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Original article

Characteristics, and predictive factors of disease severity in hospitalized patients with SARS-CoV-2 in Fayoum governorate, Egypt: a multicenter study

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ABSTRACT

Background: Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemic is a serious health problem all over the world including Egypt, thus realizing the predictive factors and disease's characteristics is an essential issue. **Objectives**: To evaluate the characteristics of laboratory-confirmed cases of SARS-CoV-2 infection in Fayoum governorate, Egypt, and to determine the predictive factors of disease severity. **Methods**: One hundred-fourty patients confirmed with SARS-CoV-2 from the Fayoum governorate, Egypt, were collected in this descriptive multicenter study. The subtype classification of SARS-CoV-2 was according to the World Health Organization (WHO) guideline SARS-CoV-2 disease severity classification. Patients were divided into a asymptomatic/non-severe cases group and a severe/critical case group. Each patient was subjected to chest computed tomography (CT), clinical, and laboratory assessment in form of complete blood count, neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-monocyte ratio (LMR), platelet-to-lymphocyte ratio (PLR), liver function tests, urea, creatinine, C-reactive protein (CRP), serum ferritin, and D-dimer. **Results:** Severe/critical patients were older (52.0±12.6) with a statistical significantly higher rate of diabetes mellitus, hypertension, and tuberculosis (TB) ($p<0.001$) than non-severe cases. Dyspnea was the most prevalent significant symptom among severe /critical group (87.5%, $p<0.001$). A negative correlation between radiographic score and oxygenation index (r = -0.302, $p=0.007$). Using the ROC analysis, the area under curve (AUC) was highest for a radiographic score, D-dimer, CRP, ferritin, and NLR, with $p<0.05$ in severe/critical cases. **Conclusions**: Elevated CRP, D-dimer, serum ferritin, radiograph score, and NLR may contribute to the judgment of SARS-CoV-2 severity, and help clinicians to evaluate the patient's condition. Co-infection of SARS-CoV-2 and TB can occur, and may progress towards severe SARS-CoV-2.

Introduction

In December 2019, the 2019 novel coronavirus pneumonia (NCP) was first discovered, which initially broke out in China, especially in Hubei province. The previously provisionally named 2019-nCoV was renamed by the International Committee on Taxonomy of Viruses as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), one month after the first novel

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coronavirus infected disease (SARS-CoV-2) was diagnosed [1].

By March 16, 2020, the number of SARS-CoV-2 cases outside China had drastically increased and the number of affected countries, states, or territories reporting infections to the World Health Organization (WHO) was 143 [2]. Egypt announced its first SARS-CoV-2 case, On February 14, 2020 [3].

The final diagnosis relies on real-time reverse-transcriptase polymerase chain reaction (RT-PCR) positivity for the presence of coronavirus [4]. Also, imaging plays an important role in the evaluation and diagnosis of the disease [5].

Peripheral white blood cell (WBC) count, neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-monocyte ratio (LMR) and platelet-to-lymphocyte ratio (PLR) are considered as indicators of the systematic inflammatory response [6]. That are regularly used as important predictors for the prognosis of patients with viral pneumonia.

Co-infection of SARS-CoV-2 and mycobacterium tuberculosis (TB) could occur during the recent SARS-CoV-2 pandemic [7].

To our knowledge, the information on the patients' characteristics of SARS-CoV-2 infection, and the risk factors of disease severity in Egypt is scarce, therefore, we conducted this descriptive study to evaluate the characteristics of laboratory-confirmed cases of SARS-CoV-2 infection in Fayoum governorate, Egypt, and to determine the predictive factors of disease severity.

Materials and Methods

Study design and setting

For this multicenter, descriptive cross-sectional study, we identified 140 patients with laboratory-confirmed SARS-CoV-2 infection from three designated SARS-CoV-2 hospitals (Fayoum chest hospital, Fayoum fever hospital, and Fayoum university hospital) in Fayoum governorate, Egypt, convenience sampling was selected in the period between May1 and June 30, 2020.

The study was reviewed and approved by The Ethics Committee of Faculty of Medicine, Fayoum University (ethical approval number, 2020-R135). The research was performed according to the Declaration of Helsinki guidelines, and the requirement for patient consent was waived in light of the nature of this emerging infectious disease.

