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International Diabetes Federation

Prevalence of diabetes, management and outcomes among Covid-19 adult patients admitted in a specialized tertiary hospital in Riyadh, Saudi Arabia

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ARTICLE INFO

Article history:
Received 1 September 2020
Received in revised form
21 October 2020
Accepted 30 October 2020
Available online 13 November 2020

Keywords:
Type 2 Diabetes Mellitus
Covid-19
Saudi Arabia
South Asians

ABSTRACT

This retrospective study aimed to characterize comorbidities and associated with mortality among hospitalized adults with Covid-19 managed as per the Saudi Ministry of Health protocol in a specialized tertiary hospital in Riyadh, Saudi Arabia. Medical records of 300 adult patients with PCR-confirmed SARS-CoV2 infection and admitted in King Salman Hospital (KSH) from May 1 to July 31, 2020 were included. Medical history, management and outcomes were noted. Males significantly outnumber females (259 versus 41). South Asians comprise 41% of all admitted patients. Mortality rate was 10% and highest among Saudi males (28.9%). Type 2 diabetes mellitus (T2DM) was the most common comorbidity (45.7%). Almost all patients (99%) had pneumonia. Patients > 50 years were three times more likely to die (confidence interval, CI 1.3–6.9; $p = 0.01$) from Covid-19. Congestive heart failure (odds ratio OR 19.4, CI-1.5–260.0; $p = 0.02$) and acute kidney injury (OR 11.7, CI-4.7–28.6; $p < 0.001$) were significantly associated with higher mortality. Dexamethasone use significantly improved the final outcome based on net reclassification improvement (NRI) and integrated discrimination improvement (IDI) ($p < 0.05$). In this single-center study, T2DM was very common among hospitalized Covid-19 patients. Patients > 50 years, those with congestive heart failure and acute kidney injury are at higher risk for worse Covid-19 outcome.

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https://doi.org/10.1016/j.diabres.2020.108538
0168-8227/

1. Introduction

The coronavirus disease 19 (Covid-19) global pandemic is an on-going public health catastrophe that has infected>25 million individuals and has resulted to>840,000 casualties as of August 30, 2020, based on John Hopkins University's interactive web-based dashboard to track COVID-19 in real time [1]. Among the Gulf Cooperation Council (GCC) countries, Saudi Arabia holds the record with the highest number of cases (>340,000) and deaths (>5200) [1]. While management of Covid-19 is generally supportive care in nature, different countries do not follow the same protocols and are considered living guidance since they are constantly subject to change. Saudi Arabia is no different, and hospitals in the country follow the most updated version (July 31, 2020) issued by the Ministry of Health (MoH) [2].

Currently, many observational studies have emerged from different countries in identifying risk factors and associations with Covid-19 severity. A consistent risk factor associated with Covid-19 mortality is old age, which has been singled out by both the World Health Organization (WHO) and the Centers for Disease and Control (CDC) as the most vulnerable population from Covid-19 [3]. While this may also be the case for Saudi Arabia, the country is fortunate to have a relatively young population, but it is also replete with other risk factors associated with old age such as diabetes mellitus (DM), hypertension and obesity [4], making the population potentially more susceptible for worse Covid-19 outcomes. Another unique feature in Saudi Arabia, which is also true for the GCC region, is the abundance of migrant labor workers, mostly men, coming less developed countries such as North Africa and South Asia, the latter of which were recently observed to also have their own share of increasing prevalence of cardiometabolic diseases [5]. In the first national study on Covid-19 done in the country, 46.6% of the 1519 individuals who tested positive from SARS-CoV2 were non-Saudis [6]. The heterogeneity, age and health risk burden of the population, as well as the strength of the countries healthcare system, all comes into play when assessing Covid-19 risk factors and prognosis, making such studies' results different geographically. Fortunately, and as per the royal decree (issued in March 30, 2020) of his Royal Highness, King Salman, free treatment has been provided to all citizens, residents and even residency violators in all Saudi hospitals whether public or private to all matters related to Covid-19 [7].

