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Regional differences in COVID-19 ICU admission rates in the Kingdom of Saudi Arabia: A simulation of the new model of care under vision 2030

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ABSTRACT

Objective: Saudi Arabia has succeeded in having one of the lowest rates of COVID-19 worldwide due to the government's initiatives in taking swift action to control both the spread and severity of the virus. However, Covid-19 can serve as a test case of the expected response of the new healthcare system under Vision 2030. This study used data from the thirteen present administrative regions of KSA to simulate the variations in ICU admission as a quality indicator in the five business units proposed by a new Model of Care.

Methods: We determined the rates of ICU admission for patients with confirmed SARS-CoV-2 (COVID-19) from March to mid-July 2020. The final sample included 1743 inpatients with moderate to severe COVID-19. Patient characteristics, including demographics, pre-existing chronic conditions, and COVID-19 complications, were collected. Business units (BUs) were compared with respect to the relative odds of ICU admission by using multiple logistic regression.

Results: After keeping patient and clinical characteristics constant, clear BU differences were observed in the relative odds of ICU admission of COVID-19 patients. Inpatient admission to ICU in our total sample was almost 50%. Compared to the Central BU, the Northern and Western BUs showed significantly higher odds of ICU admission while the Eastern & Southern BUs had significantly lower odds.

Conclusion: ICU use for COVID-19 patients differed significantly in KSA healthcare BUs, consistent with variations in care for other non-COVID-19-related conditions. These differences cannot be explained by patient or clinical characteristics, suggesting quality-of-care differences. We believe that privatization and the shift to fewer administrative BUs will help lessen or eliminate altogether the present variations in healthcare service provision.

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Introduction

The first cases of novel coronavirus disease 2019 (COVID-19) appeared in Saudi Arabia on March 2, 2020, and as of October 17, 2020, there have been 341,495 cases of COVID-19 and 5144

Abbreviations: KSA, Kingdom of Saudi Arabia; ICU, intensive care unit; CI, confidence interval; OR, odds ratio; HTN, hypertension; ARDS, acute respiratory distress syndrome; MOH, Ministry of Health; GIT, gastrointestinal tract.

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deaths in Saudi Arabia [1,2]. The COVID-19 pandemic has also led to devastating economic and social disruptions in Saudi Arabia [2] (University, 2020). The severity of COVID-19 depends on the presence of several risk factors such as advanced age, comorbidities such as asthma, chronic obstructive pulmonary disease (COPD), tuberculosis, pneumonia, ARDS, diabetes mellitus, hypertension, renal disease, hepatic disease, and cardiac disease, and behavioral factors such as smoking and substance abuse [3,4]. Since the organs targeted by COVID-19 include the lung, liver, heart, and kidneys [3,5–7], patients with functional impairments in these organs are more prone to a more severe disease course [8].

Approximately 80% of infected individuals with COVID-19 do not require hospitalization [9,10]. In a study in Wuhan, China,

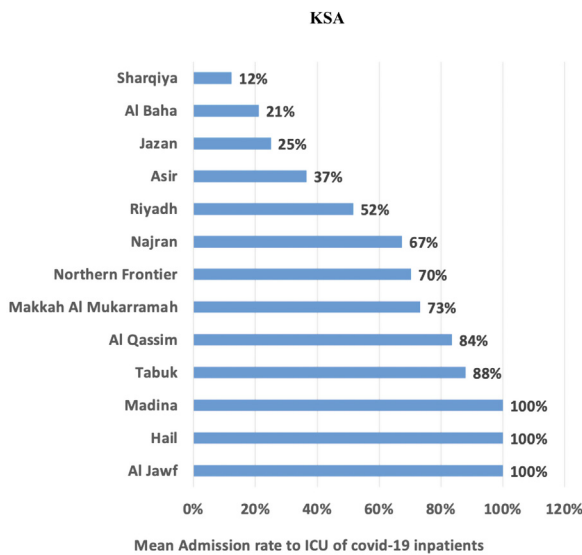


Fig. 1. The rates of ICU admission in the current 13 administrative regions model of KSA.

