Comparative study of Clinical, Laboratory, and Imaging Features of COVID-19

Rami Qaisieh, Mohammad Al-Tamimi, Naser Hammouri, Marwan Shalabi, Muna M Kilani, Hana Taha, Abdallah Al-Muhtaseb, Ibrahim Alfarrajin, Marwan Abu Shaqra, Almothana Hamdan

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Abstract

Background: The clinical features, laboratory and imaging findings of COVID-19 disease are variable. Comparative studies of gender-related differences are limited.

Objective: This study aims to analyze the clinical, laboratory, and imaging features of COVID-19 in Jordan.

Methods: Clinical, laboratory and imaging data were collected for 557 confirmed COVID-19 patients admitted to Prince Hamzah Hospital (PHH), Jordan. Analysis was performed using appropriate statistical tests with SPSS version 24.

Results: Of the 557 COVID-19 PCR-positive cases admitted to PHH, the mean age was 34.4±18.95 (5 weeks to 87 years), 86% were males, 41.4% were blood group A+, and 57% were overweight or obese. Past medical history was documented in 25.9%, surgical history in 12.7%, current smoking in 15.0%, and 0.5% were pregnant. The mean duration of hospitalization was 16.3±9.2 (5 to 70) days. 53% were asymptomatic, 13% had more than 5 symptoms, with generalized malaise and dry cough were the most common symptoms. Only 2.8% had respiratory rate over 25/min and 2% had oxygen saturation below 85%. Laboratory investigations showed a wide range of abnormalities with lymphocytosis, CRP, ESR, and D-Dimer were the most common abnormalities. Ground glass opacity was the most common imaging finding. Male gender had significantly higher frequency of symptoms, smoking, hemoglobin, monocyte%, and creatinine levels, and ICU admissions compared to females (P ? 0.05). Hospitalization duration was associated with increased age, male gender, symptoms score, history of smoking, elevated systolic blood pressure, elevated respiratory rate, and elevated monocyte%, CRP, ESR, creatinine, and D-dimer (P ? 0.05).

Conclusions: The majority of COVID-19 cases admitted to PHH were asymptomatic. Variabilities in symptoms, signs, laboratory, and imaging findings should be noted. Increased age, male gender, smoking history, and elevated inflammatory markers were significantly associated with longer duration of hospitalization.

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Original Paper

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Abstract

Background: The clinical, laboratory and imaging features of COVID-19 disease are variable. Multiple Factors can affect the disease progression and outcome.

Objective: This study aims to analyze the clinical, laboratory, and imaging features of COVID-19 in Jordan.

Methods: Clinical, laboratory and imaging data were collected for 557 confirmed COVID-19 patients admitted to Prince Hamzah Hospital (PHH), Jordan. Analysis was performed using appropriate statistical tests with SPSS version 24.

Results: Of the 557 COVID-19 PCR-positive cases admitted to PHH, the mean age was 34.4±18.95 (5 weeks to 87 years), 86% were males, 41.4% were blood group A+, and 57% were overweight or obese. Significant past medical history was documented in 25.9%, significant surgical history in 12.7%, current smoking in 15.0%, and pregnancy in 0.5%. The mean duration of hospitalization was 16.3±9.2 (5 to 70) days. 53% were asymptomatic, 13% had more than 5 symptoms, with generalized malaise and dry cough the most common symptoms. Only 2.8% had a respiratory rate over 25

breaths/min, and 2% had an oxygen saturation below 85%. Laboratory investigations showed a wide range of abnormalities with lymphocytosis and elevated CRP, ESR, and D-Dimer the most common abnormalities. Ground glass opacity was the most common imaging finding. Males had a significantly higher frequency of symptoms, incidence of smoking, reduced hemoglobin, increased monocyte %, elevated creatinine levels, and ICU admissions compared to females ($P < 0.05$). Hospitalization duration was associated with increased age, male gender, symptom score, history of smoking, elevated systolic blood pressure, elevated respiratory rate, and elevated monocyte %, CRP, ESR, creatinine, and D-dimer ($P < 0.05$).

Conclusions: Most COVID-19 cases admitted to PHH were asymptomatic. Variabilities in symptoms, signs, laboratory results, and imaging findings should be noted. Increased age, male gender, smoking history, and elevated inflammatory markers were significantly associated with longer duration of hospitalization.

Keywords: COVID-19; gender; clinical; laboratory; imaging; SARS-CoV2; Jordan

Introduction

In December 2019, an outbreak of pneumonia of unknown etiology had been identified in Wuhan city, China [1]. Later, it was found that the causative pathogen was Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV2) [1]. The routes of transmission of this virus are mainly droplets and direct contact with patients, and the main source of the disease at present is patients with Coronavirus disease 2019 (COVID-19) [2]. On March 11th, the WHO declared COVID-19 a pandemic due to its exponential spread all over the globe [3].

