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ORIGINAL: Comparative Evaluation of SOFA and qSOFA in Predicting In-Hospital Mortality among COVID-19 Patients

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ABSTRACT

Introduction: In late December 2019, a novel pneumonia case emerged in Wuhan, China, which was later identified by the WHO as COVID-19. Evaluating disease severity at the time of admission is crucial in reducing COVID-19 mortality. This study examines the effectiveness of the SOFA and qSOFA tools in predicting hospital mortality among ICU COVID-19 patients.

Material and Methods: This comparative-descriptive study examined 205 severe and critical COVID-19 patients in the ICU. Data on demographics, clinical characteristics, and lab findings at admission were collected to calculate SOFA and qSOFA scores, correlated with in-hospital outcomes (survival or death). Analysis was conducted using SPSS software, with predictive accuracy assessed via ROC curve analysis.

Results: Factors such as age ≥ 65, diabetes, hypertension, cardiovascular, cerebrovascular, and pulmonary diseases, elevated creatinine and bilirubin levels, reduced PaO2 levels, tachypnea, tachycardia, decreased SPO2 levels, increasing FiO2, high SOFA score, and qSOFA were significant in predicting mortality ($P<0.05$). The qSOFA score had an area under the curve of 0.983 (95% CI: 0.968-0.998), outperforming SOFA (95% CI: 0.885-0.959). SOFA did not significantly predict outcomes in the presence of other variables ($P>0.05$), whereas qSOFA did ($P<0.05$).

Conclusion: Both SOFA and qSOFA effectively predicted COVID-19 outcomes, but qSOFA was superior in predicting mortality. Given its simplicity and suitability for routine use, qSOFA is more practical for everyday clinical application.

Introduction

In December 2019, new cases of pneumonia of unknown origin emerged in Wuhan, Hubei Province, China. The causative agent of this disease is identified as a novel strain of RNA viruses not previously identified in humans, now recognized as

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Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), leading to the disease named COVID-19 (1, 2). Although SARS-CoV-2 has shown phylogenetic and clinical similarities to SARS-CoV, the new coronavirus appears to have a higher transmission capability and lower mortality rates (3). On January 30, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency of international concern, and on March 11, the disease escalated to a global pandemic(4) .

Coronaviruses are enveloped, single-stranded positive-sense RNA viruses widely distributed in humans and animals worldwide (5). While most human coronavirus infections are mild, the major outbreaks of Beta coronaviruses, namely Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) in 2002-2003 and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in 2012, have caused lethal pneumonia with mortality rates of 10% for SARS-CoV and 36% for MERS-CoV (6)

The primary mode of virus transmission is through respiratory droplets between individuals. The incubation period averages 6 to 8 days, followed by a symptomatic period lasting one to two weeks (7). Common symptoms include fever, dry cough, shortness of breath, fatigue, and lymphopenia, with severe cases leading to viral pneumonia, possibly progressing to Severe Acute Respiratory Syndrome (SARS) and even death (5, 8).

Reports indicate that the mortality rate of COVID-19 patients increases with age, with those aged 65 and older experiencing higher mortality compared to younger individuals. COVID-19 has been identified as the leading cause of death in males, particularly in individuals with an average age of 75 (9,10), as well as those with underlying conditions such as diabetes, high blood pressure(11 ,12), heart diseases (12,9), and cerebrovascular diseases(13-16,9). According to the China Center for Disease Control and Prevention, individuals with cardiovascular diseases exhibit the highest vulnerability to the virus, followed by patients with diabetes, chronic respiratory diseases, high blood pressure, and malignancies (17-21). As of today, 7,616,791 individuals in Iran have been diagnosed with this disease, and unfortunately, 146,386 individuals have succumbed to it(22)

Given the rapid and global spread of COVID-19, it is crucial to develop reliable tools for predicting patient outcomes. This section introduces predictive models specifically designed for patients with COVID-19 who are admitted to ICUs. Due to limitations in human resources, bed capacities, and the urgent need to provide care for critically ill patients to reduce mortality rates, standardized measurement criteria have been established. These criteria are essential for optimizing patient management and resource allocation.