In our study, the subtype classification of SARS-CoV-2 was according to WHO guideline; SARS-CoV-2 disease severity classification into mild, moderate, severe, and critical types [8].

Patients were divided into two groups: asymptomatic/non-severe cases group including: (asymptomatic-mild-moderate cases), and severe/critical cases group including: (severe & critical cases).

The inclusion criteria were (1) the availability of a positive RT-PCR tests confirming SARS-CoV-2 (2) the availability of a chest CT at the time of diagnosis. **The exclusion criteria** were (1) patients who had not been confirmed by RT-PCR tests (2) a delay between chest CT and confirmation of the clinical type longer than 3 days (3) patients with common bacteria or viruses associated with community-acquired pneumonia.

Detailed medical history for the included patients in the form of age, gender, co-morbidity (e.g., diabetes mellitus (DM), systemic hypertension (HTN), TB, and chronic diseases), and clinical manifestation of SARS-CoV-2 (fever, dry cough, dyspnea, sore throat, anosmia, loss of taste, bone pain, vomiting, diarrhea, and epigastric pain) were analyzed.

Laboratory assessments consisted of; Complete blood count [(hemoglobin (HB), platelet count, WBC count, lymphocyte count and percent, mononuclear count and percent, neutrophils count and percent] was assessed by (Horiba ABX Micros 60 Hematology Analyzer). NLR, PLR, and LMR were measured as indicators of prognosis and severity of patients.

Blood biochemistry parameters: aspartate aminotransferase (AST), alanine aminotransferase (ALT), urea, and creatinine were assessed by (Beckman Coulter AU 480/JAPAN). Quantitative C-reactive protein (CRP) was assessed by automated CRP analyzer (HEALES QR-1000), serum ferritin was measured using the electrochemiluminescence method on (Beckman Coulter ACCESS 2immunoassay/US), and D- dimer was assessed by quantitative chemiluminescent enzyme immunoassay by (THE PATHFAST D-Dimer assay).

Laboratory confirmation of SARS-CoV-2 by real-time reverse-transcriptase polymerase chain reaction (RT-PCR) method was done in the molecular biology lab in Clinical Pathology Department, Faculty of Medicine, Fayoum University Hospital. Nasopharynx-swab specimens

from all suspected SARS-CoV-2 infection patients were collected using specialized Dacron swabs, and preserved into vials containing viral transport medium STOR-F (DNA technology, Russia). After collection, samples must be packaged appropriately and transported to the laboratory as soon as possible and processed immediately. Viral RNA was extracted and purified from the specimen using automated extractor Lab Turbo 48 Compact System (Tiagen Bioscience Corporation, Taiwan), on the basis of the manufacturer's protocol. SARS-CoV-2 detection by RT-PCR was performed using SARS-CoV-2/SARS-CoV Multiplex REAL-TIME PCR Detection Kit (cat. no R3-P436-S3/9EU; DNA technology Research &. Production, LLC, Russia), according to the manufacturer's protocol. The thermocycling conditions of RT-PCR were as follows: 35˚C for 20 min and 95˚C for 5 min, 50 cycles of amplification at 94˚C for 10 sec and 64˚C for 15 sec, followed by 80˚C for 1 min using DT lite thermocycler (DNA technology Research &. Production, LLC, Russia). Negative and positive control samples were included in the SARS-CoV-2 Fluorescent PCR kit. The viral load of the studied group was analyzed by calculate the RT-PCR cycle threshold (CT) of ORF1ab gene at time of hospital admission which reflected the quantification of viral nucleic acid in nasopharyngeal specimens.

Radiological assessment was performed for all patients by a non-enhanced CT. All lesions were evaluated for the following characteristics: a) attenuation: ground-glass attenuation including ground-glass opacity (GGO), consolidation, or mixed pattern; b) involvement of the five lung lobes; (c) location: right, left, or bilateral; d) total radiographic score was calculated with a range from 0 to 5 [9].

Statistical analysis

Analyses were done using SPSS software (Version 16.0). Variables were described as (r) that calculate the correlation coefficient of the sample, percentages, mean and standard deviation (SD), and median (interquartile range) values. The comparison between groups was performed by $\chi 2$ and Fisher exact tests for categorical variables, independent sample t-test for normally distributed data; otherwise, the Mann-Whitney U test was used. Spearman correlation was used to assess the association of the radiographic score and oxygenation index. Predictive factors for severe/critical novel coronavirus pneumonia cases were detected by forward stepwise logistic regression analysis. Receiver operating characteristic (ROC) was used, the corresponding cutoff value was identified. Statistical significance was considered if $p < 0.05$.