Studies have shown that COVID-19 is a systemic disease where different systems are affected differently; therefore, the clinical manifestations of the disease vary from patient to patient, with fever (78-87%) and cough (57-68%) being the most common manifestations in adults. Other manifestations like dyspnea (23-24%), myalgia (17-24%), and fatigue (31-39%) were present to a lesser extent [4,5]. A small percentage of patients developed gastrointestinal symptoms such as nausea (6-6.5%), vomiting (4-6.5%), and diarrhea (8-10%) [4,5]. The least prevalent symptoms were ophthalmological (2-4%) and neurological (0-14%) [4,5]. The severity of the disease varies among patients with the elderly and patients with comorbidities being affected the most [6]. There are many complications of the disease such as acute respiratory distress syndrome, acute cardiac injury, acute kidney injury, and shock [7]. Patients are also at increased risk of hypercoagulability and thromboembolism [8].

X-ray imaging studies showed that bilateral involvement is more common than unilateral, and the most common lesion is a ground glass appearance followed by consolidation [4]. CT scans also confirmed these findings [9]. The most prevalent laboratory findings are decreased albumin, high C-reactive protein, lymphopenia, increased platelets, increased lactate dehydrogenase, and high erythrocyte sedimentation rate (ESR) [10].

Although the prevalence of COVID-19 is equal between males and females, the disease is more severe in males [11]. Some studies attributed this to a higher expression of angiotensin-converting enzyme 2 (ACE2), the receptor for SARS-CoV2, in males than females in pathological conditions [12]. Furthermore, it has been found that ACE2 expression is increased in current and ex-smokers, and smoking is more common in males than in females. Thus, the disease is more severe in males [13]. Patients with hypertension or COPD tend to have more severe COVID-19 disease. Children have less severe disease compared to adults, and these differences are possibly due to having different expression levels of ACE2 receptors [14]. While this disease involves mainly the respiratory tract, different organ systems can become involved.

Researchers have dug into massive gene expression datasets to show that other potential target cells that also produce ACE2 and TMPRSS2 are scattered throughout the body, which could explain the systemic nature of this disease [14]. While multiple studies reported the increased disease severity and mortality in males infected with COVID-19, no comparative studies were conducted regarding the differences in clinical, laboratory, and imaging findings according to gender [11-13,15].

The first case of COVID-19 in Jordan was registered on 2 March 2020 in a Jordanian citizen who came back from Italy [16], and the current number of cases as of 12 December 2020 exceeded 250,000 cases [3,16,17]. Even though there is a tremendous number of studies worldwide regarding COVID-19 patients' clinical features, laboratory, and imaging findings, there are only a few in our region (the Middle East), and no study has yet been done in Jordan. Clinical, laboratory, and imaging findings are widely variable according to geographic location, disease severity, SARS-CoV2 strains, population demographics and immunity, and other factors [2,10]. The aim of this study is to describe clinical manifestations, laboratory, and imaging findings of COVID-19 patients in Jordan with an emphasis on gender-related differences.

Methods

Study population

A total of 557 confirmed COVID-19 cases admitted to Prince Hamzah Hospital (PHH) during the period from 1 March 2020 to 1 August 2020 were recruited prospectively to this study after giving formal voluntary consent, and they were followed daily for clinical, para-clinical, and outcome parameters. All COVID-19 cases were confirmed by at least one positive COVID-19 RT-PCR test performed by an accredited referral lab. All COVID-19 recovery cases were confirmed by complete clinical and laboratory resolution, including two negative COVID-19 RT-PCR tests within 2 days. The government of Jordan had a policy at the time of the study to admit all COVID-19 positive patients to the hospital for isolation regardless of symptom severity.

Demographic, clinical, and laboratory data of COVID-19 patients in Jordan

Confirmed COVID-19 patients' demographics; clinical, social and medical history; and laboratory and imaging data were obtained directly from patients, relatives and/or medical records of patients admitted to PHH, Amman, Jordan (the main COVID-19 isolation and management center in Jordan). Data was recorded on the first day of admission and daily during follow ups. Demographic data collected included age, gender, weight, height, BMI, and blood group. Clinical data included symptoms reported by patients, vital signs, medical and surgical history, and duration of hospitalization. Laboratory data included all laboratory tests performed for patients during their admission. Imaging data assessed by an accredited radiology specialist was extracted for the 135 patients who had imaging studies (questionnaire (appendix 1) and primary data file (appendix 2) are provided as a supplementary material).

Statistical analysis

Descriptive statistical analysis was used for determination of demographic, clinical, laboratory, and imaging findings. Percentages and means ± standard deviation (SD) were calculated to describe the distributions of categorical and continuous variables, respectively. Chi-square and Fisher's exact tests were used to assess the association between the study participants' age, gender, body mass index (BMI), and duration of hospitalization with their clinical, laboratory and imaging data. The level of statistical significance was set at ≤ 0.05. Data were analyzed using Microsoft Excel-2010 and SPSS version 24.0.