The Sequential Organ Failure Assessment (SOFA) score was introduced in 1996 not for predictive purposes, but rather to describe a set of complications in critically ill patients (23) . Today, this scale is employed to assess the onset and severity of organ failure in debilitated patients, aiding in predicting patient outcomes. The SOFA system comprises six subcategories related to respiratory, cardiovascular, neurological, renal, hepatic, and coagulation functions, each scored from 0 (normal) to 4 (severe failure), resulting in a total score ranging from 0 to 24. A higher score indicates more critical conditions (24-26).

The Quick Sequential Organ Failure Assessment (qSOFA) is a modified version of the SOFA scale, focusing on three parameters: systolic blood pressure, consciousness status, and respiratory rate, with each assigned a specific score. A qSOFA score of ≥ 2 indicates organ dysfunction. Given the rapid global spread of COVID-19, the need for tools to predict outcomes in affected patients is imperative (25).

The objective of this study was to assess the predictive power of in-hospital mortality between two tools, SOFA and qSOFA, in hospitalized COVID-19 patients at Bo Ali Sina Hospital in Sari. Considering the potential for future pandemics and the utility

of these tools in predicting outcomes for diseases similar to COVID-19, this study could significantly benefit intensive care units and healthcare professionals (27). In situations with limited ICU beds and a high number of critically ill patients, the use of tools that rapidly evaluate patients with minimal time and clinical parameters is essential.

Methods

The present study is a comparative-descriptive investigation aimed at assessing the predictive capability of two tools, Sequential Organ Failure Assessment (SOFA) and Quick Sequential Organ Failure Assessment (qSOFA), in predicting mortality among COVID-19 patients. The study also explores the correlation between the calculated scores using these tools and the outcomes of patients from the time of admission to the intensive care unit until either discharge or death.

All patients aged 18 and above, with a confirmed diagnosis of severe COVID-19, admitted to the intensive care unit between March 20, 2021, and August 22, 2021, were included in the study. Out of these patients, a sample size of 205 individuals meeting the inclusion criteria was selected. All required information for the study, including patients' demographic data, clinical symptoms, manifestations, and laboratory test results, were extracted from admission to the intensive care unit until discharge or death to calculate SOFA and qSOFA scores.

The qSOFA score was initially calculated at the time of patients' admission and then reassessed daily. The average qSOFA score for each patient was ultimately estimated. By comparing the obtained scores from each tool with the observed outcomes (including mortality or recovery) for patients, the predictive power of SOFA and qSOFA in predicting mortality among COVID-19 patients was assessed and compared.

For data analysis, descriptive statistical methods were first applied, presenting quantitative variables as mean ± standard deviation and qualitative variables as summary tables. Logistic regression analysis was used for single-variable analysis, and Generalized Estimating Equation (GEE) models were employed to control for confounding variables. The accuracy and performance of the SOFA and qSOFA scales in predicting outcomes for COVID-19 patients were evaluated using Receiver Operating Characteristic (ROC) curves. Data analysis was conducted using SPSS version 25, and significance was considered for P-values less than 0.05.

The study protocol was approved by the Ethics Committee of Mazandaran University of Medical Sciences under the code IR.MAZUMS.REC.1402.13717.

Results

A total of 205 patients were included in the study, with a mean age of 63.78 ± 13.07 years (minimum 25 years and maximum 85 years). Among the study participants, 58% were aged 65 and above. 52% of the patients were female. Overall, 172 individuals out of the total patient population (83.9%) had underlying medical conditions. The breakdown of these comorbidities is as follows: 124 patients had a history of diabetes, 51 patients had a history of hypertension, 78 patients had a history of cardiovascular diseases, 43 patients had a history of respiratory diseases, 41 patients had a history of cerebrovascular diseases, and 14 patients had a history of malignancy.

Initial symptoms included fever in 140 patients (68.3%), cough in 137 patients (66.8%), sore throat in 116 patients (56.6%), diarrhea in 106 patients (51.7%), and body pain in 126 patients (61.5%).

The mean systolic blood pressure was 103.21 ± 21.21 (ranging from 55 to 160), the mean diastolic blood pressure was 76.6 ± 14.74 (not assessable to 100), the mean SPO2 was 81.4 ± 11.53 (ranging from 44 to 95), the mean FiO2 was 71.69 ± 28.07 (ranging from 21 to 100), the mean heart rate was 88.26 ± 13.77 (ranging from 63 to 121), and the mean respiratory rate was 22.13 ± 8.4 (ranging from 15 to 38).

