.67%)
	Female	59 (39.33%)
BMI (kg/m^2)[a] n=20	Mean ± SD	28.90 ±7.85
Smoking n=150	No	120 (80.00%)
	Yes	30 (20.00%)
COVID-19 symptoms		
Fever n=150	No	67 (44.67%)
	Yes	83 (55.33%)
Cough n=150	No	65 (43.33%)
	Yes	85 (56.67%)
Dyspnea n=149	No	121 (81.21%)
	Yes	28 (18.79%)
Other n=150	No	73 (48.67%)
	Yes	77 (51.33%)
Disease course and outcomes		
Length of hospital stay (days) n=150	Mean ± SD	14.99 ± 7.58
Patient was discharged while PCR-positive, n=141	No	88 (62.41%)
	Yes	53 (37.59%)
Disease cure n=149	No	9 (6.04%)
	Yes	140 (93.96%)
Time to PCR test conversion (days) n=140	Mean ± SD	21.30 ± 11.00

[a]BMI was only recorded for patients admitted to the ICU

Prevalence of risk factors, comorbidities, and symptoms

Regarding comorbidities, hypertension (18.67%) and diabetes (16.67%) were the most commonly reported, followed by CVD (9.33%), obesity (4%), malignant neoplasms (3.33%), chronic kidney disease (2.00%), chronic neurological disorder (1.33%), and chronic lung disease (0.67%). None of the patients had chronic liver disease. Overall, 103 patients reported no comorbidities (68.67%) (Figure 1).