The present retrospective study aims to determine the common comorbidities and risk factors that are associated with mortality among hospitalized patients admitted for Covid-19 and managed as per the Saudi MoH protocol for patients suspected of/confirmed with COVID-19 in a single specialized tertiary hospital in the capital Riyadh, Saudi Arabia. The study also aims to determine whether differences exist in presentation, management and outcomes among males and female patients admitted for Covid-19.

2. Methodology

This is a single-center, retrospective study done at King Salman Hospital (KSU), Riyadh, Saudi Arabia. Medical records of 300 hospitalized adults from Riyadh, Saudi Arabia who were found to be PCR-positive by nasopharyngeal swab for SARS-CoV2 and admitted at KSH from May 1 to July 31, 2020 were obtained. Those who tested negative for SARS-CoV2, children and without an outcome were excluded. A flowchart has been provided in Fig. 1. Ethical approval was obtained from the Institutional Review Board (IRB) of the College of Medicine in King Saud University in Riyadh, Saudi Arabia (E-20–4803/Aug 13, 2020).

2.1. *Data collection*

Data obtained included age, nationality, comorbidities, symptoms and vital signs on prior to admission, serological tests done (complete blood count, profiles of liver, renal, glycemic, inflammatory markers and others). Management given was based on the guidelines set by the Saudi Ministry of Health protocol for patients suspected of/confirmed with Covid-19. T2DM was based on known medical history and history of anti-DM medication intake. Newly diagnosed T2DM patients were based on HbA1c $\geq$ 6.5 and fasting glucose $\geq$ 7.0 mmol/l [8]. For the purpose of this study, several clinical outcomes were included such as pneumonia (presence of unilateral or bilateral lung infiltrates by chest x-ray), acute respiratory distress syndrome (ARDS), shock (hypoxic-ischemic damage with dysrhythmias), acute liver injury (elevated liver profile), acute renal injury (elevated renal profile), stroke (abrupt and

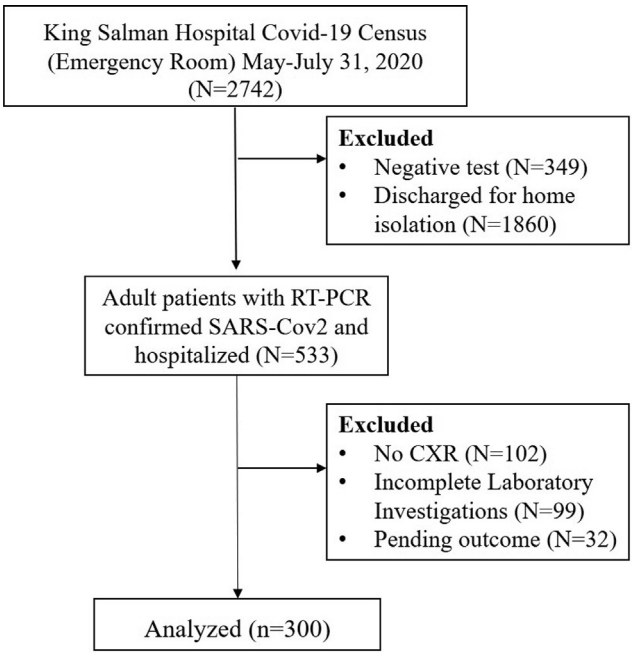

Fig. 1 – Flowchart of Participants.

persistent focal neurologic deficit) and myocardial infarction (abnormal echocardiogram with elevated troponin level). Mortality was defined as death as a direct result of Covid-19 infection. Final outcome was recorded number of days from hospital admission to final outcome were noted.

2.2. Data analysis

G*Power 3.1 was used to determine sample size. Based on a previous *meta*-analysis indicating DM risk for Covid-19 mortality [pooled odds ratio 1.75 (95% Confidence Interval, CI 1.31–2.36; P = 0.0002)] [9] at 95% CI and 80% power, the required sample size is N = 214. Statistical analysis was done using SPSS version 21.0 (IBM, SPSS, Chicago, IL, USA) Categorical variables were presented as percentages (%) and continuous variables were presented as mean ± standard deviation (SD) for normal variables and mean ± standard error mean (SEM) for non-normal variables. Chi-Square test was done to determine differences in categorical variables. Independent *T*-test and Mann-Whitney *U* test were done to determine differences between sex and DM status for normal and non-normal variables, respectively. Multivariable logistic regression analysis was done to determine odds ratios with 95% confidence intervals (CI) to determine significant risk factors for outcomes, adjusted for age and sex. Likelihood ratio tests was performed using cox regression while area under the curve (AUC) was obtained from ROC curve. Furthermore, the net reclassification improvement (NRI) and integrated discrimination improvement (IDI) was also obtained using R survIDINRI package. Significance was set at $p < 0.05$.