Laboratory-wise, the mean PaO2 was 63.36 ±

15.27 (ranging from 30 to 95), the mean platelet count was 248,412 ± 150,486 (ranging from 20,000 to 690,000), the mean bilirubin was 1.1 ± 0.42 (ranging from 0.3 to 2.9), and the mean creatinine was 2.23 ± 1.41 (ranging from 0.6 to 9).

In the course of hospitalization, 77 patients (37.6%) required intubation, 65 patients (31.7%) required oxygen supplementation with a reserve mask, 32 patients (15.6%) required oxygen with a simple mask, and 20 patients (9.8%) required oxygen with a nasal cannula. Only 11 patients (5.4%) did not require supplementary oxygen.

Out of the total 205 study patients, 126 patients (61.5%) experienced mortality, and 79 patients (38.5%) were discharged. The average age of deceased patients was 68.11 ± 11.68 years, while the average age of discharged patients was 87.56 ± 12.02 years. The average age of deceased patients was significantly less than discharged patients (P < 0.001).

Of 126 deceased patients, 59 were male, and 67 were female. In the discharged group, there were 38 male patients and 41 female patients. The observed difference in gender distribution between the two patient groups was not statistically significant (P = 0.859).

the mean Sequential Organ Failure Assessment (SOFA) score was 6.35 ± 4.17 (ranging from 0 to 19), and the mean Quick Sequential Organ Failure Assessment (qSOFA) score was 1.1 ± 0.76 (ranging from 0.3 to 3).

The mean SOFA score for deceased patients was 82.3 ± 46.8, and the mean SOFA score for discharged patients was 83.1 ± 97.2. the mean scores between the two groups of patients were statistically significant (P < 0.001). however, the mean qSOFA score for deceased patients was 54.0 ± 53.2, and the mean qSOFA score for discharged patients was 59.0 ± 51.0. the mean qSOFA scores between the two groups of patients were also statistically significant (P < 0.001).

Table 4-10 and 4-11. Mean scores of SOFA and qSOFA in COVID-19 patients in two groups (deceased and discharged).

1. Laboratory Factors:
   1. Creatinine:
      - Statistically, an increase in creatinine significantly impacts the likelihood of mortality in COVID-19 patients.
      - An increase in creatinine can raise the likelihood of death by approximately 5 times.
      - [P-value < 0.001, OR 5.172, 95% CI (3.007-8.898)]
   2. Bilirubin:

Table 1 .Comparison of demographic characteristics in the studied population

Variable	Mean	Standard Deviation	Minimum	Maximum
Systolic BP	103.21	21.21	55	160
Diastolic BP	76.6	14.74	NA	100
SPO2	81.4	11.53	44	95
FiO2	71.69	28.07	21	100
Heart Rate	88.26	13.77	63	121
Respiratory Rate	22.13	8.4	15	38

Table 2. Laboratory values and descriptive statistics of the study population

Variable	Mean	Standard Deviation	Minimum	Maximum
PaO2	63.36	15.27	30	95
Platelet Count	248,412	150,486	20,000	690,000
Bilirubin	1.1	0.42	0.3	2.9
Creatinine	2.23	1.41	0.6	9

Table 3. Mean scores of SOFA and qSOFA in COVID-19 patients in two groups (deceased and discharged)

	Mean SOFA	Standard Deviation SOFA	P-value SOFA	Mean qSOFA	Standard Deviation qSOFA	P-value qSOFA
Deceased	82.3	46.8	<0.001	54.0	53.2	<0.001
Discharged	83.1	97.2		59.0	51.0	

- A statistically significant increase in bilirubin influences the likelihood of mortality in COVID-19 patients.
- An increase in bilirubin can elevate the likelihood of death by about 15 times.
- [P-value < 0.001, OR 15.646, 95% CI (5.344-45.804)]

3. PaO2:
- A statistically significant increase in PaO2 has a meaningful effect on reducing the likelihood of mortality in COVID-19 patients.
- An increase in PaO2 reduces the likelihood of death by approximately 13%.
- [P-value < 0.001, OR 0.875, 95% CI (0.845-0.907)]