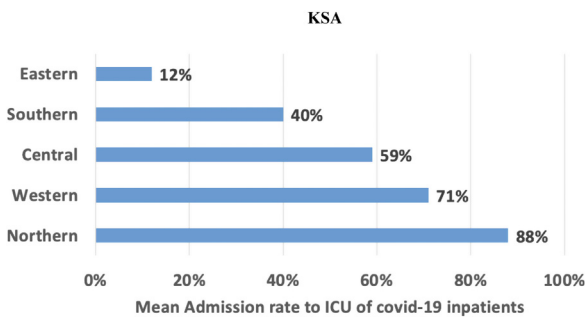


Fig. 2. The rates of ICU admission in the prospective 5 administrative BUs model of KSA.

Among individuals requiring hospitalization, up to one-third were admitted to the intensive care unit (ICU) [11]. Several comprehensive studies have reported variable outcomes and high rates of ICU admission for patients with coronavirus infections, ranging from 3% to 100% of confirmed cases [11–19]. The rate of ICU admissions may be influenced by patient conditions such as age, cardiovascular disease, obesity, and diabetes [3,4,20].

As a developing country, KSA has a heavy burden on its healthcare system due to increasing demands and thus has an impetus to transition to privatization of the healthcare system [21,22]. In compliance with Vision 2030, KSA has started to privatize most of the healthcare system in 2020, and aims to complete this process by 2030 [23]. Through the Vision Realization Office of the MOH, the process has begun to consolidate the current 13 regions in the KSA into five BUs managed by five holding companies, one each for the Central, Eastern, Western, Northern, and Southern BUs, (Figs. 1 and 2) [24].

Given the current situation and the COVID-19 pandemic, there is a lack of studies regarding the healthcare utilization experience of patients with COVID-19 in Saudi Arabia, specifically ICU utilization, which may be viewed as an indicator of the quality of healthcare being delivered across the nation's healthcare BUs. To address this gap in the literature, the present study compared ICU admission rates and the related risk factors in COVID-19 inpatients among different BUs in Saudi Arabia. We hypothesized that the ICU admission rates for COVID-19 patients would differ among the proposed five administrative BUs in the Kingdom of Saudi Arabia (KSA).

Methodology

Design, participants and setting

In this retrospective study we analyzed administrative data of inpatients with confirmed SARS-CoV-2 during the period from March to mid-July 2020. The patients were identified from the database of the Ministry of Health on COVID-19 inpatients, which collects data through reporting by KSA hospitals that accept patients diagnosed with COVID-19. The sample was composed of all patients diagnosed with SARS-CoV-2 who were admitted to these hospitals during the study period and were adults (18 years and over), since people under 18 years of age are rarely hospitalized, and, therefore, very little data exist for this group. In total, the study analyzed 1743 inpatients from across 30 MOH hospitals in the 13 administrative regions of KSA (Fig. 1). KSA occupies 80% of the Arab Peninsula and is populated with 34,218,169 people. The current Saudi healthcare system is structured into public (60%) and private (40%) sectors that provide services in thirteen administrative regions. During the COVID-19 pandemic, all COVID-19 patients were treated free of charge at Public Health Healthcare Centers (PHCCs), the public and private hospitals.

Data source and measures

The data were collected from all MOH hospitals that were assigned to treat COVID-19 inpatients in all regions in KSA. We initially identified cases classified as confirmed or suspected COVID-19 positive. We then restricted the study to all confirmed cases with moderate to severe disease, based on MOH protocols, who were admitted as hospital inpatients. We excluded cases of mild disease because these should not have been admitted per the MOH protocols.

Data extracted for this research involve demographics, comorbid conditions, presenting symptoms, complications, and hospital course (ICU, discharge, and mortality). BUs were defined as follows: Western include Makkah, Medina, and Al Baha regions. The Central includes Riyadh, AL Qassim regions. The Eastern includes the Sharqiyah region only. The Northern includes Al Jawf, Hail, Northern Frontier, and Tabuk regions. Finally, the Southern includes Asir, Jazan, and Najran regions.