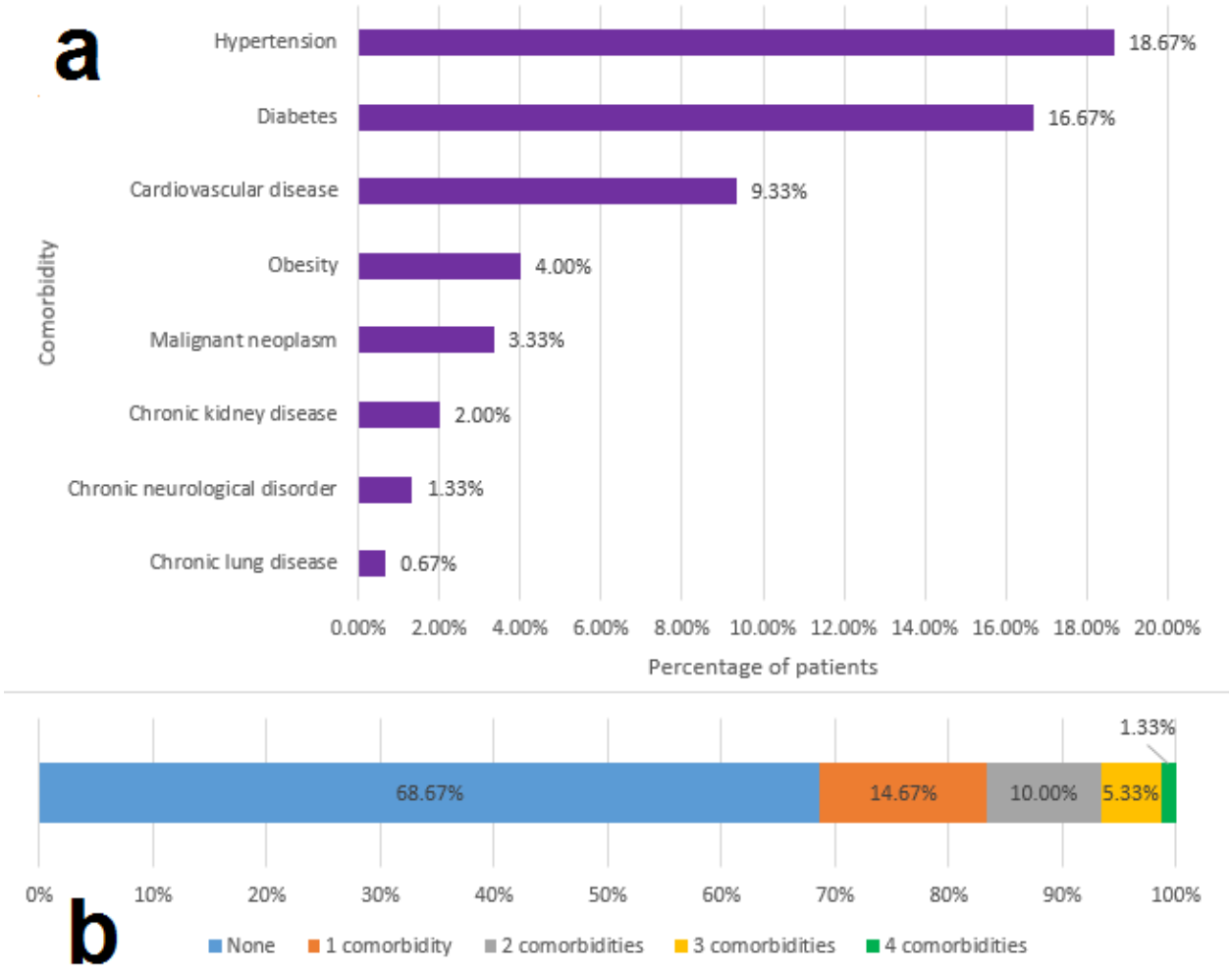

Figure 1: Numbers and types of comorbidities in the study population

During COVID-19 illness, the most common symptoms were cough (56.67%) and fever (55.33%), while dyspnea was less common (18.79%) (Table 1). 31 patients have not reported having any symptoms (20.67%). The