2. Clinical Findings:
1. Respiratory Rate:
- Logistic regression analysis reveals that a respiratory rate greater than or equal to 22 significantly intensifies the likelihood of mortality in COVID-19 patients by up to 13 times.
- Additionally, an increase in respiratory rate can increase the likelihood of death by about 1.5 times.
- [P-value < 0.001, OR 13.8, 95% CI (6.456-29.497)]
- [P-value < 0.001, OR 1.418, 95% CI (1.266-1.589)]

2. Heart Rate:
- Statistical analysis shows that an increase in heart rate has a statistically significant impact on the increased likelihood of mortality.
- [P-value = 0.039, OR 1.022, 95% CI (1.001-1.044)]

3. SPO2:
- A statistically significant increase in SPO2 has a meaningful effect on reducing the likelihood of mortality in COVID-19 patients by approximately 35%.
- [P-value < 0.001, OR 0.655, 95% CI (0.569-0.755)]

Statistical analysis indicates that an increase in the SOFA score, qSOFA Score, FiO2, heart rate, creatinine, and bilirubin significantly increase the likelihood of mortality in COVID-19 patients, and a significant increase in mean arterial pressure, SPO2, PaO2 significantly reduces the likelihood of mortality in COVID-19 patients. (Table 1)

Discussion

Given that patients with pathophysiological causes and various diseases are admitted to the intensive care unit (ICU) in a treatment center, determining prognosis and comparing different patient groups to establish admission priority have consistently posed challenges. Considering the ongoing spread of the COVID-19 disease, this study aims to analyze the ability of SOFA and qSOFA tools to predict the mortality of patients with COVID-19. Additionally, we examine the correlation of scores calculated by these tools with the outcomes of patients from the commencement of hospitalization in the ICU until either their demise or discharge.

Following meticulous consideration of inclusion and exclusion criteria, we examined 205 patients with an average age of 63.78 ± 13.07 years, with 58% of the patients being over 65 years old. The average age of deceased patients was 68.11 ± 11.81 years, while the average age of discharged patients was 56.87 ± 12.02 years. The observed average age difference between the two patient groups was statistically significant (P-value < 0.001).

Furthermore, the results of the logistic regression test indicate that increasing age significantly exacerbates the likelihood of death in COVID-19 patients. Substantial evidence from around the world underscores that age itself is the most critical risk factor for the severe manifestation of COVID-19 and its adverse consequence (28).

The initial data from China, the origin country of the COVID-19 pandemic, indicates that with increasing age, the mortality rate has grown from 4.0% or less in patients aged 40 years and younger to 3.1% in those aged 50, 6.3% in those aged 60, 8% in those aged 70, and 14.8% in those aged 80 and older (30,29)The profound impact of advanced age on the outcomes of COVID-19

has been demonstrated by data from Italy, the first country significantly affected by the pandemic after China. Results show that the mortality rate has increased from less than 4.0% in patients aged 40 and younger to 1% in those aged 50, 5.3% in those aged 60, 12.8% in those aged 70, and 20.2% in those aged 80 and older (31) . Considering that, in the current study, the average age of deceased patients was significantly higher compared to recovered patients, and statistical analysis results indicate that with increasing age, the likelihood of mortality in these patients must increase, the findings align consistently with previous studies.

Many studies assert the mortality rate due to COVID-19 is higher in males than females (32,9). Haitao and colleagues attribute these differences to specific gender behaviors, genetic factors, hormonal influences, and gender differences in the biological pathways related to SARS-CoV-2 infection(33). Despite the belief in many studies that the mortality rate in male patients is higher than in females, data from Global Health 50/50 indicate that the confirmed cases of COVID-19 are equal between males and females (34). In the present study, over half of the participants (52%) were females. Additionally, the highest number of fatalities, 67 patients, was among females, although this difference was not statistically significant (P-value > 0.05). On the other hand, logistic regression test results demonstrated that, statistically, the gender of patients does not significantly influence the likelihood of mortality. Thus, the findings of the current study in this regard contradict previous studies and align with the data from Global Health 50/50, which may be attributed to the limited sample size of the present study.