Data analysis

Descriptive and Inferential statistics were used to analyze the study data. Categorical variables were reported in percentage and tested for associations using the Chi-Square test. Continuous numerical data were presented as means and standard deviation (SD) and were assessed for differences using two independent sample t-test and one-way ANOVA as appropriate. Another level of analysis was conducted using multivariate logistic regression to assess the factors associated with ICU admission. For conducting the logistic regression model the ICU admission, our primary outcome, was categorized as binary, where 0 = inpatient not admitted to ICU and 1 = admitted to ICU. The main independent variable of interest was the BU where a patient was admitted to a hospital; BUs was a categorical variable, in which 0 = Central, 1 = Eastern, 2 = Western, 3 = Northern, and 4 = Southern BUs. Central BU was chosen as a reference because it includes Riyadh City which, as the capital, has more resources than other BUs. Covariates included sociodemographic characteristics such as age & gender, clinical variables relating to the presence of pre-existing conditions such as type 2 diabetes mellitus (DM2), hypertension (HTN), and complications related to COVID-19 such as pneumonia, sepsis, acute respiratory distress syndrome (ARDS), and acute kidney injury.

The results of the logistic model were reported as odds ratios (OR) with 95% confidence intervals. All tests were two-sided and a p -value < 0.05 was considered to be statistically significant. The software used for all analyses was STATA 14.

Ethical considerations

The study was ethically approved by the Central Institutional Review Board at the Saudi Ministry of Health with a reference number of (20-163E). Secondary data were used in this study and written consent forms were read, understood, and signed by participating patients. The privacy and confidentiality of the data were maintained.

Results

Table 1 shows the characteristics of the patient population overall and by BU. The 1743 participants represented all five BUs of KSA, with the majority from the Western and Eastern BUs. The majority of patients were men with a mean age of 50 years, and the study population had a relatively equal distribution of Saudi and Non-Saudi participants. The most common chronic disease was diabetes (42%) followed by hypertension (32%), while immunocompromised and cancer patients combined represented less than 7% of the study population. Obesity and cardiac disease were relatively equally distributed (14% and 13%, respectively). We observed statistically significant differences in demographic characteristics and the presence of chronic diseases between BUs ($p < 0.001$ for all). Compared to the patients in the Central BU, those in the Northern and Western BUs were older on average and had a significantly higher rate of combined pre-existing chronic diseases, while those in the Southern and Eastern BUs showed a significantly lower presence of combined chronic diseases.

Table 2 illustrates the clinical course, complications, and outcomes of COVID-19 patients according to the five BUs of KSA. Average length of stay in the hospital was 12 days, with about half of hospitalized patients admitted to the ICU and a mortality rate of 30%. Those admitted with ARDS represented 12% of the patient population. Regarding complications, the three most common were bacterial pneumonia, sepsis, and ARDS affecting 39%, 31%, and 21% of the study participants respectively. Multiorgan failure and acute kidney injury were significant complications while arrhythmia, hepatotoxicity, and GIT perforation were less common complications. Regarding the occurrence of complications, there was variation among BUs: sepsis was higher in the Western BU while bacterial pneumonia was significantly lower in the Eastern BU ($p < 0.001$). ARDS was significantly higher in the Western BU followed by the Central and Northern BUs but was significantly lower in the Eastern BU ($p < 0.001$). The Western BU also showed significantly higher incidences of acute kidney injury, hepatotoxicity, and GIT perforation ($p < 0.001$).