Results

Demographics and clinical features of COVID-19 in Jordan

Of the 557 COVID-19 cases who were admitted to PHH, the gender distribution was 86% males, and 14% females. Among these patients, the mean age was 34.40 ± 18.95 years, range (5 weeks to 87 years), and the largest age group was 21-40 years (34.1%). The BMI was documented in 163 patients, 8.0% of them were underweight, 35.0% were normal weight, 29.4% were overweight and 27.6% were obese (**Table 1**). Blood groups were determined for 70 patients (12.6%) with blood group A+ (41.4%) and O+ (27.1%) being the most common. Significant past medical history was documented in 25.9% of patients, significant surgical history in 12.7%, current smoking in 15.0%, a history of allergies in 1.8%, and pregnancy in 0.5%. The mean duration of hospitalization was 16.35 ± 9.25 days, ranging from 5 to 70 days **(Table 1)**.

Table 1. Demographic and clinical data of COVID-19 patients admitted to PHH (n = 557). BMI: body mass index, and ND: not determined.

Category	Variable		Number	Relative Percentage	Absolute Percentage
Demographics	Age	< 1	10	1.8	1.8
		1-20	152	27.4	27.4
		21-40	190	34.1	34.1
		41-60	154	27.6	27.6
		61-80	48	8.6	8.6
		>80	3	0.5	0.5
	Gender	Male	478	86.0	86.0
		Female	78	14.0	14.0
	BMI	Underweight >18.5	13	8.0	2.3
		Normal 18.5-24.9	57	35.0	10.2
		Overweight 25-29.9	48	29.4	8.6
		Obese >30	45	27.6	8.1
		ND	394		70.7
	Blood group	A+	29	41.4	5.2
		B+	13	18.6	2.3
		AB+	2	2.9	0.4
		O+	19	27.1	3.4
		A-	1	1.4	0.2
		B-	1	1.4	0.2
		O-	5	7.1	0.9
		ND	487		87.4
	Admission Duration	5-14 days	336	60.3	60.3
		15-30 days	177	31.8	31.8
		31-46 days	33	5.9	5.9
		47-70 days	11	2.0	2.0
Symptoms	Generalized Malaise		120	21.5	21.5
	Headache		75	13.5	13.5
	Loss of Smell		70	12.5	12.5
	Diarrhea		57	10.2	10.2
	Loss of Taste		60	10.8	10.8
	Chills/Rigors		77	13.8	13.8
	Myalgia		61	11.0	11.0
	Nasal Congestion		72	12.9	12.9
	Dry Cough		121	21.7	21.7
	Fever		108	19.4	19.4
	Rhinorrhea		57	10.2	10.2
	Sweating		35	6.3	6.3
	Wet Cough		44	7.9	7.9

	Shortness of Breath		56	10.0	10.0
	Abdominal Pain		33	5.9	5.9
	Chest Pain		29	5.2	5.2
	Palpitations		12	2.2	2.2
	Hemoptysis		5	0.9	0.9
	Others		48	8.6	8.6
	Symptoms scores	Asymptomatic	293	52.6	52.6
		Mild: 1-5	192	34.5	34.5
		Moderate: 6-10	50	9.0	9.0
		Severe: 11-17	22	4.0	4.0
Past Medical History	Yes		144	26.1	25.9
	Asthma		8	1.4	1.4
	Hypertension		25	4.5	4.5
	Diabetes		19	3.4	3.4
	Diabetes and hypertension		60	10.8	10.8
	Pregnancy		3	0.5	0.5
	Others		33	5.9	5.9
	No		408	73.9	73.2
	ND		5		0.9
Past Surgical History	Yes		70	12.6	12.6
	No		487	87.4	87.4
Allergic History	Yes		10	2.6	1.8
	No		377	97.4	67.7
	ND		170		30.5
Smoking	Past smoker		12	3.6	2.2
	Current smoker		83	25.2	15.0
	None smoker		234	71.1	42.0
	ND		228		41.0
Signs	Heart rate	less than 60/min	2	0.4	0.4
		60-80/min	257	48.5	46.1
		81-128/min	271	51.1	48.7
		ND	27		4.8
	Systolic BP	less than 120 mmHg	243	47.8	43.6
		120-139 mmHg	241	47.4	43.3
		140-159 mmHg	21	4.1	3.8
		more than 160 mmHg	3	0.6	0.5
		ND	49		8.8
	Diastolic BP	less than 80 mmHg	374	73.6	67.1
		80-89 mmHg	115	22.6	20.6
		90-99 mmHg	16	3.1	2.9
		More than 100 mmHg	3	0.6	0.5
		ND	49		8.8
	Respiratory rate	less than 12/ min	0	0.0	0.0
		12-25/min	493	97.2	88.5
		more than 25/min	14	2.8	2.5
		ND	50		9.0
	Oxygen Saturation	less than 80%	4	0.8	0.7
		80-84%	6	1.2	1.1
		85-94%	52	10.0	9.3
		95-100%	458	88.1	82.2
		ND	37		6.6