disease severity was mild in 47.33% of patients, moderate in 37.33% and severe in 15.33% (Figure 2).

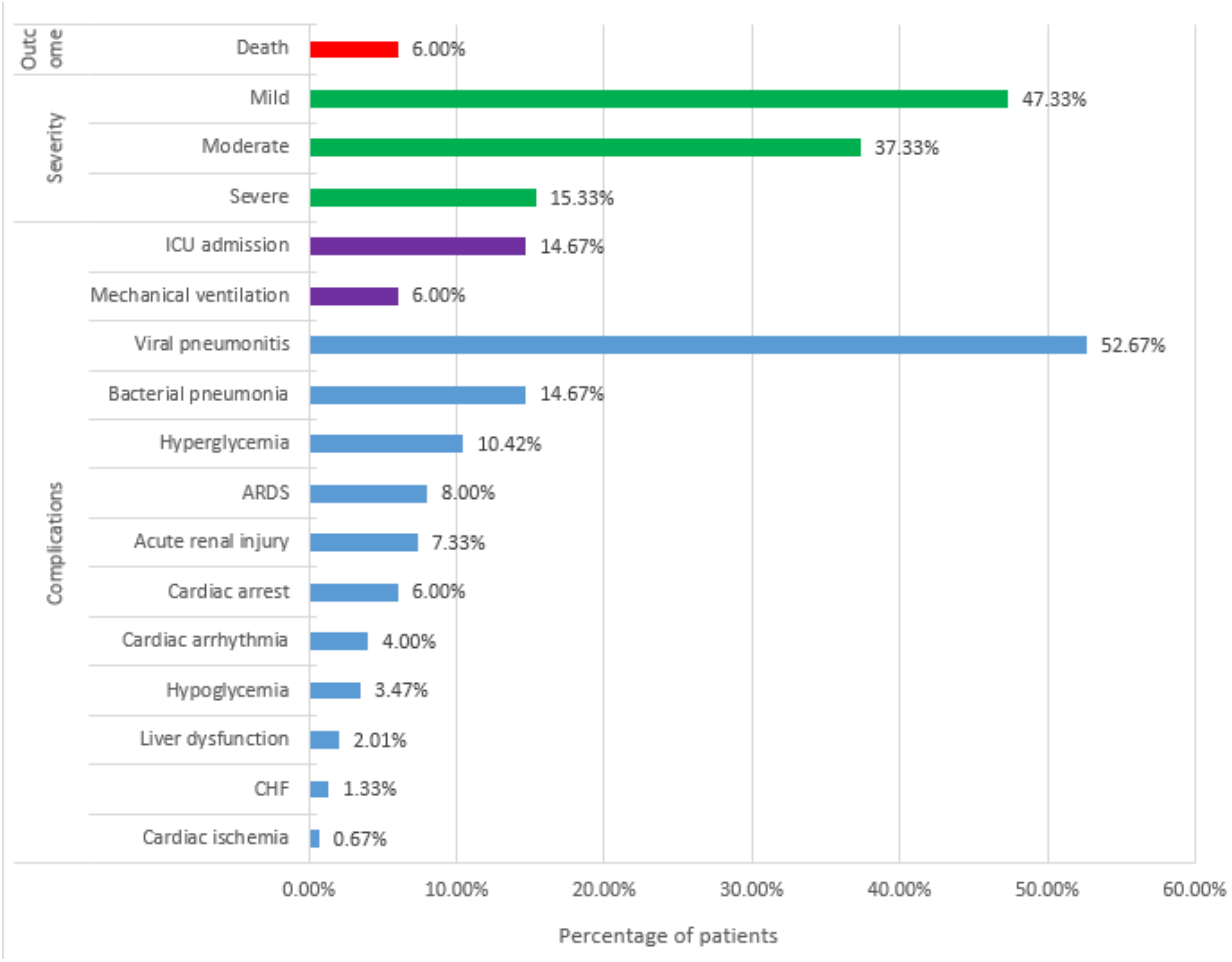

Figure 2: COVID-19 disease severity, complications, and outcome
ICU: Intensive Care Unit; ARDS: Acute Respiratory Distress Syndrome; CHF: Congestive Heart Failure