Inpatients admitted to the ICU compared to patients not admitted to ICU, showed statistically significant differences in a number of characteristics as follows (**Table 3** and **Fig. 2**): The Northern and Western BUs showed statistically significantly higher rates of ICU admission than the other BUs ($p < 0.001$). Of the total sample, those admitted to the ICU were 9 years older on average, 1.5 times more likely to be male than female, and were twice as likely to be Non-Saudi as Saudi. ICU patients had a 40% longer hospital stay (14 vs. 10 days) and an almost 32-fold higher mortality rate (97% vs 3%). Patients with a history of pre-existing chronic disease had significantly higher rates of admission to ICU ($p < 0.001$ for all): those with DM2 & HTN showed around 1.5-fold higher rate; those with obesity showed a 3-fold increase, those with immunocompromised conditions and cardiac disease showed around 2.5-fold

increase, and those with ARDS showed almost 100% admission to ICU. The incidence of all complications were significantly higher among ICU-admitted patients ($p < 0.001$ for all). The most frequent complications are bacterial pneumonia occurring at a rate of 3.3-fold, all other complications including sepsis, acute kidney injury, ARDS, and multi-organ failure occurring in almost 100% of ICU patients. The incidences of all complications were significantly higher among ICU-admitted patients ($p < 0.001$ for all).

In multiple logistic regression analysis of inpatients admitted to ICU by BU (**Table 4**), with the Central BU as the referent, the relative odds of ICU admission were significantly higher in the Northern BU followed by the Western BU, significantly lower in the Southern BU and lowest in the Eastern BU. Compared to the Central BU and controlling for other explanatory variables, the odds of admission to ICU in the Western BU is 1.55 times (OR = 1.55, 95% CI 1.04–2.31, $P = 0.028$), in the Eastern BU is 0.23 times (OR = 0.23, 95% CI 0.14–0.38, $P < 0.001$), in the Northern BU is 9.90 times (OR = 9.90, 95% CI 4.53–21.61, $P = 0.001$), and in the Southern BU is 0.60 times (OR = 0.60, 95% CI 0.36–0.99, $P = 0.046$).

Discussion

The goal of this study was to understand the quality-of-care variation among the proposed five BUs in KSA by using the rate of ICU admission of inpatients with confirmed COVID-19 as a quality indicator. Our sample reflects the MOH criteria for hospital admission regarding COVID-19 which stipulates that only patients with moderate to severe symptoms should be admitted to hospital. The overall rate of ICU admission in KSA in all regions for all COVID-19 patients who were admitted to hospital based on MOH criteria is almost 50%. However, our study clearly demonstrates variations in the quality of service provision between BUs based on the rate of ICU admission after controlling for explanatory factors associated with an increased demand for ICU admission. After regression, using the Central BU as a reference we found that the rate of ICU admission was the highest in the Northern and Western BUs compared to the Central (900% and 55% percent higher, respectively, with statistically significant p values). In contrast, the ICU admission rates in the Eastern and Southern BUs were 77% and 40% lower, respectively, than that in the Central BU (**Table 4**). The high ICU admission rate in the Central BU may reflect a much higher peak in COVID-19 cases in the Central BU during the time of our data collection. Although several international studies of other coronavirus infections have identified disparities in ICU admission rates across locations, our study is the first to specifically apply ICU admission as a quality indicator focused on COVID-19 care in the KSA [11–19].

However, the disparity in ICU admissions for patients between BUs may also be explained by factors other than quality of care. Since it is not fully clear what those factors might be, we adjusted for factors known to be associated with a higher risk of ICU admission, such as patient age, presence of pre-existing chronic conditions, and occurrence of COVID-19 complications. Future research should focus on identifying the healthcare structure and process factors that account for the observed differences in likelihood of ICU admission.

The difficulties in measuring quality through healthcare utilization rates has been highlighted in previous studies [25]. The variation in the quality of healthcare services among countries, cities, or even hospitals in the same city is a key issue discussed in several studies [26–30]. Our findings for COVID-19 patients provide evidence for the BU differences in quality of care in the KSA. This evidence has the potential to guide efforts to improve the quality and efficiency of healthcare services with the application of the new Model of Care under the 2030 vision and consolidation of the current thirteen regions to five BUs. With the development

Table 1
Demographic and clinical characteristics of COVID-19 patients according to the five BUs of KSA.