Results

Clinical characteristics, and radiological results of the studied groups

We categorized patients into asymptomatic /non-severe cases group (108,77%) including: asymptomatic-mild-moderate cases, and severe/critical cases group (32, 23%) including: severe & critical cases.

Regarding the severity classification of SARS-CoV-2 , 16 (11.4%) were asymptomatic cases, there were equal number of mild and moderate cases 46 (32.9%) for each, 26 (18.6%) were severe cases and 6 (4.30%) were critical cases.

The mean age of the studied groups was (38.64 ± 13.39). While, the mean age of severe/critical cases was (52.0 ± 12.6) which was significantly older than that of asymptomatic /non-severe group (34.69 ± 10.89) (*p<0.001*). Nighty-sex cases (68.6%) were men with no sex difference between the 2 groups.

Regarding co-morbidity, the number and percent of patients with comorbidity as DM (n=12, 37.5%), HTN (n=6, 18.8%), and TB (n=6, 18.8%) were significantly high in severe/critical cases (*p<0.001*). While, no detected patients with such comorbidity in asymptomatic /non-severe cases.

The most common symptoms in the studied groups were fever 86 (61.4%), dry cough 66 (47.1%), and dyspnea 38 (27.5%).

The most prevalent symptom among sever /critical group was dyspnea (87.5%) with a statistically significant difference (*p<0.001*) followed by fever, and dry cough (68.5% for each) (*p=0.333*, and *0.005* respectively). The details of clinical characteristic of the studied groups were discussed in **(Table 1)**.

In our study, 140 patients infected with SARS-CoV-2 who underwent CT scan at time of admission; 62 patients had entirely normal CT findings. Excluding those with a normal initial imaging finding, the details radiological results of the remaining 78 of 140 patients were discussed in **(Table 2)**.

The median of the total radiographic score was 2.0; the radiographic score was significantly correlated with the oxygenation index (r = -0.302, *p=0.007*).

Laboratory features of severe/critical cases

A significantly higher NLR, CRP, ferritin, and D-dimer were observed in severe/critical group

compared to asymptomatic /non-severe group (8.27± 5.04 vs. 4.43± 4.85 ,107.5 vs. 12.5, 592.5 vs. 173.5,1.35 vs. 0.4 respectively *p<0.001*). Also, higher total leucocytic count (9.75 ± 8.48 vs. 7.16 ± 3.32), neutrophils count (6.19 ± 1.370 vs. 5.16 ± 2.05), neutrophils percent (74.16 ± 11.99 vs. 67.55 ± 14.39), PLR (232.76 ± 127.57 vs. 186.36 ± 98.128), urea (27 vs. 22), AST (44.4 vs 24.5), and ALT (59.5 vs. 30.5) with significant ratio (*P<0.05* for all) were observed in severe/critical group compared to asymptomatic /non-severe group with a statistical significant different. There was a statistically significant difference of the cyclic threshold (CT) mean level of the target ORF1ab gene between asymptomatic /non-severe group and severe/critical group (30.85 vs. 25.1, *p=0.02*). Patient data according to laboratory investigation are shown in **(Table 3)**.

Predictive factors for severe/critical cases

Multivariate logistic regression analysis, forward stepwise methods was used to assess the predictors of sever /critical SARS-CoV-2 cases. Increasing age (OR =1.234; 95% CI: 1.022-1.490), LMR (OR =2.162; 95% CI: 1.071-4.367), CRP (OR =1.023; 95% CI: 1.000-1.046), and radiograph score (OR =5.429;95% CI: 1.590-18.535), (all *p*< 0.05) **(Table 4).**

By ROC analysis was also used to determine the associated factors of SARS-CoV-2 severity, the area under curve (AUC) was highest for radiographic score, followed by D-dimer, CRP, ferritin, and NLR (0.914, 0.867, 0.837, 0.762, and 0.758 respectively), with *p-value<0.05* in identifying severe/critical cases. The sensitivity and specificity of those parameters were (87.5% &77.2%, 93.8%, &65%, 87.5% &72.2%, 93.8% & 61%, 71.9% & 74.1%) respectively at cut off points (2, 0.540, 30.47, 279.5, and 4.53) respectively **(Table 5).** Lower AUC was detected for PLR, and LMR less than 0.7 with *p>0.05* in identifying severe/critical cases, the AUC for PLR and LMR were (0.595, and 0.558) respectively **(Table 5)**.

