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ORIGINAL ARTICLE

# Factors Affecting Admission To Intensive Care Unit Of COVID-19 Patients In The Kingdom Of Bahrain

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## Abstract

**Objective**: Coronavirus disease-2019 (COVID-19) is a newly emerging infectious disease that has become a global pandemic. This study aimed to identify the risk factors at presentation to predict intensive care unit (ICU) admissions.

**Materials & Methods:** This retrospective observational study recruited 188 confirmed laboratory COVID-19 patients who were hospitalized in Jidhafs Maternity Hospital (JMH) from 1st June to 5th July 2020. Univariate and multivariate analyses were used to Explore risk factors associated with the increased risk of ICU admission.

**Results:** The study revealed that older age (>60 years old) (16[38.1%], *P*=0.044), male gender (30 [40.0%], *P*=0.000) were significantly associated with the increased risk of ICU admissions. The most prevalent symptoms in admission were myalgia (13[40.6%], *P*=0.035), fever (39[34.2%], *P*=0.002) and cough (37[31.4%], *P*=0.032). In addition, raised serum level of alanine amino-transferase (ALAT) (34.7% *vs.* 20.7%, *P*=0.033), D-dimers (30.7% *vs* 12.2%, *P*=0.012), lactate dehydrogenase (LDH) (31.6% vs 0.0%, *P*=0.025) and ferritin (37.7% *vs* 16.7%, *P*=0.011) found to be important predictor of ICU admission.

**Conclusion**: The finding indicates that older age, male gender, with increased alanine transferase (ALT), increased lactate dehydrogenase (LDH), high D-dimer and high ferritin was associated with an increased risk of ICU admissions. Identification of such factors will help to detect people who are more likely to develop severe COVID-19 disease and will help physicians to determine if patients need regular health care or ICU admission.

**Keywords:** COVID-19, Emerging communicable diseases, Intensive care units, Physicians, Risk factors

## Introduction

Coronavirus disease-2019 (COVID-19) is a newly emerging infectious disease, which has been declared a Pandemic by the World health organization (WHO) on March 11, 2020. On 2 May 2021, there were 151,803,822 confirmed cases of COVID-19, including 3,186,538 casualties, as reported to WHO.[1] It is caused by severe acute respiratory syndrome (SARA-CoV-2) novel coronavirus which was first identified in Wuhan, China in December 2019.[2]

On February 24, 2020, the first case of confirmed COVID-19 disease was recorded in the Kingdom of Bahrain.[3] As of 25 May 2021, there have been a total of 220,847 confirmed cases in the country, of which 196,685 have recovered and 862 have expired.[4] Most COVID-19 diseased patients are asymptomatic or experience simple flue like respiratory symptoms such as fever, myalgia, sore throat, and cough. However, older patients and those with chronic comorbidities may have poor prognosis as this could progress to viral pneumonia, acute respiratory distress syndrome (ARDS), and multi-organ failure which may prove to be fatal.[2] As the clinical spectrum of this disease ranges in severity from mild to severe or critical disease, intensive care unit (ICU) admission and mechanical ventilation are mandatory.

The complications & patient outcomes of COVID-19 disease vary from country to country, this might be related to the differences in health care facilities provided by the country as well as the limited number of ICU beds and ventilators. In coping with increase number of COVID-19 patients, many of the published studies are focusing on identifying the prognostic risk factors associated with increased risk of ICU admission and mortality rate, aiming to keep patients in the right pathway from the beginning.[5,6,7,8,16,18]

Several studies from China, USA, Germany, Italy, Iran, Pakistan, Oman, Qatar, Kuwait and United Arab Emirate (UAE) have shown that older age is associated with poor outcomes in hospitalized COVID-19 patients, in addition to some of the studies from China, Italy, Iran, Qatar and UAE added that male sex is more likely to have a severe form of the disease .[7,9,11,12,13,14,15,17] Moreover, several studies have found that COVID-19 patients with certain underlying medical conditions such as hypertension (HTN), diabetes mellitus (DM), cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD) malignancy and obesity were at higher risk of severe outcomes.[7,13,15] Reports from China, Oman, Kuwait, and United Arab Emirate (UAE) have demonstrated that higher serum levels of alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Erythrocyte sedimentation rate (ESR), D-dimer, lactate dehydrogenase (LDH), C-reactive protein (CRP) and procalcitonin could be used as a predictor of severity and prognosis of COVID-19 patients.[9,12,14,17]

The knowledge of the disease and the risk factors associated with severe clinical illness are not well established, hence, to address this knowledge gap the authors conducted this study to assess factors that increased the risk of ICU admission in COVID-19 patients, this would help in risk stratification and improvement of the clinical management of patients with COVID-19, especially in the region.