2.3. Results

Table 1 shows the general characteristics of 300 hospitalized Covid-19 patients in KSH. Males significantly outnumber females by 7:1. All patients were adults with an age-range of 20–95 years (mean age 49.7 ± 13.2, median age 50 years). Female patients were significantly older than males (median age 54 versus 49 years; $p < 0.001$). South Asians (Bangladeshi, Pakistani and Indian) were the biggest demographic in the cohort with 41% followed by non-Saudi Arabs with 23.3% and Saudis at 19.3%. South Asians were also the biggest group among male patients (45.6%) while Saudis were the majority among females (48.8%). Among the comorbidities, T2DM was the most common (45.7%) followed by hypertension (28.0%). This trend was also after stratification for sex. Among females however, the prevalence of hypertension was significantly higher than males (46.3% versus 25.1%; $p < 0.005$). Worthy to note is that 5% (n = 15) of the T2DM patients were diagnosed on admission. The list of other comorbidities in all patients and after stratification according to sex are seen in table 1.

Table 2 shows the presenting symptoms of hospitalized male and female Covid-19 patients. There were no significant differences in the symptoms between sexes. Dyspnea (94.7%), cough (89.3%) and fever (83.7%) were the three most common symptoms in seen in overwhelmingly majority of patients. Other symptoms such as myalgia (6.3%), vomiting (5.7%) and diarrhea (5.0%) were observed infrequently. Among the vital signs, mean temperature on admission was significantly higher in females than males ($p = 0.049$). The rest of the vital signs were not significantly different form one another.

Table 1 – General Characteristics of Covid-19 Patients.

Parameters	All	Males	Females	P-Value
N (%)	300 (100)	259 (86.3)	41 (13.7)	
Age (years) Mean ± SD	49.7 ± 13.2	48.6 ± 12.1	56.3 ± 17.6	<0.001
Nationality (%)				
Saudi	58 (19.3)	38 (14.7)	20 (48.8)	<0.001
Arab (non-Saudi)	70 (23.3)	63 (24.3)	7 (17.0)	
Bangladeshi	51 (17.0)	50 (19.3)	1 (2.4)	
Pakistani	33 (11.0)	29 (11.2)	0	
Indian	39 (13.0)	39 (15.1)	4 (9.8)	
Filipino	10 (3.3)	8 (3.1)	2 (4.9)	
Sudanese	17 (5.7)	14 (5.4)	3 (7.3)	
Others	22 (7.4)	18 (7.0)	4 (9.8)	
Comorbidities (%)				
Hypertension	84 (28.0)	65 (25.1)	19 (46.3)	0.005
Type 1 Diabetes Mellitus	5 (1.7)	3 (2.8)	2 (10.0)	NS
Type 2 Diabetes Mellitus*	137 (45.7)	117 (45.1)	20 (48.8)	
Coronary Artery Disease	10 (3.3)	8 (3.1)	2 (4.9)	NS
Heart Failure	4 (1.3)	4 (1.5)	0	NS
Stroke	5 (1.7)	3 (1.2)	2 (4.9)	NS
Chronic Kidney Disease	7 (2.3)	5 (1.9)	2 (4.9)	NS
On Dialysis	3 (1.0)	2 (0.8)	1 (2.4)	NS
Lung Disease	10 (3.3)	8 (3.1)	2 (4.9)	NS
Liver Disease	4 (1.3)	4 (1.5)	0	NS
Cancer	1 (0.3)	1 (1.5)	0	NS

Note: *Known cases + newly diagnosed; NS, not significant; significant at $p < 0.05$.

Table 2 – Common Presenting Symptoms and Mean Vital Signs of Patients on Admission.