The patients complained of a variety of symptoms; nevertheless, most of the patients (52.6%) were

asymptomatic, while 34.5% had 1 to 5 symptoms, 9.0% had 6 to 10 symptoms, and 4.0% had more than 11 symptoms. Among the symptomatic patients, generalized malaise and dry cough were the most common symptoms, and they were documented in (21.5%) and (21.7%) of the patients, respectively. These were followed by fever (19.4%), chills and rigors (13.8%), headache (13.5%), nasal congestion (12.9%), loss of smell (12.5%), myalgia (11.0%), loss of taste (10.8%), rhinorrhea (10.2%), and shortness of breath (10.0%). Gastrointestinal symptoms were less frequently documented with diarrhea (10.2%) and abdominal pain (5.9%) being most prevalent. The least reported symptoms were chest pain (5.2%), palpitations (2.2%), and hemoptysis (0.9%) (**Table 1**). Regarding the vital signs of admitted COVID-19 patients, more than 50% of patients had heart rate over 80 beats per min and systolic blood pressure over 120 mmHg, while over 25% had a diastolic pressure above 80 mmHg. Only 2.8% had a respiratory rate over 25 per min with about 2% having an oxygen saturation below 85% (**Table 1**).

Laboratory data of COVID-19

Laboratory investigations of COVID-19 patients admitted to PHH **(Table 2)**, showed low hemoglobin and hematocrit in 10.3% and 8.1% respectively. Total white blood cell count was low in 7.5% and high in 5.1%. Differential count showed that the neutrophil percentage was low in 14.8%, the lymphocyte percentage was low in 13.1% and high in 30.0%, the basophil percentage was low in 46.6%, the eosinophil percentage was low in 45.3%, and the monocytes percentage was high in 27.4%. Platelet count was low in 6.9%, with high PT, INR, and D-dimer found in 4.5%, 7.2%, and 21.6%, respectively. Inflammatory markers including CRP and ESR were elevated in 33.2% and 50.9% of patients, respectively. Urea and creatinine were elevated in 3.8% and 5.2% respectively. AST, ALT, and LDH were elevated in 12.1%, 10.0%, and 7.7%, respectively. Bilirubin total and direct showed elevation in 15.5% and 7.5%, respectively. Hyponatremia and hypokalemia were found in 5.5% and 4.5%, respectively **(Table 2).**

Table 2. Laboratory data from COVID-19 patients admitted to PHH (n = 557). HB: hemoglobin, HCT: hematocrit, WBC: white blood cells, CRP: C-reactive protein, ESR: erythrocyte sedimentation rate, PT: prothrombin time, INR: international normalized ratio, AST: aspartate transaminase, ALT: alanine transaminase, LDH: lactate dehydrogenase, ALP: Alkaline Phosphatase, ND: not determined.

Investigations	Mean ± SD	Variable	Number	Relative Percentage	Absolute Percentage
HB g/dL	13.92 ± 1.73	Low <12	55	10.3	9.9
		Normal 12-16	418	78.3	75.0
		High >16	61	11.4	11.0
		ND	23		4.1
HCT%	41.12 ± 5.18	Low <35	43	8.1	7.7
		Normal 35-47	435	81.5	78.1
		High >47	56	10.5	10.1
		ND	23		4.1
WBC/µL	7190 ± 4.19	Low <4000	40	7.5	7.2
		Normal 4000-11000	466	87.4	83.7
		High >11000	27	5.1	4.8
		ND	24		4.3
Neutrophil %	52.82 ± 25.92	Low <40	79	14.8	14.2
		Normal 40-80	430	80.5	77.2
		High >80	25	4.7	4.5
		ND	23		4.1
Lymphocyte %	32.97 ± 15.99	Low <20	70	13.1	12.6
		Normal 20-40	304	56.9	54.6
		High >40	160	30.0	28.7
		ND	23		4.1
Basophil %	0.51 ± 0.35	Low <0.5	250	46.6	44.9