Table 1. Epidemiologic and clinical characteristics of patients infected with SARS-CoV-2 among severe and non-severe groups.

	Asymptomatic /non-severe cases (N=108)	**Severe cases /critical cases (N=32)**	**Total cases (N= 140)**	***P -value***
Age, mean±SD	34.69 ± 10.89	52.0 ± 12.6	38.64 ± 13.39	*<0.001**
Sex, Male/Female, N (%)	74 (68.5) /34(31.5)	22 (68.8)/10 (31.2)	96 (68.6%)/44 (31.4)	*0.980*
HCW, yes/no, N (%)	26 (24.1)	6 (18.8)	32(22.9)/108(77.1)	*0.916*
History of contact with confirmed case, N (%)	60 (55.6)	12 (37.5)	72 (51.4)	*0.073*
Pregnant, yes, N (%)	4 (3.7)	0	4 (2.9)	*0.574*
Comorbidity, yes (%)				
DM	0	12 (37.5%)	12(8.6%)	*<0.001**
HTN	0	6 (18.8%)	6 (3.4%)	*<0.001**
TB	0	6 (18.8%)	6 (3.4%)	*<0.001**
Others: CKD	0	2(6.2%)	2 (1.4%)	*0.943*
Cardiac disease	0	2(6.2%)	2 (1.4%)	*0.943*
CLD	2 (1.8%)	0	2 (1.4%)	*0.076*
Clinical finding Yes, N(%)				

Dry cough	44 (40.7%)	22(68.8%)	66 (47.1%)	*0.005**
fever	64 (59.3%)	22(68.8%)	86 (61.4%)	*0.333*
dyspnea	10 (9.3%)	28(87.5%)	38 (27.5%)	*<0.001**
sore throat	18(16.7)	0	18 (12.9%)	*0.013**
Bone pain	8 (7.4%)	0	8 (5.7%)	*0.567*
Anosmia/loss of taste	12 (11.1%)	4(12.4%)	16 (11.4%)	*0.828*
Diarrhea	10 (9.3%)	6(18.8%)	16 (11.4%)	*0.201*
Vomiting	8(7.4%)	2(6.2%)	10(7.1%)	*>0.999*
Epigastric pain	2(1.9%)	2(6.2%)	4(2.9%)	*0.224*
Clinical sign (mean±SD)				
Temperature C◦	37.70 ± 0.605	38.22 ± 0.775	37.8 ± 0.68	*<0.001**
Respiratory rate	16.43 ± 2.74	28.44 ± 3.59	19.2 ± 5.87	*<0.001**
Oxygen saturation	97.11 ± 1.33	85.56 ± 14.08	94.5 ± 8.26	*<0.001**
Oxygenation index (PO2/FiO2).	425.09 ± 42.88	336.55 ± 41.59	404.8 ± 56.5	*<0.001**

* *P-value < 0.05* was considered statistically significant. HCW: healthcare workers; DM: Diabetes mellitus; HTN: hypertension; T.B; Tuberculosis: CKD: chronic kidney disease; CLD: chronic liver disease; PaO2/FiO2: Arterial partial pressure of oxygen (PaO2)/ fraction of inspired oxygen (FiO2).

Table 2. Findings on imaging of pneumonic cases (n=78).

Radiological finding	N (%)
Pattern	
GGO (ground glass opacity)	50(64.1%)
GGO and consolidation	26(33.3%)
Consolidation	2(2.6%)
Number of lobes affected	
One	26 (33.3%)
Two	18 (23.1%)
Three	12 (15.4%)
Four	2(2.6%)
Five	20 (25.6%)
More than 2 lobes affection	34(43.6%)
Uni/Bilateral affection	
Unilateral	36 (46.2%)
Bilateral	42(53.6%)
Right upper lobe	30 (38.5%)
Right middle lobe	44 (56.4%)
Right lower lobe	52 (66.7%)
Left upper lobe	24 (30.8%)
Left lower lobe	52 (66.7%)
Total radiographic score (median IOR)	2 (1-5)

Table 3. Laboratory results of patients infected with SARS-CoV-2 between asymptomatic /non-severe cases and severe / critical novel coronavirus pneumonia cases.