Parameters	All	Males	Females	P-Value
N	300	259	41	
Symptoms				
Dyspnea (%)	284 (94.7)	248 (95.8)	36 (87.8)	NS
Cough (%)	268 (89.3)	234 (90.3)	34 (82.9)	NS
Fever (%)	251 (83.7)	218 (84.2)	33 (80.5)	NS
Myalgia (%)	19 (6.3)	17 (6.6)	2 (4.9)	NS
Vomiting (%)	17 (5.7)	12 (4.6)	5 (12.5)	NS
Diarrhea (%)	15 (5.0)	14 (5.4)	1 (2.4)	NS
Nausea (%)	12 (4.0)	8 (3.1)	4 (9.8)	NS
Chest Pain	9 (3.0)	7 (2.7)	2 (4.9)	NS
Sore Throat	7 (2.3)	7 (2.7)	0	NS
Headache	5 (1.7)	3 (1.2)	2 (4.9)	NS
Anosmia (%)	2 (0.7)	2 (0.8)	0	NS
Ageusia (%)	1 (0.3)	1 (0.4)	0	NS
Vital Signs				
Temperature (°C)	37.0 ± 4.4	36.8 ± 4.0	38.3 ± 6.4	0.049
Heart Rate (beats/minute)	99.5 ± 14.7	99.9 ± 13.6	96.5 ± 21.6	NS
Respiratory Rate (breaths/min)	22.8 ± 3.9	22.9 ± 4.1	22.0 ± 1.7	NS
Systolic Blood Pressure (mmHg)	127.9 ± 18.0	128.0 ± 18.2	127.1 ± 17.1	NS
Diastolic Blood Pressure (mmHg)	78.2 ± 12.0	78.5 ± 11.9	75.9 ± 12.5	NS
SpO2 (%)	85.7 ± 5.8	85.6 ± 5.9	86.5 ± 4.3	NS

Note: SpO2, oxygen saturation; NS, not significant; significant at $p < 0.05$.

Table 3 – Clinical Characteristics of Covid-19 Patients on Admission.

Parameters	All	Males	Females	P-Value
N	300	259	41	
Complete Blood Count				
Hemoglobin (g/l)	13.0 ± 1.8	13.1 ± 1.8	12.1 ± 1.6	0.003
WBC count (4.0–11.0)*	11.5 ± 1.8	11.9 ± 2.1	8.7 ± 0.5	NS
Platelet count (140–450)*	264.8 ± 6.8	267.8 ± 7.6	246.5 ± 14.9	NS
Lymphocyte (1–5)*	1.4 ± 0.05	1.4 ± 0.06	1.4 ± 0.11	NS
D-Dimer (μg/ml) (0.22–0.45)*	2.7 ± 0.7	2.8 ± 0.8	1.8 ± 0.3	NS
Liver Profile				
AST (U/l) (15–37)*	65.5 ± 4.0	66.6 ± 4.3	58.6 ± 9.0	NS
ALT (U/l) (20–65)*	70.8 ± 5.4	74.6 ± 6.2	45.9 ± 5.5	0.006
LDH (U/l) (84–246)*	474.7 ± 14.9	486.4 ± 16.1	400.3 ± 36.3	0.029
Albumin	25.1 ± 3.9	25.3 ± 4.1	24.0 ± 2.7	NS
Bilirubin*	12.6 ± 0.8	12.9 ± 0.9	10.5 ± 1.2	NS
Renal Profile				
Creatinine (μmol/l) (49–90)*	111.9 ± 6.8	111.6 ± 7.0	114.0 ± 22.6	NS
Inflammatory Markers				
Ferritin (μg/ml) (13–150)*	566.7 ± 25.4	594.0 ± 27.7	400.4 ± 55.7	0.001
CRP (mg/l) (<10.0)*	136.5 ± 8.0	139.6 ± 8.5	118.7 ± 22.9	NS
Troponin*	0.13 ± 0.08	0.14 ± 0.09	0.10 ± 0.06	NS
Glycemic Profile				
HbA1c (<6.0)**	9.0 ± 2.5	8.9 ± 2.4	9.3 ± 2.9	NS
Random blood glucose	10.0 ± 5.6	10.2 ± 5.6	9.3 ± 5.4	NS
Other Markers				
Calcium	2.1 ± 0.2	2.1 ± 0.2	2.0 ± 0.09	NS
Phosphorous	1.1 ± 0.6	1.2 ± 0.6	0.9 ± 0.5	NS
Magnesium	0.9 ± 0.2	0.9 ± 0.2	0.8 ± 0.1	NS