COVID-19 disease course and outcomes

128 patients were admitted to regular floor (85.33%) while 22 patients (14.67%) were in ICU. The most commonly reported disease complications were viral pneumonitis (52.67%), bacterial pneumonia (14.67%), hyperglycemia (10.42%), ARDS (8.00%), and acute renal injury (7.33%). Nine patients needed mechanical ventilation (6.00%) and the same number experienced cardiac arrest. Other complications are summarized in Figure 2.

For the 150 enrolled patients, the average length of hospital stay was 14.99 ±7.58 days. Nine patients died during hospitalization (6.00%). Of those who were alive at discharge, 53 patients (37.59%) were discharged while PCR-positive. At last follow-up, one patient was lost to follow-up and 140 patients were cured (93.96%) from the disease; among those, average time to conversion was 21.30 ±11.00 days (Table 1).

Association of comorbidities with disease course and outcome

COVID-19 symptoms were associated with several risk factors and comorbidities. Patients with fever were more likely to be obese (100% vs. 53.47%; p=0.033), those with cough were more likely to be ≥50 years old (67.2% vs. 48.8%; p=0.025), while dyspnea was strongly associated with age ≥50 years (p=0.002), CVD (p=0.005), obesity (p=0.005), hypertension (p<0.001), and diabetes (p=0.001). Higher disease severity was also associated with age ≥50 years, CVD, obesity, hypertension, and diabetes (p<0.001). Other associations are shown in table 2.

Table 2: Correlation between selected risk factors and COVID-19 disease symptoms and severity

			Fever			Cough			Dyspnea			Other symptom			Disease severity			
			No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	Mild	Moderate	Severe	p-value
Age category (years)	<50	n	42	44	0.234	44	42	0.025	77	9	0.002	38	48	0.203	61	24	1	<0.001
		%	48.84%	51.16%		51.16%	48.84%		89.53%	10.47%		44.19%	55.81%		70.93%	27.91%	1.16%	
	≥50	n	25	39		21	43		44	19		35	29		10	32	22	
		%	39.06%	60.94%		32.81%	67.19%		69.84%	30.16%		54.69%	45.31%		15.63%	50.00%	34.38%	
Cardiovascular disease	No	n	60	76	0.673	61	75	0.242	114	21	0.005	71	65	0.007	70	51	15	<0.001
		%	44.12%	55.88%		44.85%	55.15%		84.44%	15.56%		52.21%	47.79%		51.47%	37.50%	11.03%	
	Yes	n	7	7		4	10		7	7		2	12		1	5	8	

		%	50.00%	50.00%		28.57%	71.43%		50.00%	50.00%		14.29%	85.71%		7.14%	35.71%	57.14%	
Malignant neoplasm	No	n	65	80	1.000	64	81	0.389	119	25	0.046	72	73	0.367	70	55	20	0.044
		%	44.83%	55.17%		44.14%	55.86%		82.64%	17.36%		49.66%	50.34%		48.28%	37.93%	13.79%	
	Yes	n	2	3		1	4		2	3		1	4		1	1	3	
		%	40.00%	60.00%		20.00%	80.00%		40.00%	60.00%		20.00%	80.00%		20.00%	20.00%	60.00%	
Obesity	No	n	67	77	0.033	64	80	0.235	120	24	0.005	70	74	1.000	71	55	18	<0.001
		%	46.53%	53.47%		44.44%	55.56%		83.33%	16.67%		48.61%	51.39%		49.31%	38.19%	12.50%	
	Yes	n	0	6		1	5		1	4		3	3		0	1	5	
		%	0.00%	100.00%		16.67%	83.33%		20.00%	80.00%		50.00%	50.00%		0.00%	16.67%	83.33%	
Hypertension	No	n	56	66	0.525	57	65	0.080	105	16	<0.001	62	60	0.271	64	48	10	<0.001
		%	45.90%	54.10%		46.72%	53.28%		86.78%	13.22%		50.82%	49.18%		52.46%	39.34%	8.20%	
	Yes	n	11	17		8	20		16	12		11	17		7	8	13	
		%	39.29%	60.71%		28.57%	71.43%		57.14%	42.86%		39.29%	60.71%		25.00%	28.57%	46.43%	
Diabetes	No	n	54	71	0.419	58	67	0.090	107	17	0.001	65	60	0.068	70	46	9	<0.001
		%	43.20%	56.80%		46.40%	53.60%		86.29%	13.71%		52.00%	48.00%		56.00%	36.80%	7.20%	
	Yes	n	13	12		7	18		14	11		8	17		1	10	14	
		%	52.00%	48.00%		28.00%	72.00%		56.00%	44.00%		32.00%	68.00%		4.00%	40.00%	56.00%	
Smoking	No	n	55	65	0.565	48	72	0.099	96	23	0.739	58	62	0.870	56	46	18	0.878
		%	45.83%	54.17%		40.00%	60.00%		80.67%	19.33%		48.33%	51.67%		46.67%	38.33%	15.00%	
	Yes	n	12	18		17	13		25	5		15	15		15	10	5	
		%	40.00%	60.00%		56.67%	43.33%		83.33%	16.67%		50.00%	50.00%		50.00%	33.33%	16.67%	