At the onset of the COVID-19 pandemic, the medical community anticipated that individuals with a history of diabetes and any other underlying conditions would experience more severe manifestations of the disease compared to others. With the increasing prevalence of COVID-19 and the expansion of studies in this domain, many studies have confirmed this expectation. Diabetes is one of the most common comorbidities in individuals with COVID-19, with its prevalence varying between 7% to 30% (35). Studies have also indicated that chronic hyperglycemia can jeopardize innate and humoral immunity. Additionally, diabetes is associated with a chronic inflammatory state with low-grade inflammation, leading to an exaggerated inflammatory response and, consequently, the onset of acute respiratory distress syndrome (36). Recent evidence suggests that SARS-CoV-2 can directly damage the pancreas, exacerbating hyperglycemia and even triggering the onset of diabetes in non-diabetic individuals (37). Lima-Martínez and colleagues reported that diabetic patients infected with SARS-CoV-2 have higher hospitalization rates, more severe pneumonia, and increased mortality compared to non-diabetic individuals (35). Similar results have been reported by Pranata et al. (38)and Singh and Khunti (39). Furthermore, a meta-analysis showed that diabetes increases the risk of contracting COVID-19 by 2.3 times and the risk of mortality from COVID-19 by 5.2 times (40). In the current study, 124 out of 205 patients (60%) had a history of diabetes. Logistic regression analysis results demonstrated that a history of diabetes significantly influences the increased likelihood of mortality in COVID-19 patients, potentially increasing the probability of death up to 5 times (P-value<0.001). Therefore, the results of the present study align with other previous studies in this regard.

During the COVID-19 pandemic, the virus has been associated with several cardiovascular pathologies, including myocarditis, acute myocardial infarction, stress cardiomyopathy, arterial and venous thromboembolism, pericarditis, and various arrhythmias (41,42). It is believed that patients with cardiovascular diseases are more susceptible to COVID-19 because the SARS-CoV-2 virus uses the ACE2 receptor for blood entry, and individuals with cardiovascular diseases have a higher level of ACE2 (37). ACE2 has anti-hypertrophic,

anti-fibrotic, and anti-hypertensive effects on the heart (43).. Authors such as Xiaoliang Yan et al. (44), Azevedo et al. (45), and Guzik et al. (46) have identified cardiovascular diseases as exacerbating factors in the mortality of COVID-19 patients. In our study, after diabetes, cardiovascular diseases have been the most common comorbidity, affecting 78 out of 205 patients (38%). Statistical analysis results also showed that a history of cardiovascular diseases significantly influences the increased likelihood of mortality from COVID-19 and can potentially increase this likelihood up to 8 times (P-value<0.001). Therefore, it can be concluded that the results of the current study in this regard are consistent with the findings of previous studies.

Reports present conflicting perspectives regarding the association between pre-existing chronic respiratory diseases and the outcomes of COVID-19. While many studies suggest that having this type of illness is linked to a weaker prognosis, opposing studies reject this hypothesis. An example of studies supporting this theory is the work by Polverino and Kheradmand in 2021, where the authors believe that older patients with cardiovascular diseases and chronic obstructive pulmonary disease (COPD) are more susceptible to a more severe disease accompanied by acute respiratory distress syndrome (ARDS), leading to adverse outcomes and high mortality(47). Chronic obstructive pulmonary disease is associated with increased susceptibility to respiratory infections, with viruses being major contributors to the acute exacerbation of COPD (48). On the contrary, Motoc et al.'s study in 2023, examining 165 COVID-19 patients, found that the outcomes of COVID-19 patients without a history of pre-existing respiratory diseases did not differ significantly from those with such a history. Although patients with a history of COPD had a higher chance of contracting COVID-19, this disease does not impact the outcomes of COVID-19; instead, the severity of COVID-19 is the determining factor, not a history of COPD(49). Additionally, Guan et al.'s study shows that COVID-19 patients with a history of COPD have a higher likelihood of hospitalization and mechanical ventilation requirement, but their mortality probability is comparable to that of other patients(50). While there is no unified conclusion regarding the relationship between a history of respiratory diseases and the outcomes of COVID-19, our statistical analysis and clinical observations suggest that a history of these diseases increases the likelihood of mortality in COVID-19 patients. According to the statistical results of the present study, a history of these comorbidities can potentially increase the likelihood of mortality in COVID-19 patients up to 8 times (P-value<0.001). Thus, the results of the current study are more aligned with the findings of Polverino and Kheradmand (47) and confirmatory of their study's outcomes.