Note: *denotes non-normal data and presented as mean ± standard error; ** Only 67 patients had HbA1c levels assessed on admission; WBC, white blood count; AST, aspartate aminotransferase; ALT, alanine transferase; LDH, lactate dehydrogenase; CRP, C-reactive protein; HbA1c, glycated hemoglobin; NS, not significant; all p-values adjusted for age; significant at $p < 0.05$.

Table 3 displays the biochemical assessments done for the hospitalized male and female patients. Mean circulating hemoglobin, ALT, LDH and ferritin levels were significantly higher in males than females (p-values 0.003, 0.006, 0.029 and 0.001, respectively). Majority of patients had abnormal levels in nearly all metabolic markers assessed, including

Table 4 – Management and Outcomes of Covid-19 Patients.

Parameters (%)	All	Males	Females	P-Value
N	300	259	41	
LMWH	298 (99.3)	258 (99.6)	40 (97.6)	NS
Antibiotics	297 (99.0)	259 (100)	39 (95.1)	0.02
Vitamin D	292 (97.3)	252 (97.3)	40 (97.6)	NS
Vitamin C	291 (97.0)	251 (96.9)	40 (97.6)	NS
Azithromycin	290 (96.7)	252 (97.3)	38 (92.7)	NS
Hydroxychloroquine	267 (89.0)	234 (90.3)	33 (80.5)	NS
Dexamethasone	206 (68.7)	176 (68)	30 (73.2)	NS
Methylprednisolone	47 (15.7)	42 (16.2)	5 (12.2)	NS
Antiviral	46 (15.3)	38 (14.7)	8 (19.5)	NS
Triple Combination Therapy	36 (12.0)	31 (12.0)	5 (12.2)	NS
Faviperavir	11 (3.7)	7 (3.3)	4 (12.5)	NS
Outcomes				
Pneumonia	299 (99.7)	259 (100)	40 (97.6)	NS
ARDS	33 (11.0)	29 (11.2)	4 (9.8)	NS
Shock	16 (5.3)	13 (5.0)	3 (7.3)	NS
Acute Kidney Injury	41 (13.7)	38 (14.7)	3 (7.3)	0.02
Acute Liver Injury	78 (26.0)	70 (27.0)	8 (19.5)	NS
Stroke	2 (0.7)	2 (0.8)	0	NS
MI	2 (0.7)	0	2 (4.9)	0.02
Required Mechanical Ventilation	21 (7.0)	18 (6.9)	3 (7.3)	NS
Mortality	30 (10.0)	26 (10.0)	4 (9.8)	NS
Discharged/Recovered	270 (90.0)	233 (90.0)	37 (91.2)	NS
Time Lapse from Diagnosis				
Length of Stay	7.9 ± 5.2	8.1 ± 5.4	6.3 ± 3.3	NS

Note: ICU, intensive care unit; NS, not significant; significant at $p < 0.05$.

liver and renal and glycemic profile. Inflammatory markers in particular (ferritin, CRP and troponin) were 2–3 times higher than normal (Table 3).

Table 4 shows the management given to hospitalized patients. Almost all patients were given LMWH and antibiotics, with all males receiving the latter (p = 0.02). Majority (~97%) also received vitamin C, vitamin D and azithromycin. Majority also received hydroxychloroquine (89%) and dexamethasone (68.7%). For other treatments, antiviral therapy was given to 15.3% of patients, triple combination therapy was administered in only 12% of patients and Faviperavir in 11% of cases.

In terms of outcome, mortality rate was at 10% while the rest were discharged. Twenty-one patients (7%) required mechanical ventilation. Only one out of the 300 hospitalized patients did not develop pneumonia. Eleven percent had ARDS, 26% had acute liver injury while another 13.7% had acute kidney injury, majority of whom were males (p = 0.02). Only 2 patients developed MI and were both females (p = 0.02). Lastly, the median length of hospital stay was 7 days, ranging from 1 to 37 days. The rest of the outcomes are shown in table 4.