## Methods

*Study Design, Population & Eligibility Criteria*

This is a retrospective, cross-sectional observational study that was conducted in Jidhafs Maternity Hospital JMS, a tertiary care hospital in the Kingdom of Bahrain between June 1st and July 7th, 2020. The study included 188 patients between the ages of 5 and 90 years with laboratory-confirmed COVID-19 infection. Confirmed cases of COVID-19 were defined by a positive result on a reverse transcriptase-polymerase chain reaction (RT-PCR) assay of specimen collected on a nasopharyngeal swab. All patients without a positive COVID-19 PCR were excluded from the study. The admission criteria were according to guidelines published by the Ministry of Health of the Kingdom of Bahrain for the management of patients with confirmed COVID-19 pneumonia based on a combination of clinical characteristics, laboratory, and radiological information. The study was approved by the institutional scientific and ethics committees of the National COVID research committee in the Kingdom of Bahrain.

*Data Collection*

Data was collected through the hospital's electronic medical records system by the research team members according to the research form. The extracted variable included demographic data, comorbid conditions, symptoms at presentation, laboratory investigations, and radiological findings during admission. Outcome measures included the risk of ICU admission.

*Statistical Analysis*

IBM SPSS statistic 21, program was used for data analysis. Descriptive statistics using frequencies and percentages were calculated for categorical variables. Chi-square test was used in univariate analysis to evaluate the association between the independent categorical variables and the admission to ICU. For the multivariate assessment of risk factors, the multivariate logistic regression model was used. Adjusted odds ratios controlling for some confounding variables included in the final model were evaluated to assess the association between some risk factors and ICU admission, calculating odds ratios for each factor separately before and after adjusting for a potential confounder such as C- reactive protein, cardiovascular disease, hypertension, diabetes, obesity, and smoking.

## Results

*Demographic data on baseline admission*

A total number of 188 hospitalized patients with confirmed COVID-19 were enrolled in the study. The mean age of the hospitalized patients was 47 years old, 39.9% (n=75) were males and 85.1% (n=160) were Bahraini citizens. A total of 26.1% (n=49) patients were transferred to ICU (Figure 1).

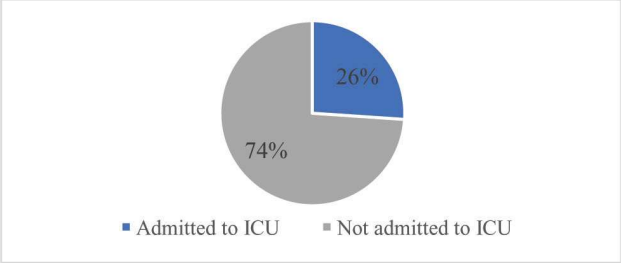


**Figure 1:** Percentage of patients transferred to ICU from JMH cases

**Table 1:** Demographic and general clinical variables of COVID-19 patients admitted to JMH classified by ICU admission

| | | Total (%)' | | Transfer to ICU | | | | Chi-Square Test |
|---|---|---|---|---|---|---|---|---|
| | | | | No | | Yes | | |
| | | | | Count (%)' | | Count (%)' | | *P*-Value |
| **Age (years)** | <60 | 146 | 77.7% | 113 | 77.4% | 33 | 22.6% | |
| | >=60 | 42 | 22.3% | 26 | 61.9% | 16 | 38.1% | **0.044*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Gender** | Female | 113 | 60.1% | 94 | 83.2% | 19 | 16.8% | |
| | Male | 75 | 39.9% | 45 | 60.0% | 30 | 40.0% | **0.000*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Nationality** | Bahraini | 160 | 85.1% | 116 | 72.5% | 44 | 27.5% | |
| | Non-Bahraini | 28 | 14.9% | 23 | 82.1% | 5 | 17.9% | 0.284 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Clinical Status** | Non-Symptomatic | 27 | 14.4% | 26 | 96.3% | 1 | 3.7% | |
| | Symptomatic | 161 | 85.6% | 113 | 70.2% | 48 | 29.8% | **0.004*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Chest X-Ray** | Normal | 89 | 47.3% | 80 | 89.9% | 9 | 10.1% | |
| | Abnormal | 99 | 52.7% | 59 | 59.6% | 40 | 40.4% | **0.000*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |

*Count (%): Row Percentage, Total (%): Column Percentage.* Significant Association at the 0.05 level (2-tailed).*

In univariate analysis older age more than 60 years are at high risk of being admitted to ICU (16[38.1%], *P*=0.044) in comparison to less than 60 years of age. Similar trend applies for males (30 [40.0%], *P*=0.000). Most of the patients who were admitted to ICU were symptomatic (85.6%) and were at high risk of being admitted to ICU (48[28.9%], *P*=0.004) than symptomatic patients (3.7%). Patients with abnormal chest X-rays were significantly at higher risk of being admitted to ICU (40.4%) in comparison to those with normal findings (10.1%) (Table 1).

