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PREVALENCE AND OUTCOMES OF DIABETES AMONG COVID-19 PATIENTS IN DUHOK COVID-19 HEALTH FACILITIES: A CROSS-SECTIONAL STUDY

CZĘSTOŚĆ WYSTĘPOWANIA I WYNIKI LECZENIA CUKRZYCY WŚRÓD PACJENTÓW Z COVID-19 W PLACÓWKACH OCHRONY ZDROWIA ZAJMUJĄCYCH SIĘ COVID-19 W DUHOK: BADANIE PRZEKROJOWE

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Summary

Background. The objectives of this study were to determine the prevalence of type 2 diabetes mellitus (T2DM) among patients with COVID-19, examining the relationship between COVID-19 severity and T2DM in hospitalized patients, detecting T2DM outcomes in COVID-19 patients, and identifying the vaccination rates of COVID-19 patients with T2DM.

Material and methods. A prospective, cross-sectional study was conducted on Duhok (Iraqi Kurdistan) hospitalized COVID-19 patients. Demographic, clinical, and laboratory characteristics of all confirmed COVID-19 by RT-PCR with coexisting T2DM were collected between early November 2021 and late April 2022. T2DM patients with HbA1c levels ≥7% were considered a poor control group, while those <7% were considered a good control group.

Results. Out of 530 hospitalized COVID-19 patients, 158 (29.81%) were T2DM. Among 158 patients, 23 (14.56%) were vaccinated, of whom 17 (10.76%) were fully vaccinated and 6 (3.80%) partially vaccinated. Considering patient outcomes, chronic pulmonary disease (p=0.0106), obesity (p=<0.0001), patients on combined oral antidiabetic and insulin (p=0.0204), and poorly controlled DM (p=<0.0001) were significant predictors of mortality.

Conclusions. The prevalence of T2DM in hospitalized COVID-19 patients was relatively high in Duhok. In contrast with the previous studies reported in the literature, the COVID-19 vaccination coverage was unsatisfactory. Therefore, raising awareness concerning health education about the severity and mortality rates of COVID-19 should be mandatory to achieve better disease prognosis.

Keywords: type 2 diabetes mellitus, outcomes, COVID-19, vaccine, prevalence, mortality

Streszczenie

Wprowadzenie. Celem niniejszego badania było określenie częstości występowania cukrzycy typu 2 wśród pacjentów z COVID-19, zbadanie związku między nasileniem COVID-19 a cukrzycą typu 2 u pacjentów hospitalizowanych, stwierdzenie wyników leczenia cukrzycy typu 2 u pacjentów z COVID-19 oraz określenie wskaźników szczepienia pacjentów z COVID-19 z cukrzycą typu 2.

Materiał i metody. Prospektywnym badaniem przekrojowym objęto pacjentów z COVID-19 hospitalizowanych w Duhok w irackim Kurdystanie. Charakterystyka demograficzna, kliniczna i laboratoryjna wszystkich potwierdzonych metodą RT-PCR przypadków COVID-19 ze współistniejącą cukrzycą typu 2 została zgromadzona między początkiem listopada 2021 a końcem kwietnia 2022. Pacjenci z cukrzycą typu 2 z poziomem HbA1c ≥7% zostali uznani za słabą grupę kontrolną, natomiast pacjenci z <7% za dobrą grupę kontrolną.

Wyniki. Spośród 530 hospitalizowanych pacjentów z COVID-19, u 158 (29,81%) występowała cukrzyca typu 2. Wśród 158 pacjentów 23 (14,56%) było zaszczepionych, w tym 17 (10,76%) w pełni, a 6 (3,80%) częściowo. Biorąc pod uwagę wyniki leczenia, przewlekła choroba płuc (p=0,0106), otyłość (p=<0,0001), pacjenci przyjmujący doustne leki przeciwcukrzycowe w skojarzeniu z insuliną (p=0,0204) oraz źle kontrolowane przypadki cukrzycy (p=<0,0001) były istotnymi predyktorami śmiertelności.