As for COVID-19 complications, ICU admission was highly associated with age ≥50 years, CVD, obesity, hypertension, and diabetes (p<0.001), and so were bacterial pneumonia and acute renal injury. Mechanical ventilation and cardiac arrest were associated with age ≥50 years (p=0.005), obesity (p<0.001), and hypertension (p=0.012). Viral pneumonitis was associated with age ≥50 years, CVD, hypertension, and diabetes, while ARDS and hyperglycemia were associated with age ≥50 years, obesity, hypertension, and diabetes (Table 3).

Table 3: Correlation between selected risk factors and COVID-19 complications

			ICU admission			Mechanical ventilation			Viral pneumonitis			Bacterial pneumonia			ARDS			CHF		
			No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
Age category (years)	<50	n	85	1	<0.001	85	1	0.005	58	28	<0.001	82	4	<0.001	85	1	<0.001	86	0	0.180
		%	98.84%	1.16%		98.84%	1.16%		67.44%	32.56%		95.35%	4.65%		98.84%	1.16%		100.00%	0.00%	
	≥50	n	43	21		56	8		13	51		46	18		53	11		62	2	
		%	67.19%	32.81%		87.50%	12.50%		20.31%	79.69%		71.88%	28.13%		82.81%	17.19%		96.88%	3.13%	
Cardiovascular disease	No	n	122	14	<0.001	129	7	0.199	69	67	0.009	120	16	0.007	127	9	0.086	135	1	0.179
		%	89.71%	10.29%		94.85%	5.15%		50.74%	49.26%		88.24%	11.76%		93.38%	6.62%		99.26%	0.74%	
	Yes	n	6	8		12	2		2	12		8	6		11	3		13	1	
		%	42.86%	57.14%		85.71%	14.29%		14.29%	85.71%		57.14%	42.86%		78.57%	21.43%		92.86%	7.14%	
Malignant neoplasm	No	n	126	19	0.023	137	8	0.269	70	75	0.370	125	20	0.156	135	10	0.051	144	1	0.066
		%	86.90%	13.10%		94.48%	5.52%		48.28%	51.72%		86.21%	13.79%		93.10%	6.90%		99.31%	0.69%	
	Yes	n	2	3		4	1		1	4		3	2		3	2		4	1	
		%	40.00%	60.00%		80.00%	20.00%		20.00%	80.00%		60.00%	40.00%		60.00%	40.00%		80.00%	20.00%	
Obesity	No	n	127	17	<0.001	139	5	<0.001	70	74	0.213	126	18	0.004	137	7	<0.001	142	2	1.000
		%	88.19%	11.81%		96.53%	3.47%		48.61%	51.39%		87.50%	12.50%		95.14%	4.86%		98.61%	1.39%	
	Yes	n	1	5		2	4		1	5		2	4		1	5		6	0	
		%	16.67%	83.33%		33.33%	66.67%		16.67%	83.33%		33.33%	66.67%		16.67%	83.33%		100.00%	0.00%	
Hypertension	No	n	113	9	<0.001	118	4	0.012	63	59	0.027	112	10	<0.001	117	5	0.002	122	0	0.034
		%	92.62%	7.38%		96.72%	3.28%		51.64%	48.36%		91.80%	8.20%		95.90%	4.10%		100.00%	0.00%	
	Yes	n	15	13		23	5		8	20		16	12		21	7		26	2	
		%	53.57%	46.43%		82.14%	17.86%		28.57%	71.43%		57.14%	42.86%		75.00%	25.00%		92.86%	7.14%	
Diabetes	No	n	116	9	<0.001	119	6	0.173	68	57	<0.001	113	12	<0.001	119	6	0.006	124	1	0.306
		%	92.80%	7.20%		95.20%	4.80%		54.40%	45.60%		90.40%	9.60%		95.20%	4.80%		99.20%	0.80%	
	Yes	n	12	13		22	3		3	22		15	10		19	6		24	1	
		%	48.00%	52.00%		88.00%	12.00%		12.00%	88.00%		60.00%	40.00%		76.00%	24.00%		96.00%	4.00%	