Table 5 – Multinomial Logistic Regression Analysis Using Mortality as Dependent Variable and Select Demographic and Comorbidities as Independent Variables.

Risk Factor	Adjusted for Age and Sex		
	OR	95% CI	P-Value
Age > 50 years	2.96	1.3–6.9	0.01
Male	1.0	0.34–3.1	NS
Hypertension	1.6	0.7–3.7	NS
Type 2 Diabetes Mellitus	1.7	0.7–4.0	NS
Coronary Artery Disease	2.1	0.4–9.7	NS
Congestive Heart Failure	19.4	1.5–260	0.02
Chronic Kidney Disease	5.8	0.9–37.8	NS
Acute Kidney Injury	11.7	4.7–28.6	<0.001
Stroke	1.5	0.2–10.8	NS
Methylprednisolone	0.35	0.1–0.9	0.02
Dexamethasone	0.2	0.07–0.38	<0.001
Hydroxychloroquine	0.12	0.05–0.31	<0.001
Azithromycin	0.03	0.01–0.02	<0.001

Note: OR, odds ratio; CI, confidence interval; Significant at $p < 0.05$.

Table 5 shows the odds of Covid-19 mortality relative to several risk factors and therapy schemes and adjusted for age and sex. Covid-19 patients above 50 years was almost three times more likely to die (confidence interval, CI 1.3–6.9; p = 0.01) from Covid-19 compared to patients aged below 50 years. Among the comorbidities, only congestive heart failure was significantly associated with higher mortality (odds ratio OR 19.4, CI- 1.5–260.0; p = 0.02). Among the treatment options, patients who were given methylpredinosolone, dexamethasone, hydroxychloroquine and azithromycin were significantly less likely to die from Covid-19 by as much as 65%, 80%, 88% and 97%, respectively. The rest of the odds ratios are shown in Table 5.

A sub-analysis was done focusing only on male patients. Fig. 2 shows the prevalence of T2DM, those above 55 years and mortality rate between Saudis and other ethnic groups. Saudi nationals had the highest percentage of patients above 55 years (63.2%) and mortality rate of 28.9% compared to other ethnic groups (unadjusted p-values 0.002 and 0.001, respectively). Multinomial logistic regression analysis using death

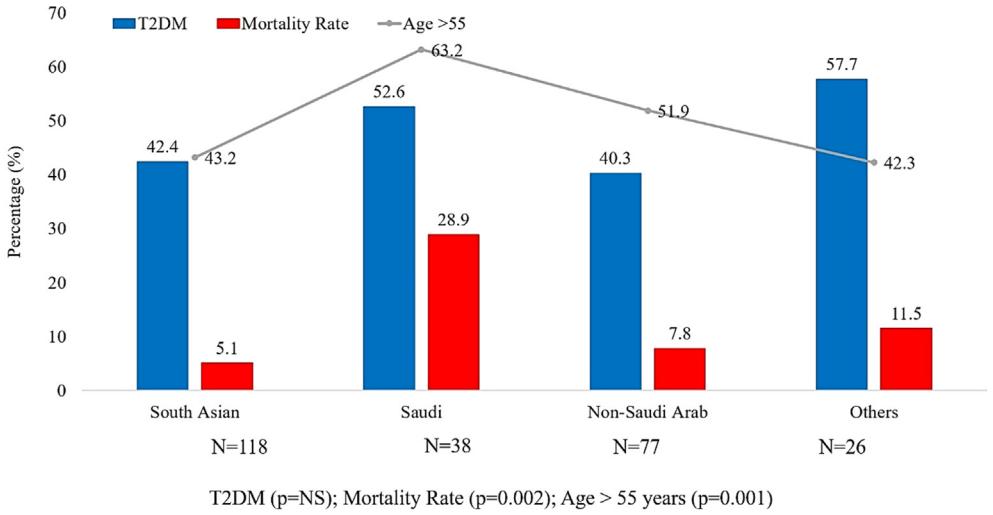

Fig. 2 – T2DM, Mortality Rate and Age above 55 among Saudis and other Ethnic Groups (male patients only).

Table 6 – Risk Prediction Model.