Wnioski. Częstość występowania cukrzycy typu 2 u pacjentów z COVID-19 hospitalizowanych w Duhok była stosunkowo wysoka. W przeciwieństwie do wcześniejszych danych, współczynniki szczepień przeciwko COVID-19 były niezadowalające. W związku z tym, podnoszenie świadomości w zakresie edukacji zdrowotnej na temat ciężkości i śmiertelności COVID-19 powinno być obowiązkowe w celu uzyskania lepszej prognostyki choroby.

Słowa kluczowe: cukrzyca typu 2, wyniki leczenia, COVID-19, szczepionka, częstość występowania, śmiertelność

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Introduction

Coronavirus disease 2019 (COVID-19) is caused by a novel strain of Beta-coronavirus called Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). The World Health Organization (WHO) recognized the disease as a pandemic on March 11, 2020 [1]. Global confirmed and deaths of COVID-19 have exceeded 200 million and 4 million, respectively [2]. The SARS-CoV-2 virus can be transmitted directly and indirectly through contact between individuals, through droplets spread by sneezing, coughing, or speaking, or through infected animals.

The clinical presentations of COVID-19 range from asymptomatic to severe pneumonia and even death [3]. As SARS-CoV-2 primarily affects the respiratory system, the diagnosis can be achieved by performing reverse transcription polymerase chain reaction (RT-PCR) over the upper respiratory tract [4]. Other laboratory parameters such as C-reactive protein (CRP), D-dimer, Procalcitonin (PCT), lactate dehydrogenase (LDH), and others are necessary for assessing disease severity [5]. Patients with comorbidities such as hypertension, diabetes mellitus (DM), heart disease, and respiratory disease are at a high risk of hospitalization and death [6]. Diabetic patients, especially those who are poorly controlled, are at an increased risk of severe clinical adverse effects, resulting from microbial infections, including respiratory viruses. Chronic hyperglycemia is associated with inflammation and immune imbalances, which may exacerbate viral infections, such as COVID-19 [7]. It has been documented that DM is more prevalent among patients with severe COVID-19, who require hospitalization or admission to intensive care unit (ICU) [8]. Diabetic patients with COVID-19 have a much worse prognosis, which increases their risk of mechanical ventilation, shock, and multiple organ failures [9]. It is estimated that 20-30% of non-surviving COVID-19 patients have underlying type 2 DM (T2DM) [10].

The negative impact of DM on the course of COVID-19 infection necessitates administering the COVID-19 vaccine to prevent the disease or attenuate its severity [11]. In Duhok, three COVID-19 vaccines are approved for use, namely: Sinopharm, AstraZeneca and Pfizer-BioNTech. The first vaccine dose was administered in Duhok province on March 26, 2021 [12,13].

The purposes of this study were to determine the prevalence of T2DM among patients with COVID-19, examining the relationship between COVID-19 severity and T2DM in hospitalized patients, detecting T2DM outcomes in COVID-19 patients and identifying the vaccination rates of COVID-19 patients with T2DM.

Material and methods

Study setting

Two hospitals in Duhok city, Iraqi Kurdistan, were allocated for the treatment of COVID-19 patients. First, Duhok COVID-19 hospital (previously called plastic and burn hospital), which has 50 ward beds and 20 ICU beds and was mainly used for severe and critical cases. Furthermore, another 100-bed hospital, called the Lalav Infectious Diseases Hospital, which was recently built in March 2020 to meet the demands of the COVID-19 pandemic. It was mainly used for moderate to severe cases.

Study design and patients

A prospective cross-sectional study was conducted in Duhok city on T2DM patients with COVID-19. Data had been collected between early November 2021 and late April 2022. All hospitalized patients, who were confirmed positive for SARS-CoV-2 by RT-PCR with coexisting T2DM, were included. A standardized questionnaire was used to collect the demographic, clinical, and laboratory characteristics of all the patients. Informed consent was obtained from all the patients who agreed to participate in the study. The ethics committee of the Directorate

General of Health (DGOH), Duhok, Iraqi Kurdistan has approved this study (Reference no. 1011, dated 10 November 2021).