*Clinical Characteristic on Admission*

Comorbidities were present in more than half of the patients, of which hypertension (HTN) was the most common comorbidity found to be present in 29.8% (n=56) followed by diabetes mellitus (DM) -28.7% (n=56) and cardiovascular disease (CVD)- 12.8% (n=24). None of the comorbidities were significantly associated with ICU admission in univariate analysis. However, obesity was borderline with a *P*=0.091 (Table 2).

The most common presenting symptoms in admission were cough, which was found in 62.8% (n=188) of the patients followed by fever (114[60.6%]), shortness of breath (65[34.6%}), fatigue (48[25.5%]) and chest pain (40[21.3%]). The most prevalent symptoms that were found to be associated with increasing the risk of ICU admission were myalgia (13[40.6%], *P*=0.035), fever (39[34.2%], *P*=0.002) and cough (37[31.4%], *P*=0.032). Chest pain was a complaint in many patients as well with a borderline significance (*P*=0.063) (Table 3).

**Table 2:** Comorbidities variables of COVID-19 patients admitted to JMH classified by ICU admission

| | | Total (%)' | | Transfer to ICU | | | | Chi-Square Test |
|---|---|---|---|---|---|---|---|---|
| | | | | No | | Yes | | |
| | | | | Count (%)' | | Count (%)' | | *P*-Value |
| **Cardiovascular Diseases** | No | 164 | 87.2% | 120 | 73.2% | 44 | 26.8% | |
| | Yes | 24 | 12.8% | 19 | 79.2% | 5 | 20.8% | 0.532 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Hypertension** | No | 132 | 70.2% | 100 | 75.8% | 32 | 24.2% | |
| | Yes | 56 | 29.8% | 39 | 69.6% | 17 | 30.4% | 0.382 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Diabetes Mellitus** | No | 134 | 71.3% | 103 | 76.9% | 31 | 23.1% | |
| | Yes | 54 | 28.7% | 36 | 66.7% | 18 | 33.3% | 0.149 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Obesity** | No | 166 | 88.3% | 126 | 75.9% | 40 | 24.1% | |
| | Yes | 22 | 11.7% | 13 | 59.1% | 9 | 40.9% | 0.091 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Respiratory Diseases** | No | 173 | 92.0% | 129 | 74.6% | 44 | 25.4% | |
| | Yes | 15 | 8.0% | 10 | 66.7% | 5 | 33.3% | 0.504 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Renal Diseases** | No | 174 | 92.6% | 127 | 73.0% | 47 | 27.0% | |
| | Yes | 14 | 7.5% | 12 | 85.7% | 2 | 14.3% | 0.297 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Smoking** | No | 176 | 93.6% | 131 | 74.4% | 45 | 25.6% | |
| | Yes | 12 | 6.4% | 8 | 66.7% | 4 | 33.3% | 0.553 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |

*'Count (%): Row Percentage, Total (%): Column Percentage.*

**Table 3:** Symptoms and signs of COVID-19 patients admitted to JMH classified by ICU admission

| | | Total (%)' | | Transfer to ICU | | | | Chi-Square Test |
|---|---|---|---|---|---|---|---|---|
| | | | | No | | Yes | | |
| | | | | Count (%)' | | Count (%)' | | *P*-Value |
| **Fever** | No | 74 | 39.4% | 64 | 86.5% | 10 | 13.5% | |
| | Yes | 114 | 60.6% | 75 | 65.8% | 39 | 34.2% | **0.002*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Runny Nose** | No | 161 | 85.6% | 118 | 73.3% | 43 | 26.7% | |
| | Yes | 27 | 14.4% | 21 | 77.8% | 6 | 22.2% | 0.623 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Sore Throat** | No | 140 | 74.5% | 104 | 74.3% | 36 | 25.7% | |
| | Yes | 48 | 25.5% | 35 | 72.9% | 13 | 27.1% | 0.852 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Headache** | No | 146 | 77.7% | 111 | 76.0% | 35 | 24.0% | |
| | Yes | 42 | 22.3% | 28 | 66.7% | 14 | 33.3% | 0.223 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Fatigue** | No | 140 | 74.5% | 108 | 77.1% | 32 | 22.9% | |
| | Yes | 48 | 25.5% | 31 | 64.6% | 17 | 35.4% | 0.087 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Anosmia** | No | 171 | 91.0% | 128 | 74.9% | 43 | 25.2% | |
| | Yes | 17 | 9.0% | 11 | 64.7% | 6 | 35.3% | 0.363 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Myalgia** | No | 156 | 83.0% | 120 | 76.9% | 36 | 23.1% | |
| | Yes | 32 | 17.0% | 19 | 59.4% | 13 | 40.6% | **0.039*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Chest pain** | No | 148 | 78.7% | 114 | 77.0% | 34 | 23.0% | |
| | Yes | 40 | 21.3% | 25 | 62.5% | 15 | 37.5% | 0.063 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Cough** | No | 70 | 37.2% | 58 | 82.9% | 12 | 17.1% | |
| | Yes | 118 | 62.8% | 81 | 68.6% | 37 | 31.4% | **0.032*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Shortness of breath** | No | 123 | 65.4% | 95 | 77.2% | 28 | 22.8% | |
| | Yes | 65 | 34.6% | 44 | 67.7% | 21 | 32.3% | 0.156 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Diarrhea** | No | 161 | 85.6% | 119 | 73.9% | 42 | 26.1% | |
| | Yes | 27 | 14.4% | 20 | 74.1% | 7 | 25.9% | 0.986 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Nausea/ Vomiting** | No | 157 | 83.5% | 118 | 75.2% | 39 | 24.8% | |
| | Yes | 31 | 16.5% | 21 | 67.7% | 10 | 32.3% | 0.390 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |

*'Count (%): Row Percentage, Total (%): Column Percentage.*

*Treatment Received During Hospital Admission*

Most of the moderate cases in admission received antibiotics (105 [55.9%]), and some of them received anti-viral therapy such as triple therapy (67 [35.6%]) and hydroxychloroquine (38[20.1%]). Severe cases received steroids (11[5.9%]) and 4 patients in the severe group received tocilizumab (4[2.1%]) (Table 4).

Patients admitted to the ICU were more likely to have been prescribed antibiotic (37[35.3%], *P*=0.001) followed by hydroxychloroquine (4[10,5%], *P*=0.015), triple therapy (24[35.8%], *P*=0.023) and steroid (6[54.6%], *P*=0.027) as they have a more severe form of the disease.

**Table 4:** Drug variables of COVID-19 patients admitted to JMH classified by ICU admissions

| | | Total (%)' | | Transfer to ICU | | | | Chi-Square Test |
|---|---|---|---|---|---|---|---|---|
| | | | | No | | Yes | | |
| | | | | Count (%)' | | Count (%)' | | *P*-Value |
| **Tocilizumab** | No | 184 | 97.9% | 136 | 73.9% | 48 | 26.1% | |
| | Yes | 4 | 2.1% | 3 | 75.0% | 1 | 25.0% | 0.961 |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Triple Therapy** | No | 121 | 64.4% | 96 | 79.3% | 25 | 20.7% | |
| | Yes | 67 | 35.6% | 43 | 64.2% | 24 | 35.8% | **0.023*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Antibiotic** | No | 83 | 44.2% | 71 | 85.5% | 12 | 14.5% | |
| | Yes | 105 | 55.9% | 68 | 64.8% | 37 | 35.2% | **0.001*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Hydroxychloroquine** | No | 150 | 79.8% | 105 | 70.0% | 45 | 30.0% | |
| | Yes | 38 | 20.2% | 34 | 89.5% | 4 | 10.5% | **0.015*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Steroids** | No | 177 | 94.2% | 134 | 75.7% | 43 | 24.3% | |
| | Yes | 11 | 5.9% | 5 | 45.5% | 6 | 54.6% | **0.027*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |

**Table 5:** Biomarkers of COVID-19 patients admitted to JMH Classified by ICU admission

| | | Total (%)' | | Transfer to ICU | | | | Chi-Square Test |
|---|---|---|---|---|---|---|---|---|
| | | | | No | | Yes | | |
| | | | | Count (%)' | | Count (%)' | | *P*-Value |
| **Alanine Transaminase** | Normal | 116 | 61.7% | 92 | 79.3% | 24 | 20.7% | |
| | High | 72 | 38.3% | 47 | 65.3% | 25 | 34.7% | **0.033*** |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **D-dimer** | Normal | 49 | 28.3% | 43 | 87.8% | 6 | 12.2% | |
| | High | 124 | 71.7% | 86 | 69.4% | 38 | 30.7% | **0.012*** |
| | **Total** | **173** | **100.0%** | **129** | **74.6%** | **44** | **25.4%** | |
| **Lactate Dehydrogenase** | Low | 1 | 0.6% | 1 | 100.0% | 0 | 0.0% | |
| | Normal | 72 | 42.9% | 62 | 86.1% | 10 | 13.9% | **0.025*** |
| | High | 95 | 56.6% | 65 | 68.4% | 30 | 31.6% | |
| | **Total** | **168** | **100.0%** | **128** | **76.2%** | **40** | **23.8%** | |
| **Ferritin** | Low | 6 | 3.8% | 5 | 83.3% | 1 | 16.7% | |
| | Normal | 92 | 58.2% | 76 | 83.5% | 15 | 16.5% | **0.011*** |
| | High | 60 | 38.0% | 38 | 62.3% | 23 | 37.7% | |
| | **Total** | **158** | **100.0%** | **119** | **75.3%** | **39** | **24.7%** | |
| **Procalcitonin** | Low | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | |
| | Normal | 154 | 94.5% | 114 | 73.1% | 42 | 26.9% | 0.458 |
| | High | 9 | 5.5% | 6 | 85.7% | 1 | 14.3% | |
| | **Total** | **163** | **100.0%** | **120** | **73.6%** | **43** | **26.4%** | |
| **C-Reactive Protein** | Normal | 18 | 9.7% | 16 | 94.1% | 1 | 5.9% | |
| | High | 167 | 90.3% | 122 | 72.6% | 46 | 27.4% | 0.052 |
| | **Total** | **185** | **100.0%** | **138** | **74.6%** | **47** | **25.4%** | |

*The biomarkers and other laboratory parameters on admission*

Patients admitted to the ICU were more likely to have an elevated inflammatory marker in comparison to non-ICU admitted patients. Overall elevation above normal was seen in serum alanine aminotransferase (ALAT) (34.7% *vs* 20.7%., *P*=0.033), D-dimers (30.7% *vs* 12.2%, *P*=0.012), lactate dehydrogenase (LDH) (31.6% *vs* 0.0%, P=0.025) and ferritin (37.7% *vs* 16.7%, *P*=0.011). Such factors were strongly associated with the progression of severe forms and increasing the risk of ICU admission. Another biomarker such as high C-reactive protein was found to have borderline significance association with *P*= 0.052 (Table 5).

Table 6 summarizes the laboratory findings on admission, with most patients who have been within the normal range (normal reference ranges listed in appendix 1). About one-third (n=37, 30.83%) of the patients admitted to ICU had normal white blood. Most patients had normal platelet levels but were below normal in ICU admitted patients (n=10, 34.5%). The other parameters such as hematocrit, prothrombin time and creatinine levels were within the normal range.

**Table 6:** Laboratory Variables of COVID 19 Patients Admitted to JMH Classified by ICU Admission

| | | | | Transfer to ICU | | | | Chi-Square Test |
|---|---|---|---|---|---|---|---|---|
| | | Total (%)' | | No | | Yes | | |
| | | | | Count (%)' | | Count (%)' | | *P*-Value |
| **White blood cells** | Low | 54 | 28.7% | 43 | 79.6% | 11 | 20.4% | 0.085 |
| | Normal | 120 | 63.8% | 83 | 69.2% | 37 | 30.8% | |
| | High | 14 | 7.5% | 13 | 92.9% | 1 | 7.1% | |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Hemoglobin** | Low | 62 | 33.0% | 55 | 88.7% | 7 | 11.3% | 0.003 |
| | Normal | 91 | 48.4% | 63 | 69.2% | 28 | 30.8% | |
| | High | 35 | 18.6% | 21 | 60.0% | 14 | 40.0% | |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Hematocrit** | Low | 20 | 10.6% | 19 | 95.0% | 1 | 5.0% | 0.076 |
| | Normal | 122 | 64.9% | 87 | 71.3% | 35 | 28.7% | |
| | High | 46 | 24.5% | 33 | 71.7% | 13 | 28.3% | |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Platelets** | Low | 29 | 15.5% | 19 | 65.5% | 10 | 34.5% | 0.443 |
| | Normal | 151 | 80.8% | 113 | 74.8% | 38 | 25.2% | |
| | High | 7 | 3.7% | 6 | 85.7% | 1 | 14.3% | |
| | **Total** | **187** | **100.0%** | **138** | **73.8%** | **49** | **26.2%** | |
| **Prothrombin time activated / partial thromboplastin time** | Low | 97 | 68.3% | 75 | 77.3% | 22 | 22.7% | 0.568 |
| | Normal | 42 | 29.6% | 31 | 73.8% | 11 | 26.2% | |
| | High | 3 | 2.1% | 3 | 100.0% | 0 | 0.0% | |
| | **Total** | **142** | **100.0%** | **109** | **76.8%** | **33** | **23.2%** | |
| **International normalized ratio** | Normal | 133 | 93.7% | 102 | 76.7% | 31 | 23.3% | 0.495 |
| | High | 9 | 6.3% | 6 | 66.7% | 3 | 33.3% | |
| | **Total** | **142** | **100.0%** | **108** | **76.1%** | **34** | **23.9%** | |
| **Urea** | Low | 44 | 23.4% | 31 | 70.5% | 13 | 29.6% | 0.793 |
| | Normal | 130 | 69.2% | 97 | 74.6% | 33 | 25.4% | |
| | High | 14 | 7.5% | 11 | 78.6% | 3 | 21.4% | |
| | **Total** | **188** | **100.0%** | **139** | **73.9%** | **49** | **26.1%** | |
| **Creatinine** | Low | 73 | 39.0% | 60 | 82.2% | 13 | 17.8% | 0.096 |
| | Normal | 95 | 50.8% | 64 | 67.4% | 31 | 32.6% | |
| | High | 19 | 10.2% | 14 | 73.7% | 5 | 26.3% | |
| | **Total** | **187** | **100.0%** | **138** | **73.8%** | **49** | **26.2%** | |