Smoking	No	n	103	17	0.774	114	6	0.384	56	64	0.744	102	18	1.000	111	9	0.707	118	2	1.000
		%	85.83 %	14.17 %		95.00 %	5.00%		46.67 %	53.33 %		85.00 %	15.00 %		92.50 %	7.50%		98.33%	1.67%	
	Yes	n	25	5		27	3		15	15		26	4		27	3		30	0	
		%	83.33 %	16.67 %		90.00 %	10.00 %		50.00 %	50.00 %		86.67 %	13.33 %		90.00 %	10.00 %		100.00 %	0.00%	

			Cardiac arrhythmia			Cardiac ischemia			Cardiac arrest			Acute renal injury			Liver dysfunction			Hyperglycemia			Hypoglycemia		
			No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value	No	Yes	p-value
Age category (years)	<50	n	85	1	0.084	86	0	0.427	85	1	0.005	86	0	<0.001	85	1	0.574	85	0	<0.001	85	0	0.010
		%	98.84 %	1.16%		100.00%	0.00 %		98.84 %	1.16 %		100.00%	0.00%		98.84 %	1.16%		100.00%	0.00%		100.00 %	0.00%	
	≥50	n	59	5		63	1		56	8		53	11		61	2		44	15		54	5	
		%	92.19 %	7.81%		98.44 %	1.56 %		87.50 %	12.50 %		82.81 %	17.19 %		96.83 %	3.17%		74.58 %	25.42 %		91.53 %	8.47%	
Cardiovascular disease	No	n	131	5	0.450	135	1	1.000	129	7	0.199	129	7	0.011	132	3	1.000	124	6	1.000	126	4	0.405
		%	96.32 %	3.68%		99.26 %	0.74 %		94.85 %	5.15%		94.85 %	5.15%		97.78 %	2.22%		95.38 %	4.62%		96.92 %	3.08%	
	Yes	n	13	1		14	0		12	2		10	4		14	0		5	9		13	1	
		%	92.86 %	7.14%		100.00%	0.00 %		85.71 %	14.29 %		71.43 %	28.57 %		100.00%	0.00%		35.71 %	64.29 %		92.86 %	7.14%	
Malignant neoplasm	No	n	139	6	1.000	144	1	1.000	137	8	0.269	136	9	0.043	141	3	1.000	127	12	0.008	135	4	0.164
		%	95.86 %	4.14%		99.31 %	0.69 %		94.48 %	5.52%		93.79 %	6.21%		97.92 %	2.08%		91.37 %	8.63%		97.12 %	2.88%	
	Yes	n	5	0		5	0		4	1		3	2		5	0		2	3		4	1	
		%	100.00%	0.00%		100.00%	0.00 %		80.00 %	20.00 %		60.00 %	40.00 %		100.00%	0.00%		40.00 %	60.00 %		80.00 %	20.00 %	
Obesity	No	n	141	3	0.001	144	0	0.040	139	5	<0.001	136	8	0.005	141	3	1.000	127	12	0.008	135	4	0.164
		%	97.92 %	2.08%		100.00%	0.00 %		96.53 %	3.47%		94.44 %	5.56%		97.92 %	2.08%		91.37 %	8.63%		97.12 %	2.88%	
	Yes	n	3	3		5	1		2	4		3	3		5	0		2	3		4	1	
		%	50.00 %	50.00 %		83.33 %	16.67 %		33.33 %	66.67 %		50.00 %	50.00 %		100.00%	0.00%		40.00 %	60.00 %		80.00 %	20.00 %	
Hypertension	No	n	120	2	0.011	122	0	0.187	118	4	0.012	119	3	<0.001	120	1	0.091	113	5	<0.001	118	0	<0.001
		%	98.36 %	1.64%		100.00%	0.00 %		96.72 %	3.28%		97.54 %	2.46%		99.17 %	0.83%		95.76 %	4.24%		100.00 %	0.00%	
	Yes	n	24	4		27	1		23	5		20	8		26	2		16	10		21	5	
		%	85.71 %	14.29 %		96.43 %	3.57%		82.14 %	17.86 %		71.43 %	28.57 %		92.86 %	7.14%		61.54 %	38.46 %		80.77 %	19.23 %	
Diabetes	No	n	121	4	0.262	125	0	0.167	119	6	0.173	120	5	0.003	121	3	1.000	121	1	<0.001	121	1	0.002
		%	96.80 %	3.20%		100.00%	0.00%		95.20 %	4.80%		96.00 %	4.00%		97.58 %	2.42%		99.18 %	0.82%		99.18 %	0.82%	
	Yes	n	23	2		24	1		22	3		19	6		25	0		8	14		18	4	
		%	92.00 %	8.00%		96.00 %	4.00%		88.00 %	12.00 %		76.00 %	24.00 %		100.00%	0.00%		36.36 %	63.64 %		81.82 %	18.18 %	
Smoking	No	n	115	5	1.000	119	1	1.000	114	6	0.384	113	7	0.231	117	2	0.493	104	11	0.503	111	4	1.000
		%	95.83 %	4.17%		99.17 %	0.83%		95.00 %	5.00%		94.17 %	5.83%		98.32 %	1.68%		90.43 %	9.57%		96.52 %	3.48%	
	Yes	n	29	1		30	0		27	3		26	4		29	1		25	4		28	1	
		%	96.67 %	3.33%		100.00%	0.00%		90.00 %	10.00 %		86.67 %	13.33 %		96.67 %	3.33%		86.21 %	13.79 %		96.55 %	3.45%	