Predictors	IDI	NRI	ΔAUC	Δ-2log Likelihood
Hypertension	0.02 (−0.06–0.1)	0.35 (−0.8–0.7)	0.02 ± 0.07	2.81
Type 2 Diabetes Mellitus	−0.03 (−0.2–0.1)	−0.49 (−1.2–0.9)	0.02 ± 0.07	1.28
Coronary Artery Disease	0.01 (−0.02–0.1)	0.05 (−0.6–0.4)	0.04 ± 0.07	2.93
Congestive Heart Failure	0.04 (−0.02–0.1)	0.15 (−0.6–0.8)	0.06 ± 0.07	11.8**
Chronic Kidney Disease	0.02 (−0.05–0.1)	0.49 (−1.5–1.0)	0.04 ± 0.07	4.02*
Acute Kidney Injury	0.01 (−0.01–0.05)	0.02 (−0.75–0.8)	0.01 ± 0.07	2.2
Stroke	0.01 (−0.03–0.05)	−0.56 (−1.2–0.6)	0.03 ± 0.07	4.15*
Methylprednisolone	0.03 (−0.04–0.2)	0.32 (−0.7–1.0)	0.04 ± 0.07	2.41
Dexamethasone	0.16 (0.01–0.5)*	0.64 (0.0–1.6)*	0.16 ± 0.07*	16.30**
Hydroxychloroquine	0.11 (−0.08–0.5)	0.41 (−0.3–1.5)	0.17 ± 0.07*	16.31**
Azithromycin	0.14 (−0.2–0.4)	0.31 (−0.76–0.9)	0.11 ± 0.07	15.18**

Note: ΔAUC and Δ-2logLikelihood indicates change in the statistic after the addition of the corresponding independent variable in the model. ** & * indicates P-value < 0.01 and < 0.05 respectively.

as dependent variable, T2DM as independent variable and age as covariate revealed no significance, even after stratification according to ethnicity (not shown in tables).

Lastly, Table 6 shows the results of survival analysis using survIDINRI package and revealed that the inclusion of dexamethasone was the only factor in the model that significantly improved the outcome as indicated by the significant IDI and NRI ($p < 0.05$). The results were confirmed using changes in AUC and the predictive power as indicated by the significant decline in the deviance (Δ-2logLikelihood).

3. Discussion

In this retrospective study, characteristics of hospitalized patients with confirmed Covid-19 are presented. These patients were admitted at a specialized tertiary hospital in the capital Riyadh, Saudi Arabia, following the Ministry of Health's latest protocol for supportive care and treatment of patients suspected of/with confirmed Covid-19. An overwhelming majority of the patients were males, South Asians in particular, while Saudis were the predominant in females. The preponderance for males can largely be explained by the cultural set-up in Saudi Arabia, where females are less socially mobile and home-based, as well as the relatively larger population of men over-all. At a national level however, the number of men infected with SarsCov-2 is only slightly higher than females (54% versus 46%) [6]. South Asians are a big part of the labor migrants in Saudi Arabia and the GCC region in general, who, but not all, typically lives in camps provided by their employers [10]. The crowded living environment of workers prevent them from practicing the needed precautionary distance to avoid risk f SarsCov2 infection, and this could explain why majority of the patients are coming from this demographic group. In the present study, almost all patients had pneumonia, as confirmed by the presence of lung infiltrates in the patients' chest x-rays. Fifteen also had elevated random blood glucose levels. Whether these patients can be considered as newly diagnosed T2DM or non-T2DM patients experiencing stress-induced acute hyperglycemia cannot be discerned in the dataset.