	Asymptomatic /non-severe cases (N=108)	**Severe/critical cases(N=32)**	**Total cases (140)**	***P-value***
	Mean ±SD	Mean ±SD	Mean±SD	
H.B (g/L; normal range: male 13–17, female 11.5–15.5)	12.919±1.64	12.08 ± 2.18	12.726±1.79	*0.019**
WBC (× 10⁹per L; normal range 4–10)	7.16 ± 3.32	9.75 ± 8.48	7.75±5.027	*0.010**
Lymphocytes count (× 10⁹per L; normal range 0.8–4)	1.86 ± 1.11	1.63 ± 1.19	1.81±1.12	*0.316*
Lymphocyte ratio (normal rang 20-40)	25.75±12.89	21.15±12.858	24.75±13.03	*0.086*
Neutrophils count (× 10⁹ per L; normal range 2–7)	5.16 ± 2.05	6.19 ± 1.370	5.39±1.96	*0.008**
Neutrophils ratio % (normal rang 40-80)	67.55±14.39	74.16 ± 11.99	69.06±14.08	*0.019**
Monocyte count (× 10⁹per L; normal range 0.2–1)	0.582 ± 0.32	0.469 ± 0.31	0.556±0.321	*0.077*
Monocytic ratio % (normal range 2-10)	4.80 ± 4.27	4.24 ± 2.87	4.67±3.98	*0.482*
Platelet count (×10⁹ per L; normal range 150·0–450·0)	267.67±109.40	235.62±93.56	260.34±106.21	*0.133*
NLR	4.43± 4.85	8.27± 5.04	5.31±5.14	*<0.001**
LMR	3.45 ± 2.021	3.94 ± 2.21	3.56±2.06	*0.239*
PLR	186.36±98.128	232.76±127.57	196.96±106.39	*0.029**
Median (IQR)				
CRP (mg/L; normal range 0·0–5·0)	12,5 (4 - 38.6)	107.5(47.32 -180.2)	20 (4.75 - 71.18)	*<0.001**
Urea (normal range 8-23 mg/dL)	22 (19.75 - 25)	27 (22 - 30.5)	23(20 - 27)	*0.001**
Creatinine (normal range 0.84 to 1.21 mg/dL)	0.9 (0.778 - 1.02)	0.95 (0.70 - 1.08)	0.9 (0.7 - 1.03)	*0.590*
AST (U/L; normal range 7-40 mU/mL)	24.5(17.25-45)	44.4 (18.25-62.75)	25(18-46)	*0.030**
AlT (U/L; normal range 10.0-40.0)	30.5(18.75-49.75)	59.5 (20.0 - 89.5)	32(20-65)	*0.030**
Ferritin (ng/mL; normal range20–250 ng/mL)	173.5(95.25- 173.5)	592.5 (560 - 660)	299.5(117-596.5)	*<0.001**
D-dimer (normal range up to 0.5)	0.4 (0.3 - 1.1)	1.35 (1.2 -1.5)	0.53 (0.3-1.3)	*<0.001**
CT of ORF1ab gene	30.85 (25.9–35.8)	25.1 (21.7–28.5)	28.75 (21.7-35.8)	*0.02**

* *P-value < 0.05* was considered statistically significant; H.B: hemoglobin; WBC: white blood cells; NLR: neutrophils to lymphocyte ratio; LMR: lymphocyte to monocyte ratio: PLR: platelet to lymphocyte ratio: AST: aspartate aminotransferase; ALT: alanine aminotransferase; CRP:C-reactive protein ;CT:cyclic threshold.IQR:interquartile range.

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Table 4 . Predictive factors for severe/critical novel coronavirus pneumonia cases (forward stepwise logistic regression analysis).

	P- value	**OR**	**95.0% C.I. OR**
Age	*0.028**	1.234	1.022 - 1.490
LMR	*0.032**	2.162	1.071 - 4.367
CRP	*0.05*	1.023	1.000 - 1.046
Radiograph score	*0.007**	5.429	1.590 - 18.535
Constant	*0.007**	0.000	

C.I. OR: confidence interval. Odds ratio: LMR, lymphocyte to monocyte ratio; CRP, C-reactive protein.