		Normal 0.5-1	258	48.1	46.3
		High >1	28	5.2	5.0
		ND	21		3.8
Monocyte %	9.17 ± 4.10	Low <2	4	0.8	0.7
		Normal 2-10	383	71.9	68.8
		High >10	146	27.4	26.2
		ND	24		4.3
Eosinophil %	1.59 ± 1.82	Low <1	242	45.3	43.4
		Normal 1-6	276	51.7	49.6
		High >6	17	3.0	3.1
		ND	22		3.9
Platelets count/µL	251 900/µL ± 107 320	Low <150 000	37	6.9	6.6
		Normal 150 000-450 000	488	91.6	87.6
		High >450 000	8	1.5	1.4
		ND	24		4.3
CRP mg/L	14 ± 38	Normal 0-5.0	322	66.3	57.8
		High >5.0	160	33.2	28.7
		ND	75		13.5
ESR mm/hr	28.27 ± 28.96	Normal 0-15	142	49.1	25.5
		High >20	147	50.9	26.4
		ND	268		48.1
PT sec	13.54 ± 2.80	Low <12	16	5.5	2.9
		Normal 12-16	262	90.0	47.0
		High >16	13	4.5	2.3
		ND	266		47.8
INR	1.05 ± 0.18	Low <0.85	1	0.4	0.2
		Normal 0.85-1.15	255	92.4	45.8
		High >1.15	20	7.2	3.6
		ND	281		50.4
Urea mmol/L	4.74 ± 2.13	Low < 2.86	39	7.8	7.0
		Normal 2.86 – 8.2	444	88.4	79.7
		High > 8.2	19	3.8	3.4
		ND	55		9.9
Creatinine mmol/L	74.08 ± 70.52	Low < 59	161	31.1	28.9
		Normal 59 – 104	329	63.3	59.1
		High > 104	27	5.2	4.8
		ND	40		7.2
Sodium mmol/L	125.77 ± 40.04	Low < 135	28	5.5	5.0
		Normal 135 – 152	479	94.5	86.0
		High > 152	0	0.0	0.0
		ND	50		9.0
Potassium mmol/L	4.68 ± 8.29	Low < 3.5	23	4.5	4.1
		Normal 3.5 – 5.3	476	93.9	85.5
		High > 5.3	8	1.6	1.4
		ND	50		9.0
AST U/L	27.64 ± 23.15	Normal ≤ 38	414	87.9	74.3
		High > 38	57	12.1	10.2
		ND	86		15.4
ALT U/L	24.21 ± 22.18	Normal ≤ 41	443	90.0	79.6
		High > 41	49	10.0	8.8
		ND	65		11.7
LDH U/L	248.62 ± 301.74	Low < 125	13	3.6	2.3
		Normal 125-378	321	88.7	57.6
		High > 378	28	7.7	5.0
		ND	195		35.0
ALP U/L	89.74 ± 66.82	Low < 40	15	5.7	2.7
		Normal 40-150	226	85.3	40.6
		High > 150	24	9.1	4.3
		ND	292		52.4

D-Dimer µg/mL	0.524 ± 0.865	Normal < 0.5	265	78.4	47.6
		High > 0.5	73	21.6	13.1
		ND	219		39.3
Ferritin ng/ml	161.32 ± 262.51	Low <12	11	3.7	2.0
		Normal 12-300	255	86.7	45.8
		High >300	28	9.5	5.0
		ND	263		47.2
Bilirubin (total) µmol/L	11.52 ± 5.49	Low < 3	9	2.7	1.6
		Normal 3-16	269	81.8	48.3
		High > 16	51	15.5	9.2
		ND	228		40.9
Bilirubin (direct) µmol/L	2.73 ± 4.81	Normal < 5.1	282	92.5	50.6
		High > 5.1	23	7.5	4.1
		ND	252		45.2

Radiological features of COVID-19

The following radiological data were obtained for 135 COVID-19 patients. CT scan studies of the chest showed that the most common appearance of infiltrates was ground glass opacity (32.6%), followed by broncho-alveolar consolidation (10.4%). Central involvement was noticed in 7.4% of the patients, while peripheral involvement was observed in 26.0 % of the patients. Also, 25.2% of the patients had lesions that were located posteriorly, in comparison to 8.1% who had anterior lesions and 25.2% who had mediastinal lymphadenopathy. The most affected lobe was the right lower lobe (28.1%), followed by the left lower lobe (24.4%), then the left upper lobe (17%), then the right upper lobe (16.3%), and the right middle lobe (14.8%) (**Table 3)**.

Table 3. Clinical imaging data for COVID-19 patients admitted to PHH (n = 135). ND: not determined.

Chest CT scan			
Variable	**Number**	Relative Percentage	Absolute Percentage
Patterns of infiltrates			
Ground glass opacity	44	32.6	7.8
Broncho-Alveolar Consolidation	14	10.4	2.5
Crazy paving	4	3.0	0.7
Subpleural retraction	3	2.2	0.5
Bronchiectasis	2	1.5	0.5
Vascular dilatation	0	0.0	0.0
Central VS Peripheral			
Central	10	7.4	1.8
Peripheral	35	26.0	6.3
Anterior VS Posterior			
Anterior	11	8.1	2.0
Posterior	34	25.2	6.1
Pleural effusion	0	0.0	0.0
Mediastinal lymphadenopathy	34	25.2	6.1
Lobe affected			
Right upper lobe	22	16.3	4.0
Right middle lobe	20	14.8	3.6
Right lower lobe	38	28.1	6.8
Left upper lobe	23	17.0	4.1
Left lower lobe	33	24.4	5.9
Chest X-Ray scan			
Variable	**Number**	**Relative Percentage**	**Absolute Percentage**
Hilum Affected	0	0.0	0.0