Classification of COVID-19 severity

Based on the National Health Commission's Diagnosis and Treatment Plan for COVID-19, COVID-19 patients were divided into four groups: mild, moderate, severe, and critical [14]:

- COVID-19 Mild Illness: includes cough, fever, malaise, sore throat, muscle pain, headache, but without dyspnea or abnormal chest imaging results;
- COVID-19 Moderate Illness: characterized by clinical assessment or imaging of lower respiratory disease with a saturation of oxygen (SpO2) more or equal to 94% in room air at sea level;
- COVID-19 Severe Illness: Patients have a respiratory frequency greater than 30 breaths per minute, SpO2 of <94% on room air (or a decrease from baseline of >3% for those with chronic hypoxia), lung infiltrates greater than 50%, or ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO2/FiO2) <300 mmHg;
- COVID-19 Critical Illness: Those experiencing respiratory failure, septic shock, and multiple organ dysfunction.

Laboratory investigations

A RT-PCR diagnostic test was performed on nasopharyngeal swabs. Furthermore, diabetic patients were assessed for glycemic control and complications based on the levels of Hemoglobin A1c (HbA1c) marker. Patients with HbA1c ≥6.5%, were considered DM based on American Diabetic Association (ADA) standards of care. HbA1c levels ≥7% were considered poor control, while those <7% were considered good control [15]. In addition, biochemical markers of inflammation were measured, including absolute lymphocyte counts (ALC), LDH, D-dimer, CRP, and PCT levels.

Statistical analyses

The general characteristics of the patients was presented in mean (SD) or number (%). The mortality rates and prevalence of disease severity were determined in number and percentage. A Pearson chi-squared test was used to compare disease severity and patient outcomes with general characteristics, comorbidities, and vaccination information, and to compare CRP and LDH between dead and recovered patients. D-dimer and procalcitonin were compared between dead and recovered patients using an independent t-test. The predictors of mortality among patients with COVID-19 were examined using a binary logistic regression model. *p*-values less than 0.05 were considered significant, and statistical calculations were conducted using JMP Pro 14.3.0.

Results

In total there were 530 hospitalized COVID-19 patients, of whom 158 were T2DM. The prevalence of T2DM was 29.81%.

Table 1 shows general characteristics of 158 hospitalized COVID-19 patients with T2DM. All the patients were adults aged 21-100 years (mean age 63.42±12.41, median age 64.5). Female patients constitute of 51.90%. Furthermore, the patients were thoroughly investigated during their hospital stay. Eighty-four patients (53.17%) passed away, while 74 (46.83%) recovered. Regarding disease severity, there were 7 (4.43%) moderate patients, 78 (49.37%) severe patients, and 73 (46.20%) critical patients.

Table 1. General characteristics of hospitalized COVID-19 patients with type 2 diabetes mellitus

General information (n=158)	Frequency distribution	
	Number	Percentage
Age (21-100 years)	**Mean: 63.42**	**SD: 12.41**
Age category		
20-29	2	1.27
40-49	15	9.49
50-59	33	20.89
60-69	58	36.71
70-79	36	22.79
80-89	10	6.33
90-100	4	2.53
Gender		
Male	76	48.10
Female	82	51.90
Previous COVID-19 infection		
No	138	87.34
Yes	20	12.66
COVID-19 vaccine		
Yes	23	14.56
No	135	85.44
Dose of vaccine		
Not vaccinated	135	85.44
Partially Vaccinated	6	3.80
Fully Vaccinated	17	10.76
Type of COVID-19 vaccine		
Not vaccinated	135	85.44
Pfizer	16	10.13
Sinopharm	7	4.43
Type of antidiabetic		
Insulin	62	39.24
Oral	47	29.75
Combine	49	31.01
T2DM Control		
Good	70	44.30
Poorly	88	55.70
Ventilation		
No	7	4.43
CPAP	69	43.67
Invasive ventilation	2	1.27
Oxygen therapy	80	50.6
Disease severity		
Moderate	7	4.43
Severe	78	49.37
Critical	73	46.20
Patient outcomes		
Passed away	84	53.17
Recovered	74	46.83

General information (n=158)	Frequency distribution	
	Number	Percentage
Age (21-100 years)	**Mean: 63.42**	**SD: 12.41**
Duration of hospitalization		
One week	61	38.61
Two weeks	59	37.34
Three weeks	15	9.49
One month	4	2.53
>One month	19	12.03

By analyzing the risk factors influencing the disease severity of patients, it was found that chronic pulmonary disease had been an influence. Moreover, it was found that the most significant risk factor was obesity, especially in critical patients. Other factors including age, gender, previous COVID-19 infection**,** smoking, thyroid disease, cardiovascular disease, cerebrovascular disease, and chronic kidney disease did not show any influence (Table 2).