Table 5. Evaluation of diagnostic parameters in identifying severe/critical novel coronavirus pneumonia cases.

Variable(s)	**AUC**	***P- value***	**Cutoff point**	**Sensitivity**	**Specificity**
Radiograph score	0.914 (0.865 - 0.962)	*<0.001**	2	87.5%	77.2%
D-dimer	0.867(0.808 - 0.927)	*<0.001**	0.540	93.8%	65%
CRP	0.837(0.767 - 0.907)	*<0.001**	30.47	87.5%	72.2%
Ferritin	0.762(0.668 - 0.856)	*<0.001**	279.5	93.8%	61%
NLR	0.758(0.668 - 0.856)	*0.046**	4.53	71.9%	74.1%
PLR	0.595(0.460 - 0.730)	*0.104*	213.3	62.5%	70.4%
LMR	0.558(0.440- 0.676)	*0.321*	3.95	50%	67%

AUC: Area under the curve; P-value < 0.05 was considered statistically significant; CRP, C-reactive protein; NLR: neutrophils to lymphocyte ratio; LMR: lymphocyte to monocyte ratio; PLR: platelet to lymphocyte ratio

Discussion

There is limited information about SARS-CoV-2 disease characteristics, and severity particularly in Egypt. The present study is aimed to discuss the characteristics of patients confirmed with SARS-CoV-2 infection in Fayoum governorate, Egypt. It focused also on the predictive factors of severity in severe /critical cases. Helpful to deepen our understanding of the mechanism of severe/critical conditions and improve its clinical diagnosis and treatment.

Overall, in the current study, elderly patients were more prominent in severe/critical than asymptomatic /non-severe group with a statistically significant difference ($p<0.001$) especially patients with comorbidity such as DM, and HTN with significant value ($p<0.001$). A similar result was reported in the study of **Xu et al**. [10].

Also, there was a predominant of male gender without significant difference ($p=0.980$) that matched with previous study [11]. That indicated sex was not a risk factor for the severity of the disease.

Many explanations for exposure of the elderly patients to SARS-CoV-2 infection is the down -regulation, and decreased expression of

angiotensin-converting enzyme 2 (ACE2) protein [12].

Angiotensin-converting enzyme 2 protein had been recognized as a surface receptor helping SARS-CoV-2 entrance into cells [13]. Also, older patients are more exposed to enhancing the immune response to other viruses [14], and there is a higher prevalence of comorbidities [15].

Our results matched with previous reports [5,16,17]. Our results suggest that SARS-CoV-2 is infected more likely older adult males with chronic comorbidities due to weak immune functions of these patients [18].

We reported a concomitant infection of SARS-CoV-2 and TB with a significant difference (*p<0.001)* in severe/critical group. Our result was matched with two systemic reviews confirmed that TB was a risk factor for SARS-CoV-2 both in terms of severity and mortality [19,20].

Both SARS-CoV-2 and TB interact with host immunity and primarily affect the respiratory system. The damage caused by the TB infection can predispose a patient to SARS-CoV-2. Tuberculosis patients coinfected with SAS-CoV-2 tend to show a worse prognosis, maybe due to primary lung damage from the TB infection. Accordingly, patients should be tested for either disease if there was a clinical deterioration, even if there is a typical clinical picture [7,19,20].

In the present study, dyspnea was the most prevalent symptom among severe/critical group (87.5%) with a statistically significant difference(*p<0.001*). While fever percentage in severe/critical group was (68.8%) without significant difference (*p=0.333*). A similar result was found in the meta-analysis study of **Zheng et al.** [21], who found that fever percentage was statistically higher in the non-critical group than critical/mortal group *(p=0.003*) Also, **Shi, et al**. [22] performed a meta-analysis study of 2818 cases in a total of fifteen studies to analyze the mortality risk factors in SARS-CoV-2 cases. They reported no significant relation between elevated body temperature and SARS-CoV-2 mortality risk factors (OR equal 0.74;95% CI: 0.50–1.09, *p=0.127*; *p=0.062*). That indicating dyspnea instead of fever is suggested as a prognostic factor of poor outcome, and disease severity [22]. As regards the radiological finding, from a total of 78 patients with abnormal radiological finding. Thirty- four (43.6%) patients had more than 2 lobe affection, 50 (64.1%), ground glass appearance, and 42(53.6%) bilateral affection of the lung were observed in our study. That was consistent with previous reports [5,16].