Infiltration			
Solitary	3	2.2	0.5
Multiple	20	14.8	3.5
ND	112	83.0	20.1
Central VS Peripheral			
Central	3	2.2	0.5
Peripheral	4	3.0	0.7
Both	1	0.7	0.2
ND	127	94.1	22.8
Affected lung lobes			
Right upper lobe	12	8.9	2.2
Right middle lobe	17	12.6	3.1
Right lower lobe	21	15.6	3.8
Left upper lobe	12	8.9	2.1
Left middle lobe	16	11.9	2.9
Left lower lobe	17	12.6	2.3
Affected lung apices	1	0.7	0.2
Pleural effusion	2	1.5	0.4
Widened Mediastinum	0	0.0	0.0

X-ray scans showed that 3 patients (2.2%) had solitary infiltrates, while 20 patients (14.8%) had multiple infiltrates. Also, it showed that 4 patients (3%) had peripheral lesions, 3 patients (2.2%) had central lesions, and 1 patient (0.7%) had both peripheral and central lesions. Regarding the most affected lung lobes the data came as the following: left lower lobe (12.6%), right lower lobe (15.6%), right middle lobe (12.6%), right upper lobe (8.9%), and left upper lobe (8.9%). Only one patient (0.7%) had affected lung apices, and only 2 patients (1.5%) had a pleural effusion. No patient had hilar involvement or a widened mediastinum **(Table 3).**

Association between age, gender, BMI, and hospitalization duration with COVID-19 clinical, laboratory, and imaging data

Males had a significantly higher frequency of having symptoms (symptom score) compared to females (51% vs 24.4%, $P = 0.004$). Furthermore, generalized malaise, diarrhea, chills/rigors, dry cough, rhinorrhea, and fever were significantly more frequent in males than females ($P \leq 0.05$). The mean heart rate and frequency of elevated heart rate was significantly higher in males compared to females ($P = 0.018$). Past medical, past surgical, allergy, and smoking history were significantly higher in males than females ($P \leq 0.001$). Hemoglobin, hematocrit, monocyte %, basophile %, and creatinine levels were significantly higher in males compared to females ($P < 0.05$), while ESR, ALP, and D-dimer levels were significantly higher in females compared to males ($P \leq 0.05$). Hospitalization duration and ICU admission were significantly higher in males than females ($P = 0.000$). Seven men and one woman were admitted to the ICU, and two men died. **Table 4** shows the association between age, gender, BMI, and hospitalization duration in relation to symptoms and signs, laboratory data, and imaging findings.

Table 4: Association between age, gender, BMI, and hospitalization duration with COVID-19 clinical, laboratory and imaging data (*Significant associations, $P \leq 0.05$).

Variable		Age	Gender	BMI	Hospitalization duration
Symptoms	Dry Cough	***0.026**	***0.020**	0.839	***0.000**
	Fever	0.068	***0.030**	0.061	***0.000**
	Wet Cough	***0.001**	0.131	0.532	***0.001**
	Chills/Rigors	0.273	***0.003**	0.311	***0.000**
	Sweating	0.993	0.270	0.611	***0.004**
	Generalized Malaise	***0.012**	***0.000**	0.228	***0.000**
	Myalgia	0.396	0.054	0.187	***0.000**
	Shortness of Breath	***0.001**	0.458	0.230	***0.000**
	Headache	***0.016**	0.083	0.219	***0.000**

	Hemoptysis	0.715	0.635	0.229	0.251
	Diarrhea	*0.013	*0.041	0.168	*0.000
	Chest Pain	*0.001	0.266	0.966	*0.002
	Abdominal Pain	0.101	0.344	0.573	*0.003
	Palpitations	*0.001	0.529	0.660	*0.013
	Loss of Taste	*0.000	0.264	0.484	*0.000
	Loss of smell	*0.000	0.228	0.770	*0.006
	Rhinorrhea	*0.003	*0.03	0.923	*0.000
	Nasal Congestion	0.140	0.199	0.161	*0.000
	Symptoms severity score	*0.029	*0.004	*0.047	*0.000
History	Past medical history	*0.000	*0.001	0.502	* 0.000
	Past surgical history	*0.000	*0.001	0.423	*0.001
	Allergy	0.239	*0.000	0.410	*0.000
	Smoking	*0.000	*0.000	0.185	*0.000
Signs	Heart rate	0.132	*0.018	0.595	* 0.000
	BP Systole	*0.000	0.416	*0.016	*0.001
	BP diastole	*0.008	0.282	*0.035	*0.000
	Respiratory rate	0.080	0.125	0.871	*0.001
	O2 saturation	*0.000	0.894	0.738	*0.000
	Hemoglobin	*0.000	*0.000	0.565	0.337
Laboratory	Hematocrit	*0.000	*0.000	0.721	0.614
	WBC	0.067	0.311	0.696	*0.000
	Neutrophil	*0.000	0.252	0.260	0.122
	Basophiles	0.320	*0.046	0.496	0.717
	Monocytes	0.308	*0.018	0.620	*0.000
	Eosinophils	*0.000	0.326	0.609	*0.002
	Lymphocytes	*0.000	0.702	0.231	0.091
	Platelets	*0.002	0.473	0.620	0.351
	C reactive protein	*0.000	0.514	0.000*	*0.006
	ESR	*0.000	*0.000	*0.029	*0.042
	PT	*0.038	0.856	0.972	0.462
	INR	0.354	0.909	0.301	*0.000
	Urea	*0.000	0.078	0.158	0.390
	Creatinine	*0.000	*0.000	*0.000	*0.014
	Sodium	*0.000	0.772	0.409	0.793
	Potassium	*0.037	0.491	0.300	0.252
	AST	*0.005	0.610	0.410	*0.050
	ALT	*0.019	0.139	*0.015	0.056
	LDH	*0.045	0.911	0.110	0.120
	ALP	*0.000	*0.037	*0.000	0.073
	D-Dimer	*0.000	*0.012	0.104	0.237
	Ferritin	*0.000	0.262	0.441	0.507
	Total bilirubin	0.704	0.310	0.107	0.668
	Bilirubin Direct	0.331	0.060	0.932	*0.005
Imaging	Chest X ray	*0.000	0.520	*0.023	0.245
	CT scan conclusion	*0.001	0.893	*0.003	0.715
Other	Hospitalization duration	*0.000	*0.001	0.906	
	Age		0.225	*0.000	*0.000
	Gender of patient	0.225		0.159	*0.001
	BMI	*0.000	0.159		0.906