Table 2. Association of disease severity with patient characteristics and comorbidities

General characteristics (n=158)	Disease severity no (%)			*p*-value
	Moderate	Severe	Critical	
Age category				
20-29	0 (0.00)	1 (50.00)	1 (50.00)	0.6983
40-49	0 (0.00)	7 (46.67)	8 (53.33)	
50-59	1 (3.03)	17 (51.52)	15 (45.45)	
60-69	3 (5.17)	30 (51.72)	25 (43.10)	
70-79	2 (5.56)	14 (38.89)	20 (55.56)	
80-89	0 (0.00)	7 (70.00)	3 (30.00)	
90-100	1 (25.00)	2 (50.00)	1 (25.00)	
Gender				
Male	3 (3.95)	37 (48.68)	36 (47.37)	0.9352
Female	4 (4.88)	41 (50.00)	37 (45.12)	
Previous COVID-19 infection				
No	5 (3.62)	69 (50.00	64 (46.38)	0.4276
Yes	2 (10.00)	9 (45.00	9 (45.00)	
Comorbidities				
No	1 (8.33)	8 (66.67)	3 (25.00)	0.2869
Yes	6 (4.11)	70 (47.95)	70 (47.95)	
Cardiovascular disease				
No	1 (2.86)	16 (45.71)	18 (51.43)	0.7267
Yes	6 (4.88)	62 (50.41)	55 (44.72)	
Cerebrovascular disease				
No	6 (4.17)	72 (50.00)	66 (45.83)	0.8046
Yes	1 (7.14)	6 (42.86)	7 (50.00)	
Chronic pulmonary disease				
No	7 (4.86)	76 (52.78)	61 (42.36)	0.0078
Yes	0 (0.00)	2 (14.29)	12 (85.71)	
Chronic kidney disease				
No	6 (4.35)	67 (48.55)	65 (47.10)	0.8375
Yes	1 (5.00)	11 (55.00)	8 (40.00)	

General characteristics (n=158)	Disease severity no (%)			*p*-value
	Moderate	Severe	Critical	
Malignancy				
No	7 (4.58)	77 (50.33)	69 (45.10)	0.3001
Yes	0 (0.00)	1 (20.00)	4 (80.00)	
Smoking				
No	5 (3.73)	64 (47.76)	65 (48.51)	0.2940
Yes	2 (8.33)	14 (58.33)	8 (33.33)	
Thyroid disease				
No	7 (4.86)	73 (50.69)	64 (44.44)	0.3092
Yes	0 (0.00)	5 (35.71)	9 (64.29)	
Obesity				
No	7 (5.88)	70 (58.82)	42 (35.29)	<0.0001
Yes	0 (0.00)	8 (20.51)	31 (79.49)	

Notes: Pearson chi-squared test was performed for statistical analyses. The numbers in bold show the significant differences.

Table 3 demonstrates the association of patient outcomes with clincodemographic characteristics and comorbid diseases. Chronic pulmonary disease, obesity, patients on combined oral antidiabetic and insulin, and poorly controlled DM were significantly associated with mortality.

Table 3. Association of patients' outcomes with general characteristics and coexisting diseases

General informaiton (n=158)	Patients' outcomes no (%)		
	Passed away	Recovered	*p*-value
Age			
20-29	1 (50.00)	1 (50.00)	0.5977
40-49	10 (66.67)	5 (33.33)	
50-59	14 (42.42)	19 (57.58)	
60-69	29 (50.00)	29 (50.00)	
70-79	23 (63.89)	13 (36.11)	
80-89	5 (50.00)	5 (50.00)	
90-100	2 (50.00)	2 (50.00)	
Gender			
Male	41 (53.95)	35 (46.05)	0.8494
Female	43 (52.44)	39 (47.56)	
Previous COVID-19 infection			
No	73 (52.90)	65 (47.10)	0.8603
Yes	11 (55.00)	9 (45.00)	
COVID-19 vaccine			
Yes	14 (60.87)	9 (39.13)	0.4231
No	70 (51.85)	65 (48.15)	
Dose of vaccine			
Not vaccinated	70 (51.85)	65 (48.15)	0.2108
Partially vaccinated	2 (33.33)	4 (66.67)	
Fully vaccinated	12 (70.59)	5 (29.41)	
Type of COVID-19 vaccine			
Not vaccinated	70 (51.85)	65 (48.15)	0.5792
Pfizer	9 (56.25)	7 (43.75)	
Sinopharm	5 (71.43)	2 (28.57)	