Patient mortality (death) was associated with age ≥50 years (12.50% vs. 1.16%; p=0.005), obesity (66.67% vs. 3.47%; p<0.001), and having hypertension (17.86% vs. 3.28%; p=0.012), but not with CVD, diabetes, nor smoking (Figure 3). None of the patients who were asymptomatic or had no comorbidities died during follow-up. Younger patients were more likely to be discharged even if they were still PCR-positive (45.88% vs. 25.00%; p=0.012) (Table 4).

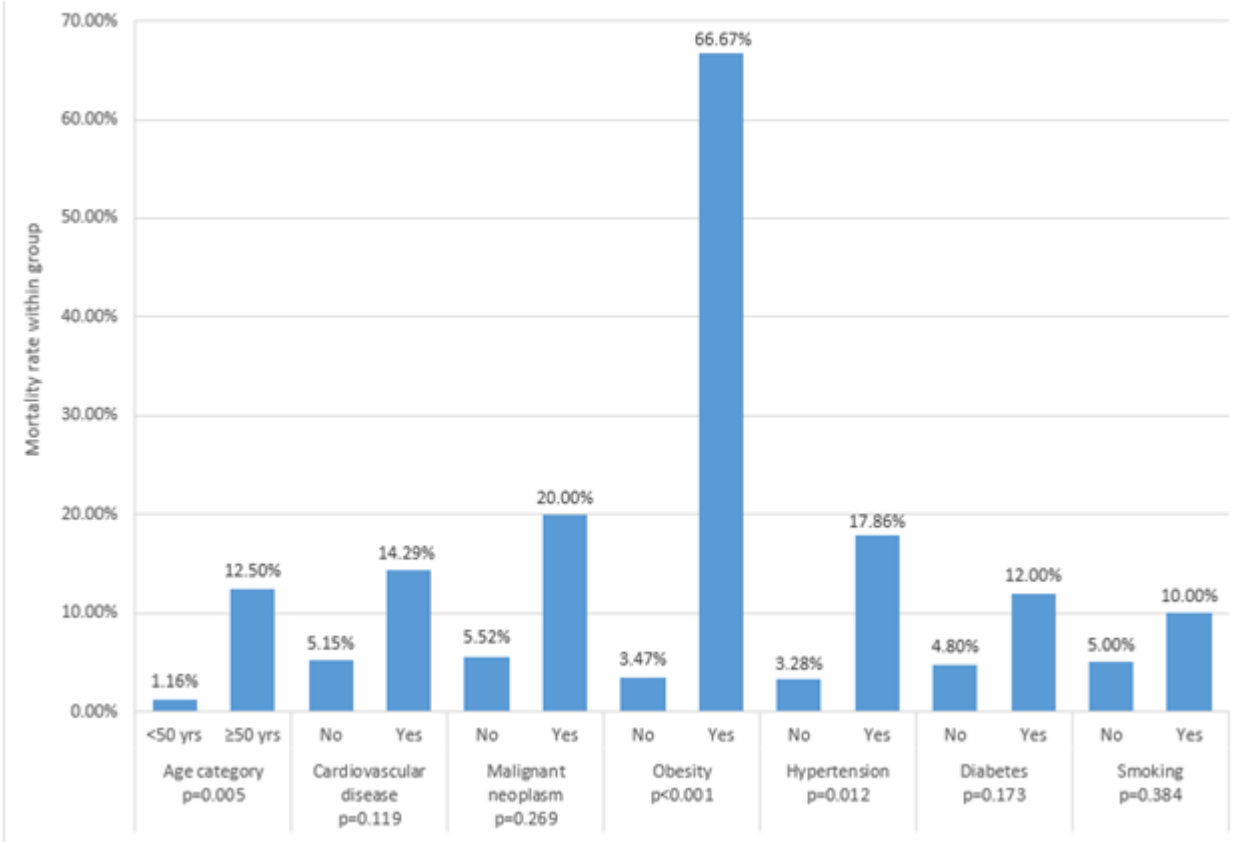

Figure 3: Mortality rate in different risk factor groups yrs: years

Table 4: Correlation between selected risk factors and disease course and outcome

			Length of hospital stay		Time to PCR test conversion			Patient was discharged while PCR-positive			Disease cure		
			days	p-value	Days	p-value		No	Yes	p-value	No	Yes	p-value
Age category (years)	<50	mean	14.79	0.926	22.26	0.561	n	46	39	0.012	1	85	0.005
		SD	7.27		12.26		%	54.12%	45.88%		1.16%	98.84%	
	≥50	mean	15.27		19.82		n	42	14		8	55	
		SD	8.03		8.6		%	75.00%	25.00%		12.70%	87.30%	
Cardiovascular disease	No	mean	15.39	0.037	21.92	0.021	n	78	51	0.211	7	128	0.201
		SD	7.6		11.18		%	60.47%	39.53%		5.19%	94.81%	
	Yes	mean	11.14		14.67		n	10	2		2	12	
		SD	6.42		5.84		%	83.33%	16.67%		14.29%	85.71%	
Malignant neoplasm	No	mean	14.96	0.850	21.39	0.608	n	84	53	0.297	8	136	0.271
		SD	7.54		11.072		%	61.31%	38.69%		5.56%	94.44%	
	Yes	mean	16		18.25		n	4	0		1	4	
		SD	9.72		8.69		%	100.00%	0.00%		20.00%	80.00%	
Obesity	No	mean	15.2	0.089	21.33	0.950	n	88	51	0.140	5	138	<0.001
		SD	7.54		11.06		%	63.31%	36.69%		3.50%	96.50%	
	Yes	mean	10		19.5		n	0	2		4	2	
		SD	7.54		7.78		%	0.00%	100.00%		66.67%	33.33%	
Hypertension	No	mean	14.83	0.639	21.72	0.503	n	70	48	0.086	4	117	0.012
		SD	7.7		11.53		%	59.32%	40.68%		3.31%	96.69%	
	Yes	mean	15.71		19.17		n	18	5		5	23	
		SD	7.13		7.61		%	78.26%	21.74%		17.86%	82.14%	
Diabetes	No	mean	15.3	0.155	22	0.106	n	71	48	0.117	6	119	0.160
		SD	7.28		11.41		%	59.66%	40.34%		4.80%	95.20%	
	Yes	mean	13.44		17.33		n	17	5		3	21	
		SD	8.95		7.3		%	77.27%	22.73%		12.50%	87.50%	
Smoking	No	mean	15.07	0.823	21.2	0.952	n	73	41	0.413	6	113	0.386
		SD	7.6		10.87		%	64.04%	35.96%		5.04%	94.96%	
	Yes	mean	14.7		21.7		n	15	12		3	27	
		SD	7.62		11.73		%	55.56%	44.44%		10.00%	90.00%	

4. Discussion

In the present study, we report the clinical characteristics, comorbidities, disease course, and outcomes of patients affected by COVID-19 in Lebanon. Our results support previous data suggesting that comorbidities and different underlying conditions are generally associated with poorer COVID-19 prognosis. Our results are in line with those previously described in the literature, which highlighted the impact of comorbidities on COVID-19 severity [9-13].

In our sample of COVID-19 patients, age ≥50 years was associated with higher rates of ICU admission, severe disease, need for mechanical ventilation, ARDS, and mortality. While older age is an independent risk factor for infection [15], older individuals are also more likely to have multiple comorbidities [16]. Several studies have reported that older individuals are at higher risk for COVID-19 infection and generally have a poorer prognosis when infected, having higher mortality and more severe illness [17]. Early reports from Wuhan have proposed that older age was an independent predictor of mortality in COVID-19, similar to previous observations in SARS and MERS [18].