** Significant Association at the 0.05 level (2-tailed). Count (%): Row Percentage, Total (%): Column Percentage.*

In the multivariate logistic regression, the risk factors associated with ICU admission were found to be gender (OR 26 [95% CI 5.4-12.5]), age (OR 6.8 [95% CI 1.2-38.7]), fever (OR 5.7 [95% CI 1.1-30.3]), alanine transaminase (OR 5 [95% CI 1.1-21.6]), D-Dimer (OR 10.1 [95% CI 1.6-63.4]) and smoking (OR51.11 [95% CI 3.23-809.64]). The other factors that were significant in univariate analysis become not significant in multivariate analysis (Table 7).

**Table 7:** Odds Ratio and Confidence Interval for Significant and Confounding Variables in Transfer to ICU Model

| | Reference | Unadjusted odds ratio | | | Adjusted odds ratio | | |
|---|---|---|---|---|---|---|---|
| | | Odd ratio | 95% C.I. for odd ratio | | Odd ratio | 95% C.I. for odd ratio | |
| | | | Lower | Upper | | Lower | Upper |
| **Gender** | Male Vs. Female | **3.3*** | 1.7 | 6.5 | **26.0*** | 5.4 | 125.5 |
| **Age** | >=60 *vs.* <60 | **2.1*** | 1.0 | 4.4 | **6.8*** | 1.2 | 38.7 |
| **Chest X-ray** | Normal *vs.* Abnormal | **6.0*** | 2.7 | 13.4 | 2.6 | 0.5 | 13.8 |
| **Clinical status** | Symptomatic *vs.* Asymptomatic | **11.0*** | 1.5 | 83.7 | 10.2 | 0.5 | 213.7 |
| **Cough** | Yes *vs.* No | **2.2*** | 1.1 | 4.6 | 2.9 | 0.6 | 13.5 |
| **Fever** | Yes *vs.* No | **3.3*** | 1.5 | 7.2 | **5.7*** | 1.1 | 30.3 |
| **Myalgia** | Yes *vs.* No | **2.23*** | 1.0 | 5.1 | 2.5 | 0.4 | 15.3 |
| **Polymorphonuclear leukocytes** | High *vs.* (Low, Normal) | 1.3 | 0.7 | 2.6 | 0.8 | 0.2 | 3.4 |
| **Alanine transaminase** | High *vs.* Normal | **2.0*** | 1.1 | 4.0 | **5.0*** | 1.1 | 21.6 |
| **D-Dimer** | High *vs.* (Low, Normal) | **3.2*** | 1.2 | 8.1 | **10.1*** | 1.6 | 63.4 |
| **Lactate dehydrogenase** | High *vs.* (Low, Normal) | **2.9*** | 1.3 | 6.4 | 1.6 | 0.4 | 7.0 |
| **Ferritin** | High *vs.* (Low, Normal) | **2.7*** | 1.3 | 5.5 | 0.8 | 0.2 | 2.9 |
| **C-Reactive Protein** | High *vs.* Normal | 6.0 | 0.8 | 46.8 | 4.0 | 0.1 | 125.6 |
| **Cardiovascular diseases** | Yes *vs.* No | 0.7 | 0.3 | 2.0 | 0.1 | 0.0 | 1.2 |
| **Hypertension** | Yes *vs.* No | 1.4 | 0.7 | 2.7 | 0.4 | 0.1 | 2.9 |
| **Diabetes mellitus** | Yes *vs.* No | 1.7 | 0.8 | 3.3 | 1.0 | 0.2 | 6.5 |
| **Obesity** | Yes *vs.* No | 2.2 | 0.9 | 5.5 | 0.4 | 0.1 | 3.3 |
| **Smoking** | Yes *vs.* No | 1.5 | 0.4 | 5.1 | **51.1*** | 3.2 | 809.6 |

*C.I: Confidence Interval. * Significant Variable in The Logistic Model at the 0.05 level (2-tailed).*

## Discussion

This study describes the association between several risk factors such as demographic data, clinical characteristics, laboratory parameters and radiological findings of 188 patients with a positive RT-PCR for COVID-19 patients admitted to two different hospitals in Bahrain, and the risk of intensive care unit (ICU) admission.