T2DM and hypertension were the most common comorbidities in both males and females, accounting for 45.7% and 28% of all patients included in the dataset, respectively. These figures are much higher at the national level (7.6% and 8.8%, respectively) [6] and this is expected since the present data set deals only with hospitalized patients with mod-

erate to severe symptoms of Covid-19. Both comorbidities however were not associated with increased likelihood of death. Nonetheless, the high prevalence of T2DM and hypertension among hospitalized Covid-19 patients have already been observed not only in majority of industrialized countries with high cases of SARS-CoV2 infection, but have also been associated with higher risk for severe outcomes, including death [11–13]. The lack of association to higher odds death in the present study can be partially explained by missing confounders not factored in the model such as BMI and T2DM duration, as well as the relatively younger population in the cohort compared to other retrospective studies. Two comorbidities in the present study however, the history of congestive heart failure and acute kidney injury in particular, stood out as a significant risk factors for mortality in the present study. This cardiac and renal disorders, together with T2DM and hypertension, all belong to a group of vascular endothelial abnormalities that gets exacerbated in the presence of Covid-19 [14–15]. The results of the present study therefore support the on-going theory that it is the underlying endothelial injury present in diseases of the elderly such as T2DM and hypertension that is mainly associated with Covid-19 severity and partly explains why the prevalence of such diseases is high among Covid-19 hospitalized patients.

Another highlight in the present study is the high mortality rate (10%) of the hospital relative to the national mortality rate in Saudi Arabia which is around 1.5% at the time of this writing. This is expected since only moderate to severe Covid-19 cases are admitted in the hospital and those with no to mild symptoms were advised to self-isolate. Separating males alone and stratifying according to ethnicity, Saudi men had the highest mortality rate compared to South Asians and others, but not statistically significant even before adjusting for age. Worthy to mention are the protective effects of corticosteroids (dexamethasone and methylprednisolone) as well as hydroxychloroquine from severe Covid-19 outcomes. Hydroxychloroquine in particular protects from Covid-19 death by 88% in the dataset studied. This percentage, while much higher compared to other recent studies done elsewhere [16–18], reiterates that the use of hydroxychloroquine is associated with reduced Covid-19 mortality. Several studies however do not consider the use of hydroxychloroquine beneficial for Covid-19 treatment [19–20]. These differences can be partly explained by differences in research methods, some of which were flawed and biased given the premature media attention it received prior to approval [21]. The use of hydroxychloroquine however in Saudi Arabia is approved by the Ministry of Health. The use of corticosteroids on the other hand has been an established treatment for patients with acute respiratory distress syndrome (ARDS) and other acute lung diseases for immediate immunosuppressive effect, given as either low dose or pulse therapy [22,23]. Dexamethasone in particular was the only drug in the present study that significantly improved the final outcome of patients based on NRI and IDI analysis. This supports the preliminary report of a mega-trial indicating that dexamethasone reduces over-all mortality among patients with Covid-19 [24].

The authors acknowledge several limitations aside from the retrospective design. As mentioned previously, important confounders such as BMI and T2DM duration were not included in medical records. The study therefore cannot ascertain whether obesity is a risk for severe Covid-19 outcome or not, given that obesity is also very prevalent in Saudi Arabia. Other factors such as socio-economic status and medications from existing comorbidities were also not recorded. Important parameters such as HbA1c were present only in a handful of patients. Findings cannot be generalized because it is a single center study, and results may not be the same if majority of the patients included were Saudi nationals. The study nevertheless is one of the more recent retrospective studies done in Saudi Arabia focusing on outcomes of hospitalized patients diagnosed with Covid-19.

In summary, the prevalence of T2DM is very high and is the most common comorbidity among hospitalized Covid-19 patients in one tertiary hospital in Saudi Arabia. Males outnumber females in hospital admission and majority of patients were of South Asian origin. The use of dexamethasone appears to reduce mortality and improve outcome from Covid-19. Larger datasets coming from the different regions in the country are needed to have a better reflection of the true mortality of Covid-19 among hospitalized patients.

Availability of data and material

Data available upon request to the joint corresponding author.

Funding

The authors are grateful to the Researchers Supporting Project (RSP-2020/21) in King Saud University in Riyadh, Saudi Arabia for their support.

Authors' Contributions

ES and SS designed the study. RMA, AAS, KSA, KA and HAA worked in the methodology. SS and NMA did the formal analysis. ES, RMA, AAS, KSA, KA and HAA helped in the data curation. SS wrote the original and revised draft. ES, RMA, AAS, KSA, KA, HAA and NMA handled manuscript review ES and NMA did the study supervision.

Declaration of Competing Interest

The authors declare that they have no competing interest.

Acknowledgement

The authors are also thankful to all nurses and study coordinators at the three study sites who helped in screening of participants, blood and data collection.

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