Hypertension was the most common comorbidity in our cohort, and was highly associated with cardiac complications during hospitalization. Hypertension, but not other CVDs, was associated with need for mechanical ventilation, ARDS, CHF, arrhythmia, cardiac arrest, and higher mortality. Data from Pranata et al. showed similar results, where hypertension was associated with increased composite poor outcome, including mortality, severe COVID-19, ARDS, need for ICU care and disease progression in a pool of 6560 patients with COVID-19 [19]. One proposed explanation for this association is the up-regulation of angiotensin-converting enzyme 2 (ACE2) expression in hypertensive patients; it is likely that SARS-CoV-2 uses ACE2 on the surface of epithelial cells as a receptor to attach and enter the host pneumocytes, in a similar manner to SARS-CoV. The up-regulation of ACE2 expression might facilitate viral entry and thus lead to higher disease severity and fatality [20].

Our data are in agreement with other studies that suggest that the prevalence of diabetes in COVID-19 patients is 15% (17% in our study) [21]. Our results suggest that diabetes was associated with higher risk for ICU admission, ARDS, and severe disease. Similar results have been found by Seiglie et al., who reported that compared to non-diabetics, a higher proportion of patients with diabetes was admitted to the ICU (42.1% vs. 29.8%) [22]. A meta-analyses on 6452 patients with COVID-19 has shown that diabetes was associated with poor outcome including mortality, severe disease, ARDS, and disease progression [23]. The compromised immune system of diabetic patients might put them at a higher risk of contracting respiratory infections as well as reduce their innate immune response to infection [24].

While obesity itself is a risk factor for other comorbidities including CVD, hypertension, and diabetes [25], our results have shown that it is also associated with poorer outcomes in COVID-19. One pooled analysis has shown that obese patients are at a 46% higher risk of COVID-19 infection, a 113% higher risk of hospitalization, a 74% higher risk of ICU admission, and a 48% higher risk of mortality due to COVID-19 [26]. Evidence suggests that obesity impairs the individual's immune response through its modulatory effects on key immune cell populations [27], however, confirming this hypothesis in SARS-CoV-2 requires measuring blood immune cell counts, which was not part of our current study.

We did not find an association between smoking and COVID-19 complications nor outcomes. Conversely, a recent systematic review and meta-analysis has suggested that patients with any smoking history are at higher risk of severe disease and worse in-hospital mortality [28]. The small number of smokers in our study might have diluted this association. However, other studies have also reported no association between COVID-19 and smoking; one cross-sectional study in the UK has even found that active smoking was linked with decreased odds of a positive RT-PCR test result [29].

The mortality rate in our sample was 6%. At end of data collection (May 15, 2020), the global case-fatality rate was 6.85% based on WHO data [5]. The number of COVID-19 cases continue to increase: Lebanon has exceeded 54,000 cases by time of writing this article [6]. In this context, more studies are needed to determine which patient should be granted priority for hospitalization and to further understand who should be treated and how.

Our study had several limitations. The study was retrospective, sampled patients from one centeronly, and had a limited sample size. However, at the time of data collection, COVID-19 prevalence in Lebanon was low. In addition, the study center at that time was still the main center receiving cases in the country. Comorbidities in this study were self-reported, which leaves a place for possible under-reporting due to lack of awareness and/or the lack of diagnosis. Considering the cross-sectional nature of the study, causality could not be confirmed between different risk factors and outcome. The relative-risk of contracting COVID-19 could not be assessed in this study due to the lack of a control group.

This study is a first step in understanding disease risk factors and predictors of prognosis in the local COVID-19 population.All patients in the study were closely followed and had a known outcome, which adds value to the study's observations.

5. Conclusions

In conclusion, older age and different comorbidities, especially hypertension, obesity, and diabetes should be thoroughly considered when treating patients for COVID-19. These factors should be evaluated when choosing treatment and when deciding if patients should be hospitalized for COVID-19. More studies are needed to explore the impact of comorbidities on contracting the disease, and more preventive measures should be considered in comorbid individuals.

List of abbreviations:
ACE2: Angiotensin-Converting Enzyme 2
ARDS: Acute Respiratory Distress Syndrome
BMI: Body Mass Index
CHF: Congestive Heart Failure
COVID-19: Coronavirus disease 2019
CVDs: CardioVascular Diseases
ICU: Intensive Care Unit
MERS: Middle East Respiratory Syndrome
NCDs: Non-Communicable Diseases
RHUH: Rafik Hariri University Hospital
RT-PCR: Real-Time Polymerase-Chain-Reaction
SARS: Severe Acute Respiratory Syndrome
SARS-CoV-2: Severe Acute Respiratory Syndrome CoronaVirus 2
WHO: World Health Organization

6. Declarations

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Consent for publication
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Authors' contributions
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