Increased age was significantly associated with a higher frequency of symptoms (symptom score) ($P = 0.029$); increased frequency of generalized malaise, headache, loss of smell, diarrhea, loss of taste, rhinorrhea, wet and dry cough, shortness of breath, chest pain, and palpitations; higher frequency of significant past medical, past surgical, and smoking history; and increased blood pressure, lower oxygen saturation, and higher BMI ($P \leq 0.05$). Furthermore, increased age was significantly associated with elevated CRP, ESR, urea, creatinine, ALT, ALP, and positive imaging findings ($P \leq$

0.05) **(Table 4)**. Higher BMI was associated with increased age, higher symptom score, elevated blood pressure, CRP, ESR, creatinine, ALT, ALP, and positive imaging findings ($P \leq 0.05$) **(Table 4)**. Hospitalization duration was positively associated with increased age, male gender, higher symptom score, history of smoking, significant past medical and surgical history, elevated systolic blood pressure, elevated respiratory rate, lower oxygen saturation, elevated monocyte %, elevated CRP and ESR, increased creatinine, and elevated D-dimer ($P < 0.05$) (**Table 4**).

Discussion

Jordan has successfully managed to contain the first wave of the SARS-CoV2 virus by implementing early lockdowns. The lockdown began on 18 March 2020, when the number of known cases of the virus was less than 20. Jordan closed its borders on 16 March 2020 and kept arriving passengers in quarantine. Extensive contact tracing was carried out, and every person who tested positive for the virus was admitted to the hospital to control the spread of the virus [17]. These measures resulted in Jordan having less COVID-19 cases per capita compared to other countries in the region and around the world. By 15 May 2020, Jordan had 58 cases per 1 million population (1 M pop) and 0.9 deaths/ 1 M pop, compared to Portugal with about the same population and 2776 cases/1 M pop and 116/1 M pop death, Greece, with 266 cases/1 M pop and 15 deaths/1 M pop. Neighboring Saudi Arabia had 1349 cases/1 M pop and eight deaths/ 1 M pop [3,16-18].

Having all patients positive for the virus admitted to the hospital for isolation provided an opportunity to study the clinical and laboratory characteristics in patients with SARS-CoV2 viral infection in Jordan. PHH in Jordan was the main hospital designated to admit patients positive for the SARS-CoV2 virus. The patients were admitted regardless of their symptoms. In Jordan, most cases were in the age range of 21-40 years (34.1%), which is comparable to other studies [2,19]. Furthermore, a meta-analysis later in the pandemic by Pourmohammad *et al* had a mean age of patients at 48 years from studies around the world [4].

In this study the younger age group (0-20 years) represented about 29% of the cases, which was higher than the percentile of young people infected in Saudi Arabia and China, where the percentage was about 15%, [2,19]. More recently, in the US, children under 18 represented 12% of all COVID19 cases, [20]. In South Korea, where all patients with positive tests were also admitted, only 9% of the patients were under 20 years of age with the population under 24 compromising about 24% of the population of the nation [21]. The age group under 20 years old represents about 44% of the Jordanian population [18], and this is the most likely reason for this higher percentage of COVID-19 cases among the young. Also likely contributing to this is the fact that all patients with positive tests were admitted, and extensive contact tracing was carried out.