General informaiton (n=158)	Patients' outcomes no (%)		
	Passed away	**Recovered**	***p*-value**
Type of antidiabetic			
Insulin	37 (59.68)	25 (40.32)	0.0204
Oral	17 (36.17)	30 (63.83)	
Combine	30 (61.22)	19 (38.78)	
T2DM Control			
Good	6 (8.57)	64 (91.43)	<0.0001
poorly	78 (88.64)	10 (11.36)	
Comorbidities			
No	5 (41.67)	7 (58.33)	0.4063
Yes	79 (54.11)	67 (45.89v	
Cardiovascular disease			
No	18 (51.43)	17 (48.57)	0.8156
Yes	66 (53.66)	57 (46.34)	
Cerebrovascular disease			
No	75 (52.08)	69 (47.92)	0.3824
Yes	9 (64.29)	5 (35.71)	
Chronic pulmonary disease			
No	72 (50.00)	72 (50.00)	0.0106
Yes	12 (85.71)	2 (14.29)	
Chronic kidney disease			
No	73 (52.90)	65 (47.10)	0.8603
Yes	11 (55.00)	9 (45.00)	
Malignancy			
No	80 (52.29)	73 (47.71)	0.2217
Yes	4 (80.00)	1 (20.00)	
Smoking			
No	74 (55.22)	60 (44.78)	0.2203
Yes	10 (41.67)	14 (58.33)	
Thyroid disease			
No	77 (53.47)	67 (46.53)	0.8037
Yes	7 (50.00)	7 (50.00v	
Obesity			
No	51 (42.86)	68 (57.14)	<0.0001
Yes	33 (84.62)	6 (15.38)	

Notes: Pearson chi-squared test was performed for statistical analyses. The numbers in bold show the significant differences.

Based on the analysis of the factors influencing the mortality rate, it was found that T2DM control, disease severity, D-dimer, age category, duration of hospitalization, and obesity had significant influences on the mortality rate (p=0.00000). In addition, the LDH category was found to have influence (p=0.00001). Other predictors did not show any influence on the mortality rate (Table 4).

Table 4. Predictors of mortality among patients with COVID-19

Controlling factors (n=158)	Outcome: Mortality	*p*-value
	Presentations	
T2DM Control		0.00000
Disease severity		0.00000

Controlling factors (n=158)	**Outcome: Mortality**	***p*-value**
	Presentations	
D-dimer		0.00000
Age category		0.00000
Duration of hospitalization		0.00000
Obesity		0.00000
LDH category		0.00001
Gender		0.98641
Previous COVID-19 infection		0.99584
CRP category		0.99635
Comorbidities		0.99942
COVID-19 vaccine		0.99997

Notes: Binary logistic regression was performed for statistical analysis.

Discussion

In view of COVID-19 pandemic, SARS-CoV-2 can cause severe morbidity and mortality, especially in the elderly and those with underlying health conditions. DM is one of the most prevalent chronic non-communicable disease worldwide, increasing the risk of hospitalization and death among COVID-19 patients [10]. In this study, we attempted to find the contribution of diabetes co-morbidity to the outcome of hospitalized COVID-19 patients, based on the level of HbA1c in two COVID-19 care facilities in Duhok province. The prevalence of T2DM in Iraq ranges from 8.5% (International Diabetes Federation—age-adjusted) to 13.9% [16]. In our study, the prevalence rate of T2DM in hospitalized COVID-19 patients was 29.81%. This finding had higher rates from Iran [4], Kuwait [17], and Türkiye [18] with a prevalence of 24.9%, 24.8%, and 22.6%, respectively. While another study from Iraq, conducted in Najaf, reported a higher rate of 34.9% [19], which could be a consequence of huge gatherings during religious events. On contrary to our study, another neighboring country, Saudi Arabia, revealed a 45.7% prevalence rate [20]; a similar high rate of 46.2% was reported from China [21]. In general, the differences between these studies are the varying results in sample sizes and characteristics of patients, in addition to the implementation of preventive measures. Therefore, evidence suggests the incidence of COVID-19 is higher among DM patients. This can be explained by a compromised immune response, increasing susceptibility to the infection [22].