Among other comorbidities investigated in the current study, a history of cerebrovascular diseases was examined, with 41 out of 205 patients having a history of these diseases. As anticipated, many studies suggest that a previous history of cerebrovascular diseases is a risk factor for unfavorable clinical outcomes and mortality due to COVID-19 (51). Such studies include the work of Siepmann et al. (51), Bai et al. (52), and Florez-Perdomo et al. (53). The results of Florez-Perdomo et al.'s study indicated that a history of cerebrovascular diseases is associated with a 2.78-fold increased risk of mortality compared to patients with other diseases or those without any comorbidities (53). In the current study, a history of cerebrovascular diseases significantly influences the increased likelihood of mortality in COVID-19 patients (P-value<0.001). Specifically, a history of these diseases can potentially increase the likelihood of mortality in COVID-19 patients up to 7 times. Given the statistical analysis results, the obtained findings are consistent with previous studies.

The first reports from China indicate that high blood pressure is recognized as the most common comorbidity in patients with COVID-

19, with a variable prevalence ranging from 27% to 30% This is in contrast to other accompanying diseases, which have been reported significantly less (54,55). High blood pressure, especially in patients experiencing severe stages of the disease, has been reported in those admitted to intensive care units, receiving mechanical ventilation, or even in critical conditions leading to death (56).

Two nationwide studies in Italy have shown a higher prevalence of high blood pressure in hospitalized patients. Additionally, patients who succumbed to COVID-19 had higher rates of high blood pressure along with older age, higher prevalence of diabetes, chronic obstructive pulmonary disease (COPD), chronic kidney disease, coronary artery disease, and heart failure (57,58).

The surprising association between COVID-19 and high blood pressure may not seem intuitively evident, but this association has been confirmed in various studies. In a study in France with more than 87,000 COVID-19 patients, metabolic heart diseases, including obesity, diabetes, high blood pressure, dyslipidemia, and cardiovascular diseases, such as heart and brain strokes, heart failure, coronary artery diseases, cardiac arrhythmias, valvular heart diseases, peripheral vascular diseases, chronic respiratory and severe kidney diseases, were significantly associated with a higher risk of hospitalization and mortality(59).

Although several studies have suggested that high blood pressure may be associated with an increased risk of SARS-CoV-2 infection and a weaker prognosis of COVID-19 (57-60), the independent role of high blood pressure in the risk of infection and worse outcomes in COVID-19 remains a topic of debate (56). Nevertheless, the statistical results of the current study suggest that a history of high blood pressure may have a significant impact on increasing the likelihood of mortality in COVID-19 patients (P-value<0.001), aligning with findings from other previous studies in this regard.

To understand the impact of laboratory factors on the outcomes of COVID-19 patients, numerous studies have been conducted. One of these studies is the meta-analysis by Qahramani et al. (61). This study revealed a significant decrease in the levels of lymphocytes, monocytes, eosinophils, hemoglobin, platelets, albumin, and serum sodium in patients with severe forms of COVID-19. Conversely, there was an increase in levels of neutrophils, alanine aminotransferase (ALT), aspartate aminotransferase (AST), total bilirubin, blood urea nitrogen (BUN), creatinine (Cr), erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), procalcitonin (PCT), lactate dehydrogenase (LDH), fibrinogen, prothrombin time (PT), D-dimer, and glucose levels (61). In the study by Izcovich and colleagues, 49 factors, including older age, male gender, smoking, a history of cerebrovascular diseases, chronic obstructive pulmonary disease (COPD), chronic kidney disease, cardiovascular diseases, cardiac arrhythmias, arterial blood pressure, diabetes, dementia, cancer, dyslipidemia, respiratory failure, low blood pressure upon admission, hypoxemia, tachycardia, shortness of breath, anorexia, tachypnea, hemoptysis, abdominal pain, fatigue, fever, myalgia, or arthralgia, elevated procalcitonin, increased white blood cells, decreased platelet count, increased plasma creatinine, increased D-dimer, increased lactate dehydrogenase (LDH), increased CRP, decreased lymphocytes, increased AST, decreased albumin, increased neutrophil count, increased blood urea nitrogen (BUN), increased plasma creatine kinase (CK), increased bilirubin, increased ESR, the presence of consolidation and pleural effusion, and a high SOFA score were introduced as effective factors in predicting the prognosis of COVID-19 patients (62). In the current study, unlike Izcovich et al. (62), none of the symptoms such as fever, cough, sore throat, diarrhea, and myalgia had a significant impact on the likelihood of mortality in COVID-19 patients (P-value>0.05). However, factors such as increased creatinine, elevated bilirubin, respiratory rate (tachypnea), heart rate (tachycardia), and decreased SPO2 (hypoxemia) had a significant impact on the