ICU admissions in COVID-19 patients have shown to occur more in older age .[5,7,11,13,14] In this study, age> or = 60 years was a strong predictor for ICU admission, like previous studies which showed that the older age groups were more prone to be admitted to ICU. [5,11,13] The results of this study showed that male patients had a higher risk of ICU admission, which is in concordance with the results of other studies from China, Pakistan, and Oman.[5,9,13,14] However, whether these differences are due to innate immunological resistance or the surrounding environmental factors such as the work field or the less exposure to the virus, it remains unclear.

COVID-19 disease is associated with significant

morbidity.[9,11,14] Hypertension and diabetes were the most common comorbidities found in our admitted patients with obesity being a borderline factor found in about 40.9% of the patients admitted to ICU. However, the study found no significant association between HTN, DM, CVD, respiratory disease or renal disease, and ICU admission. In this regard, a study conducted in Isfahan-Iran showed an association between CVD and ICU admission .[11] Along the lines of this study, a study conducted in Oman showed no significant association between hypertension and increased mortality, though it showed that diabetes is associated with a higher mortality rate in COVID-19.[14] On the other hand, several global studies conducted in China, Italy, Germany as well as some regional studies, such as studies in Qatar and Kuwait showed that the survival rate and mortality are significantly higher in older men with pre-existing comorbidities such as hypertension, diabetes, hypercholesterolemia, chronic obstructive pulmonary disease, and malignancy.[6,7,9,15,17]

Interestingly, the multivariable analysis of this study revealed an association between the risk of ICU admission and smoking. The study found that the history of smoking is a predictor of ICU admission. A recent paper from New York conducted in Stony Brook University Hospital supported such an association.[16]

Most patients were symptomatic (29.8%) at the time of admission. For symptomatic patients, the most common symptoms were myalgia (40.6%) followed by fever (34.2%) and cough (31.3%), which reflect a common immune host response to the viral infection. In contrast to our finding, some of the studies that have been conducted in China and Kuwait found that most of their patients were asymptomatic on admission.[9,17] as it may be contributed to the subjective reporting of the symptoms. In addition, such symptoms are not specified to COVID-19 disease as they are commonly found in other viral and bacterial infections which make them alone non-reliable indicators for severity.

In the study, elevated alanine transferase (ALT), D-dimer, lactate dehydrogenase (LDH) and ferritin were seen in most of the ICU admitted patients. Likewise, several studies conducted in New York, UAE found that elevated LDH, D-dimer, procalcitonin, Ferritin and CRP are an important indicator for ICU admissions and poor prognostic factors.[12,16] LDH is expressed extensively in body tissue, therefore LDH elevation indicates cell injury or death.[19] Elevated D -dimer might be associated with severe diseases such as sepsis.[20] Ferritin is an intracellular protein that stores iron and raises in several situations, such as the inflammatory condition due to its acute phase protein.[21]

All these markers are routinely done in tertiary care hospitals, especially in patients admitted to ICUs. The high parameters of these markers will guide physicians to predict patients who are at risk to have a severe clinical course of the disease and to prioritize ICU admission.

This study has potential limitations since the sample size was potentially small and conducted over a short period. Therefore, the confidence interval for many factors was wide, most probably due to the small number of patients in the study.

## Conclusion

The study addressed most of the risk factors that are considered as an important predictor for ICU admission, demographic data (advanced age, male sex), clinical data (co-morbidities / symptoms), laboratory (elevated serum LDH, D-dimer, ferritin, and AST) and imaging finding. Identification of these factors associated with severe COVID-19 disease will help physicians to decide where to admit patients either to be kept at home, normal hospital care or admission to ICU.

## Statement of Ethics

This study was approved by the institutional scientific and ethics committees of National COVID research committee in kingdom of Bahrain, and consent was not required.

## Conflict of Interests

No potential conflict of interest relevant to this article was reported.

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Authors deny any funding sources for this study.