Characteristics	Total N(%)	Central N(%)	WesternN(%)	EasternN(%)	NorthernN(%)	SouthernN(%)	p Value*
Demographics							
Age, mean (SD) years	50 (0.38)	49.05(13.26)	53 (15.97)	45 (16.28)	55 (16.08)	49 (14.44)	<0.001#
Population	1743 (100)	307 (18)	655 (37)	502 (29)	91 (5)	188 (11)	–
Gender							
Male	1239 (71)	260 (85)	465 (71)	302 (60)	74 (81)	138 (73)	<0.001
Female	538 (29)	47 (15)	190 (29)	200 (40)	17 (19)	50 (27)	
Nationality							
Non-Saudi	914 (52)	238 (78)	411 (63)	141 (28)	45 (49)	79 (42)	<0.001
Saudi	829 (48)	69 (22)	244 (37)	361 (72)	46 (51)	109 (58)	
History of chronic diseases							
Diabetes							
No	1009 (58)	149 (49)	345 (52)	370 (74)	42 (46)	103 (55)	<0.001
Yes	734 (42)	158 (51)	310 (47)	132 (26)	49 (54)	85 (45)	
Hypertension							
NO	1177 (68)	216 (70)	400 (61)	374 (75)	53 (58)	134 (71)	<0.001
Yes	566 (32)	91 (30)	255 (39)	128 (25)	38 (42)	54 (29)	
Obesity							
NO	1491(86)	256 (83)	503 (77)	484 (96)	84 (92)	164 (87)	<0.001
Yes	252 (14)	51 (17)	152 (23)	18 (4)	7 (8)	24 (13)	
Cardiac Diseases							
No	1513(87)	27 (90)	526 (80)	463 (92)	78 (86%)	169 (90)	<0.001
Yes	230 (13)	30 (10)	129 (20)	39 (8)	13 (14)	19 (10)	
Immunocompromised							
No	1673 (96)	298 (97)	617 (94)	494 (98)	80 (88)	184 (98)	<0.001
Yes	70 (4)	9 (3)	38 (6)	8 (2)	11 (12)	4 (2)	
History of cancer							
No	1700 (97.5)	299 (97)	629 (96)	495 (99)	89 (98)	188 (100)	<0.001
Yes	43 (2.5)	8 (3)	26 (4)	7 (1)	2 (2)	0 (0)	

Abbreviations: SD = Standard Deviation.

* Chi-square test.

p Value based on One Way ANOVA test.

Table 2
Clinical course, complications, and outcomes of COVID-19 patients according to the five BUs of KSA.

Characteristics	Total N(%)	CentralN(%)	WesternN(%)	EasternN(%)	NorthernN(%)	SouthernN(%)	p Value*
ARDS at admission							
NO	1531 (88)	249 (81)	547 (84)	491 (98)	72 (79)	172 (91)	<0.001
Yes	212 (12)	58 (19)	108 (16)	11 (2)	19 (21)	16 (9)	
ICU Admission							
NO	881(50.50)	127 (41)	191 (29%)	440 (88)	11 (12)	112 (60)	<0.001
Yes	862 (49.50)	180 (59)	464 (71%)	62 (12)	80 (88)	76 (40)	
Complications							
Sepsis							
No	1376 (79)	237 (77)	455 (69)	54 (90)	71 (78)	163 (87)	<0.001
Yes	367 (21)	70 (23)	2009 (31)	52 (10)	20 (22)	25 (13)	
Bacterial Pneumonia							
No	1063(61)	152 (50)	343 (52)	423 (84)	49 (54)	96 (51)	<0.001
Yes	680(39)	155 (50)	312 (48)	79 (16)	42 (46)	92 (49)	
ARDS							
No	1209(69)	205 (67)	332 (51)	464 (92)	61 (67)	147 (78)	<0.001
Yes	534(31)	102 (33)	323 (49)	38 (8)	30 (33)	41 (22)	
Arrhythmia							
No	1612(92)	269 (88)	581 (89)	500 (99.5)	80 (88)	182 (97)	<0.001
Yes	131(8)	38 (12)	74 (11)	2 (0.5)	11 (12)	6 (3)	
Acute kidney injury							
No	1495(86)	269 (88)	478 (73)	497 (99)	85 (93)	166 (88)	<0.001
Yes	248 (14)	38 (12)	177 (27)	5 (1)	6 (7)	22 (12)	
Hepatotoxicity							
No	1702(98%)	303 (99%)	629 (96%)	501 (100)	87 (96%)	182 (97)	<0.001
Yes	41(2)	4 (1)	26 (4)	0 (0)	4 (4)	6 (3)	
GIT perforation							
No	1709(98)	306 (100)	623 (95)	501 (100)	91 (100)	188 (100)	<0.001
Yes	34(2)	0 (0)	32 (5)	0 (0)	0 (0)	0 (0)	
Multi-organ failure							
No	1565(90)	283 (92)	525 (80)	500 (99.50)	83 (91)	174 (93)	<0.001
Yes	179(10)	24 (8)	130 (20)	2 (.50)	8 (9)	14 (7)	
Death in Hospital							
No	1218 (70)	231 (75)	320 (49)	463 (92)	43 (47)	161 (86)	<0.001
Yes	525 (30)	76 (25)	335 (51)	39 (8)	48 (53%)	27 (14)	
Duration of stay in days, mean (SD)	12 (0.2)	13.22 (8.1)	13.32 (8.2)	9.33 (7.8)	12.56 (7.7)	10.93 (8.4)	<0.001#