likelihood of mortality (P-value<0.001), consistent with the findings of the studies by Qahramani et al (61). and Izcovich et al. (62). The influence of changes in SOFA and qSOFA scores on the outcomes of COVID-19 patients is among the issues addressed in numerous studies. In the studies by Zhou et al. (63), Becerra-Muñoz et al. (64), Ramos-Rincon et al. (65), and also Izcovich et al. (55), a significant association between an increase in SOFA and qSOFA scores and the likelihood of mortality in COVID-19 patients has been reported. Becerra-Muñoz et al. considered qSOFA scores greater than 1 (64), and Ramos-Rincon et al. considered qSOFA scores greater than or equal to 2 (65) as weak predictive factors for mortality in COVID-19 patients. In the present study, a similar statistically significant association was observed between an increase in the scores of these two scales and an increased likelihood of mortality (P-value<0.001). In the current study, the average SOFA score in deceased patients was 82.3 ± 46.8, compared to 83.1 ± 97.2 in survivors, and the average qSOFA score in deceased patients was 54.0 ± 53.2, compared to 59.0 ± 51.0 in survivors (P-value<0.001).

The main objective of this study has been to investigate the ability of the two tools, SOFA and qSOFA, to predict mortality in COVID-19 patients and the relationship between the calculated scores by these two tools and the outcomes of patients. To achieve this goal, Receiver Operating Characteristic (ROC) curves were used. In the current study, the area under the curve for the SOFA tool was 0.922, and for the qSOFA tool, it was 0.983. Although both calculated values are very close to one and acceptable, the calculated area for qSOFA was significantly higher than the area under the curve for the SOFA tool (P-value<0.05). On the other hand, the results of the statistical analysis in the present study showed that, in the presence of other variables, the qSOFA tool could have a significant effect on predicting the outcome of the disease (P-value<0.05). At the same time, a similar finding was not obtained for the SOFA tool (P-value>0.05). Studies conducted by Citu et al. (66) and Martin et al. (67)considered both SOFA and qSOFA tools as excellent and acceptable predictors of mortality in COVID-19 patients. In contrast, some studies believe that one of these two tools has superiority over the other in predicting the outcomes of these patients. Among these studies, Lalueza et al. (68) and Liu et al. (69) can be mentioned.

The authors of these studies have considered the SOFA tool preferable in predicting the mortality of COVID-19 patients. In contrast, studies such as the one by San and colleagues have favored the qSOFA tool over other predictive scales (24). Although the numerical value of the AUC for both tools was acceptable in the present study, based on other obtained results, it is believed that the qSOFA tool is preferable in predicting the mortality of COVID-19 patients. Therefore, the results of the current study are more consistent with the study by San and colleagues (24). Given that our study utilized retrospective and descriptive study designs for collecting necessary information from patients' medical records, limitations such as incomplete patient records and the non-routine request for bilirubin levels were encountered. Considering the ongoing threat of another pandemic and limited capacity in specialized care units, further investigation into tools and scales evaluating the clinical course of patients in such pandemics is crucial. Therefore, it is recommended that future studies be conducted with larger populations, preferably multicenter and national, providing more detailed and comprehensive information. These efforts will be valuable for managing hospitalized patients in specialized care units in the face of potential future pandemics.

Conclusion

The results of the present study indicate that factors such as age, underlying illness, hematological and laboratory indices, as well as clinical findings, can impact the outcome of COVID-19. What was notable in the current study is the preference of the qSOFA

tool in predicting the mortality of these patients compared to the SOFA. While the SOFA tool comprehensively examines patients, its weakness lies in not routinely checking all items, such as bilirubin levels. Considering that the qSOFA tool is a modified form of SOFA, examining routine clinical aspects, it can be considered more practical in this regard.

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Conflicts of interest

The authors declare they have no conflicts of interest and have no financial interest related to any aspect of the study.

Authors' contributions

All authors contributed to the study's design, data analysis, manuscript drafting, and critical revisions, approved the final version for submission, and accepted accountability for the work.

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