## References


1. WHO Coronavirus (COVID-19) Dashboard [Internet]. Covid19.who.int. 2021 [cited 5 May 2021]. Available from: https://covid19.who.int/
2. WHO Coronavirus (COVID-19) Dashboard [Internet]. Covid19.who.int. 2021 [cited 5 May 2021]. Available from: https://covid19.who.int/
3. Ministry of Health – news details. [Internet]. Moh.gov.bh. 2021 [cited 5 May 2021]. Available from: https://www.moh.gov.bh/COVID19/Details/3753
4. Bahrain: WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data [Internet]. Covid19.who.int. 2021 [cited 25 May 2021]. Available from: https://covid19.who.int/region/emro/country/bh
5. Pijls B, Jolani S, Atherley A, Derckx R, Dijkstra J, Franssen G, *et al*. Demographic risk factors for COVID-19 infection, severity, ICU admission and death: a meta-analysis of 59 studies. *BMJ Open*. 2021;11(1):e044640.
6. Grasselli G, Greco M, Zanella A, Albano G, Antonelli M, Bellani G, *et al*. Risk Factors Associated With Mortality Among Patients With COVID-19 in Intensive Care Units in Lombardy, Italy. *JAMA Internal Medicine*. 2020;180(10):1345.
7. Parohan M, Yaghoubi S, Seraji A, Javanbakht M, Sarraf P, Djalali M. Risk factors for mortality in patients with Coronavirus disease 2019 (COVID-19) infection: a systematic review and meta-analysis of observational studies. *The Aging Male*. 2020;23(5):1416-1424.
8. Ponti G, Maccaferri M, Ruini C, Tomasi A, Ozben T. Biomarkers associated with COVID-19 disease progression. *Critical Reviews in Clinical Laboratory Sciences*. 2020;57(6):389-399.
9. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, *et al*. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet*. 2020;395(10229):1054-1062.
10. Bhatraju P, Ghassemieh B, Nichols M, Kim R, Jerome K, Nalla A, *et al*. Covid-19 in Critically Ill Patients in the Seattle Region — Case Series. *New England Journal of Medicine*. 2020;382(21):2012-2022.
11. Shayganfar A, Sami R, Sadeghi S, Dehghan M, Khademi N, Rikhtegaran R, *et al*. Risk factors associated with intensive care unit (ICU) admission and in-hospital death among adults hospitalized with COVID-19: a two-center retrospective observational study in tertiary care hospitals. *Emergency Radiology*. 2021.
12. Kantri A, Ziati J, Khalis M, Haoudar A, El Aidaoui K, Daoudi Y, *et al*. Hematological and biochemical abnormalities associated with severe forms of COVID-19: A retrospective single-center study from Morocco. *PLOS ONE*. 2021;16(2):e0246295.
13. Ayaz A, Arshad A, Malik H, Ali H, Hussain E, Jamil B. Risk factors for intensive care unit admission and mortality in hospitalized COVID-19 patients. *Acute and Critical Care*. 2020;35(4):249-254.
14. Khamis F, Al-Zakwani I, Al Naamani H, Al Lawati S, Pandak N, Omar M, *et al*. Clinical characteristics and outcomes of the first 63 adult patients hospitalized with COVID-19: An experience from Oman. *Journal of Infection and Public Health*. 2020;13(7):906-913.
15. Omrani A, Almaslamani M, Daghfal J, Alattar R, Elgara M, Shaar S, *et al*. The first consecutive 5000 patients with Coronavirus Disease 2019 from Qatar; a nation-wide cohort study. *BMC Infectious Diseases*. 2020;20(1).
16. Zhao Z, Chen A, Hou W, Graham J, Li H, Richman P, *et al*. Prediction model and risk scores of ICU admission and mortality in COVID-19. *PLOS ONE*. 2020;15(7):e0236618.
17. Almazeedi S, Al-Youha S, Jamal M, Al-Haddad M, Al-Muhaini A, Al-Ghimlas F, *et al*. Characteristics, risk factors and outcomes among the first consecutive 1096 patients diagnosed with COVID-19 in Kuwait. *E Clinical Medicine*. 2020;24:100448.
18. Kumar A, Arora A, Sharma P, Anikhindi S,

Bansal N, Singla V, *et al*. Clinical Features of COVID-19 and Factors Associated with Severe Clinical Course: A Systematic Review and Meta-Analysis. SSRN Electronic Journal. 2020.

19. Tests M. Lactate Dehydrogenase (LDH) Test: MedlinePlus Medical Test [Internet]. Medlineplus.gov. 2021 [cited 6 May 2021]. Available from: https://medlineplus.gov/lab-tests/lactate-dehydrogenase-ldh-test/
20. D-Dimer: Reference Range, Interpretation, Collection and Panels [Internet]. Emedicine.medscape.com. 2021 [cited 25 May 2021]. Available from: https://emedicine.medscape.com/article/2085111-overview
21. Koperdanova M, Cullis J. Interpreting raised serum ferritin levels. 2021.