Abbreviations: ICU = intensive-care unit; ARDS = acute respiratory distress syndrome; GIT = gastrointestinal tract.

* Chi-square test.

p Value based on One Way Anova Test.

Table 3
Demographic and clinical variables associated with ICU admission among COVID-19 patients, KSA.

Characteristics	Not admitted to ICUN(%)	Admitted to ICU(N%)	p Value*
Age in years (mean)	45	54	<0.001#
Duration of stay in days (mean)	10 days	14 days	<0.001#
BU			
Central	127 (41)	180 (59)	
Western	191 (29)	464 (71)	
Eastern	440 (88)	62 (12)	<0.001
Northern	11 (12)	80 (88)	
Southern	112 (60)	76 (40)	
Gender			
Male	553 (45)	686 (55)	<0.001
Female	328 (65)	176 (35)	
Nationality			
Non-Saudi	341 (37)	573 (63)	<0.001
Saudi	540 (65)	289 (35)	
Mortality			
No	865 (71)	353 (29)	<0.001
Yes	16 (3.0)	509 (97)	
History of chronic diseases			
Diabetes			
No	608 (60)	401 (40)	<0.001
Yes	273 (37)	461 (63)	
Hypertension			
No	654 (56)	523 (44)	<0.001
Yes	227 (40)	339 (60)	
Obesity			
No	820 (55)	671 (45)	<0.001
Yes	61 (24)	191 (76)	
Cardiac Diseases			
No	814 (54)	699 (46)	<0.001
Yes	67 (29.0)	163 (71)	
Immunocompromised			
No	861 (51)	812 (49)	<0.001
Yes	20 (29.)	50 (71)	
History of cancer			
No	853 (50)	847 (50)	0.053
Yes	28 (65)	15 (35)	
ARDS on admission			
No	880 (57)	651 (43)	<0.001
Yes	1 (0.50)	211 (99.5)	
Complications			
Sepsis			
No	861 (63)	515 (37)	<0.001
Yes	20 (5)	347 (95)	
Bacterial pneumonia			
No	726 (68)	337 (32)	<0.001
Yes	155 (23)	525 (77)	
ARDS			
No	866 (72)	343 (28)	<0.001
Yes	15 (3)	519 (97)	
Arrhythmia			
No	875 (54)	737 (46)	<0.001
Yes	6 (5)	125 (95)	
Acute kidney injury			
No	875 (59)	620 (41)	<0.001
Yes	6 (2)	242 (98)	
Hepatotoxicity			
No	881 (52)	821 (48)	<0.001
Yes	0 (0)	41 (100)	
GIT perforation			
No	881 (52)	828 (48)	<0.001
Yes	0 (0)	34 (100)	
Multi-organ failure			
No	881 (56)	684 (44)	<0.001
Yes	0 (0)	178 (100)	

Abbreviations: ICU = intensive-care unit; ARDS = acute respiratory distress syndrome; GIT = gastrointestinal tract.