There were more males than females in this study (86% males) which is different from other studies that either showed a slightly increased percentage of male patients [4,19] or, in a more recent meta-analysis of three million patients, showed equal infection rates between the two sexes [22]. This difference is difficult to explain but could be caused by the fact that SARS-CoV2 infection was mainly contracted by travelers and men working in the trucking business who then spread the disease to their family members [16]. Regarding the symptoms of COVID-19 patients in this study, most patients were asymptomatic (52.6%), and among symptomatic patients dry cough (21.7%) and generalized malaise (21.5%), followed by fever at (19.4%), were the most prevalent symptoms. This is quite similar to other studies where two meta-analyses showed that fever and cough were the most common symptoms [10,23]. Less common symptoms such as headache (13.5%), rhinorrhea (10.2%) and diarrhea (10.2%) were reported at much higher percentages in this study [24]. This is most likely explained by the fact that all patients with SARS-CoV2 viral infection were admitted regardless of symptoms, whereas other studies mainly included patients hospitalized due to their symptoms.

In this study, only 13.1% of COVID-19 patients had lymphopenia while 30% had lymphocytosis and 56.9% of patients had a normal lymphocyte count. This contrasts with most other studies that tended to show an association between lymphopenia and COVID-19 [4,10]. Some studies hypothesized that lymphopenia may correlate with disease severity, such that lymphocyte count could possibly be used as a prognostic factor for COVID-19 patients [26,25]. Since more than half of the patients in our study were asymptomatic, this may explain the low percentage of COVID-19 patients found to have lymphopenia.

Inflammatory markers in COVID-19 patients in our study, including CRP, ESR and LDH, were inconsistent with two meta-analyses [4,10]. This is most likely due to the high percentage of asymptomatic (52.6%) patients in this study. This finding increases the possibility of a positive association between high inflammatory markers and the severity of COVID-19, as proposed by yet another meta-analysis [27]. Abnormal liver enzymes, including AST and ALT, were at lower rates compared to the results found elsewhere [28].

The radiological data from CT and X-ray scans of 135 patients were collected and analyzed. The most common lesion detected by CT scan was ground glass appearance, and this is consistent with what was found in the meta-analysis done by ?(whom, probably need a name here) [9], but at a much lower rate than they found (32.6% vs. 90.35%, respectively). Peripheral involvement was more common than central involvement, and posterior involvement was more common than anterior involvement. These findings are similar to what was found by another study [29]. Multi-lobar distribution was more common than uni-lobar distribution, and the lower lobes were more affected than the upper lobes. Other studies found similar results [30,31]. The majority of patients who underwent chest X-ray had normal results, while Wong *et al.*, [31] found that (69%) of the patients had abnormal findings on their chest radiography. This may be related to the fact that the majority of the patients in our study were asymptomatic.

When comparing male patients to female patients admitted with SARS-CoV2 infection, it was noted that male patients were more symptomatic than female patients (51% vs 24.4%, $P < 0.05$). Males were also more likely to be admitted to intensive care units. In a meta-analysis that compared around three million patients from around the world [22], males had a higher rate of intensive care unit admission and mortality as well. The reason for this difference in morbidity and mortality between the sexes may be due to differences in the adaptive and innate immune system, as the adaptive immune system in females has a higher number of CD 4 T cells [32,33] and stronger CD 8 cytotoxic activity [34]. Women also have more B cells and antibody production [32,35]. The reason for these differences is due to X-linked genes that affect the immune response to viruses [15,35].

Age was associated with increased symptoms ($P < 0.05$) and abnormal lab results. This has been documented in many other studies [36,37]. Age is also related to increased co-morbidities, and in one meta-analysis where there was an attempt to control for co-morbidities, age itself remained a weak risk factor [38]. In our study, having an increased BMI was associated with having more symptoms, and this finding is similar to other studies and meta-analyses [39,40].

This study is the first study to address the clinical, laboratory and radiological features of COVID-19 patients in Jordan, and it was conducted on 557 patients, a considerable number of subjects. A downside of this study is that all of subjects were from one center (PHH). Also, the data regarding laboratory testing and imaging were incompletely collected.

Conclusions

This is the first study to describe in detail all the clinical, laboratory, and imaging findings of the first confirmed 557 COVID-19 patients admitted to PHH in Jordan. Most cases were asymptomatic, male,

and overweight or obese. Generalized malaise and dry cough were the most common symptoms. Only 2.8% had a respiratory rate over 25 breaths/min, and 2% had an oxygen saturation below 85%. Lymphocytosis and elevated CRP, ESR, and D-Dimer were the most common laboratory abnormalities, while ground glass opacity was the most common imaging finding. Males. had significantly higher frequency of symptoms, smoking, abnormal laboratory findings, and ICU admissions compared to females. Hospitalization duration was positively correlated with increased age, male gender, symptom score, history of smoking, elevated systolic blood pressure, elevated respiratory rate, elevated monocyte %, and elevated CRP, ESR, creatinine, and D-dimer.

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Conflict of interest statement

All authors declare no conflicts of interest.

Ethical approval

The study protocol was approved by the IRB at the Hashemite University (No: 1⁄5⁄2019⁄2020) and the Jordanian Ministry of Health⁄PHH IRB (No: 1/ 1631).

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Supplementary Files

Multimedia Appendixes

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