We found a significant negative correlation (r = -0.320, *p=0.047*) between the radiographic score and the oxygenation index. These results matching with previous report [16]. That Indicates the more involvement of the lobes, the worse is pulmonary functions.

In severe/critical cases there was statistically significantly higher CRP, NLR, ferritin, and D-dimer compared to asymptomatic /non-severe cases (*p<0.001*). Also, higher total leucocytic count, neutrophils count, neutrophils percent ($p<0.05$ for all). Lower lymphocyte count was related to severe 2019 novel coronavirus pneumonia without statistic significant ratio (*p>0.05*). Similar results were found in **Zhang et al.** [17]. Similarly, to a former study, the level of both serum ferritin, and D-dimer was significantly higher at admission compared to the mild patients [23].

Therefore, it was proved that high serum ferritin, and D-dimer levels were related closely to SARS-CoV-2 severity, in fact, increasing D-dimer level indicated a hypercoagulable state in patient with SARS-CoV-2 [24].

Our study focused on in-depth the predictive factors of severe/critical novel coronavirus pneumonia by multivariate logistic regression analysis, increasing age, CRP, LMR, and the radiographic score were possible predictors of severe/critical SARS-CoV-2 cases. Similarly, a higher total radiographic score, and increasing age were predictive factors of severity in **Zhang et al.** [16], and **XU et al.** [10] respectively. However, **Liu et al.** [25], excluded age as a predictor of death by multivariate analysis.

Using the ROC analysis, the AUC was the highest for the radiographic score, followed by D-dimer, CRP, ferritin, and NLR with a significant result (*p<0.05*) in identifying severe/critical cases. Similarly, high AUC for CRP (0.714) was seen in the study of **Yang et al.** [26], indicating that CRP may be used to identify patients with severe cases of SARS-CoV-2.

We also analyzed the immunological characteristics of peripheral blood in patients with SARS-CoV-2 and their relation with SARS-CoV-2 severity. The highest AUC was indicated for NLR and the lowest was for LMR, and the NLR level was significantly higher in severe/critical cases than non-severe/critical cases (*p<0.001*). Indicating that

NLR is a very useful prognostic factor for severe SARS-CoV2 infection. That were consistent with the previous study [26]. The clinical application of NLR was mainly seen in secondary pulmonary infectious diseases [27].

Our study was superior to other published reports from Egypt. First, it is a descriptive multicenter rather than retrospective single-center study, conducted on relatively more patients' number, and proofed more radiological, and laboratory measurement as (total radiographic score, NLR, and D-dimer) as predictive factors of severity than reported in the study of **Ghweil et al.** [28]. Second, it discussed combined clinical, laboratory, and radiological findings than a single radiological finding as in the previous study [29]. Also, it is the first study from Egypt to highlight the importance of attentiveness of the possibility of coinfection SARS-CoV-2 and TB with a severe and fatal course associated in such combined infection.

This study has some limitations. First, A relatively small number of patients was studied considering the high number of SARS-CoV-2 cases in Fayoum governorate at the study time, a large sample size in the future help to get a more comprehensive understanding of SARS-CoV-2. Second, more detailed patient information, particularly regarding clinical outcomes, was unavailable at the time of analysis; however, this study permits an early assessment of the characteristics of SARS-CoV-2 pneumonia in Egypt.

Conclusion

Older men with comorbidity were more likely to be infected by SARS-CoV-2. Co infection of SARS-CoV-2 and TB can occur during the current SARS-CoV-2 pandemic, and may progress towards severe SARS-CoV-2 pneumonia. Increasing age, LMR, CRP, and radiograph score were possible predictors of severe/critical SARS-CoV-2 cases by multivariate logistic regression analysis. Using ROC analysis, elevated CRP, D-dimer, serum ferritin, radiograph score, and NLR may contribute to the judgment of SARS-CoV-2 severity. NLR is a significant prognostic factor that helps in the initial detection of severe /critical SARS-CoV-2 cases.

Conflict of interest

The authors report no conflicts of interest

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Authors' Contribution

All authors contributed equally to this work

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