* Chi-square test.

p Value based on two independent t test.

of five BUs with separate private administrations, competition will be enhanced and the burden on the MOH for providing care will decrease, although its supervisory workload will be increased. The large variations in the quality of healthcare services shown in Fig. 1

will decrease with the shifting of accountability to the five BU authorities in KSA as in Fig. 2.

Future research should focus on using data from longer time periods of at least one year to ensure that every BU's data include the peak of their COVID-19 caseloads to more precisely measure

Table 4
Multiple logistic regression analysis of factors related to ICU admission.

Characteristics	OR	95% CI		p Value
		Lower	Upper	
BU				
Central	1	REF		
Western	1.55	1.04	2.13	0.028
Eastern	0.23	0.14	0.038	<0.001
Northern	9.90	4.53	21.61	<0.001
Southern	0.60	0.36	0.99	0.046
Age groups				
18–39 years	1	REF		
40–59 years	2.13	1.45	3.14	<0.001
60 years and older	2.75	1.68	4.51	<0.001
Gender				
Male	1	REF		
Female	0.58	0.4	0.85	0.002
Nationality				
Non-Saudi	1	REF		
Saudi	0.58	0.41	0.82	0.002
History of chronic diseases				
Diabetes	1.24	0.89	1.75	0.197
Hypertension	0.75	0.51	1.25	0.170
Obesity	1.78	1.14	2.78	0.010
Cardiac Diseases	1.51	0.9	2.54	0.118
Immunocompromised	4.1	1.53	10.97	0.005
History of cancer	0.17	0.04	0.61	0.007
Admitted with ARDS	44.93	5.88	343.28	<0.001
Complications				
Bacterial Pneumonia	3.36	1.94	3.69	<0.001
Arrhythmia	2.28	0.82	6.33	0.113
ARDS	31.67	17.9	56.06	<0.001

Abbreviations: ICU = intensive-care unit; CI = confidence interval; OR = Odds Ratios ARDS = acute respiratory distress syndrome; REF = reference category.

the burden in each BU. In addition, a comprehensive study outlining the association of service provision with each stage of healthcare services, i.e., at the levels of structure, resources, and distribution as well as at the patient level, are required to create a strong baseline from which improvements can be initiated.

Strengths

Our study has a high level of validity with its primary strength the inclusion of many factors encompassing explanatory variables such as demographics, pre-existing conditions, and the occurrence of COVID-19 complications. These additional factors may reveal the precise associations between the sites where patients receive healthcare services (i.e., BU) and the outcome, which is a quality indicator. The advantage of this study is that it is the first to utilize the current health pandemic situation to predict the future response of the system after implementation of Vision 2030 and to provide clues and tips for healthcare planners and policy makers to impose guidance and apply scientifically based research.

Limitations

A cross-sectional study with four and half months of data may not provide a clear picture of services since the peak of COVID-19 cases occurred at different times in each BU. Additionally, the study's cross-sectional study design was not ideal for assessment of the factors associated with the rate of ICU admission since the direct and causal relationships among the investigated variables could not be established appropriately.

Conclusions

As the first study to simulate the New Model of Care under Vision 2030 which aims to give a clue about the response of our future healthcare system, we found that the quality of healthcare

services as reflected by the potential of ICU admission for COVID-19 patients in the ascending order was as follows: Eastern, Southern, Central, Western, and Northern BUs. The rate of admission to ICU was almost 50% for the total inpatient sample. These differences were not explained by differences in patient characteristics. However, the findings are consistent with the results of previous studies of BU differences in healthcare quality. Further investigation is required to identify the specific factors associated with BU differences in healthcare quality.

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Competing interests

The authors declare that they have no competing interests.

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