Considering the risk factors associated with disease severity and mortality, obesity and chronic lung diseases were significant. In concordance with our findings, ICU admission among obese COVID-19 patients with DM escalated [8,23]. Obesity is associated with physical inactivity and insulin resistance, which subsequently increases the inflammatory response towards SARS-CoV-2 infection [24]. In chronic lung diseases, there is inflammation, decreased immunity, mucus production, respiratory corticosteroids, and pulmonary damage, all exacerbated by DM [23]. Moreover, diabetes-associated chronic comorbidities, such as cancer, cerebrovascular diseases, and cardiovascular disease (CVD) contributes to adverse outcomes for COVID-19 patients [25]. In the present study, the majority of T2DM patients had CVD, however, the outcomes of our patients were not affected by CVD. Since diabetes is a chronic disease with many complications, diabetic patients are more likely to have these comorbidities than the general population. Hence, DM patients with obesity and chronic pulmonary disease should be admitted to COVID-19 ICU. Accordingly, pneumococcal vaccines are recommended for such high-risk patients to prevent fatal pulmonary complications.

In the current study, poorly controlled diabetes COVID-19 was correlated with a higher mortality rate. Other researchers have documented this finding [9,26]. It has been hypothesized that hyperglycemia contributes to viral respiratory infections and suppresses the immune system, which negatively affects the pulmonary function [9]. Likewise, hyperglycemia induces changes in coagulation and overproduces inflammatory cytokines (IL-6, D-dimer, and TNF-α), resulting in a septic shock and intravascular dissemination of clots [27].

Additionally, we found that DM patients, on combined oral and insulin therapy, faced significantly higher death rates. Presuming that such a diabetic patient has often poor glycemic control for a long time, progressing to a stage demanding combination therapy. In parallel, a retrospective study, including 689 COVID-19 T2DM patients from Wuhan, documented significantly higher death rates [28]. According to COVID-19 management guidelines, steroid therapy has a pivotal role in decreasing mortality, which conversely results in a hyperglycemic surge [26]. Therefore, clinicians should aim for optimal glycemic control in T2DM patients to reduce the severity and complications of COVID-19.

The mortality rate was high (53.17), with a resemblance to studies from Kuwait (53.7%) [17] and Peru (49.6%) [7]. On the other hand, studies from England [29] and Iran [4] reported 31% and 22.2% death rates, respectively. The higher mortality rate in our study can be explained partly due to delays in hospital arrivals; hence, patients have already developed a severe disease with complications. Therefore, awareness must be raised concerning health education into seeking early medical interventions for COVID-19 patients with DM.

To the best of our knowledge, this the first study investigating the vaccination rate among DM patients in Iraqi patients. In this study, 23 (14.56%) of T2DM hospitalized patients were vaccinated, of whom 10.76% were fully vaccinated, while 3.80% were partially vaccinated. Our finding was indistinguishable to a study from India, which reported a vaccination rate of 21.5% (17% administered one dose and 4.2% administered two doses) [30]. In contrast, other studies reported lower vaccination rates (4.8%) [31]. Overall, the rate in our study was unsatisfactory compared to studies from Saudi Arabia (84.8 %) [11], Türkiye (73.6%) [32], and Iran (62.7%) [6]. This pointed to the lack of direct evidence that vaccinations benefit patients with diabetes, concerns about the vaccination's composition, and side effects that resulted in resistance to vaccine uptake among DM patients [31]. Consequently, health education and targeted interventions, intended to raise awareness about safety concerns, should be highly encouraged [30].

The main limitations of the study are the small sample size and the inclusion of only hospitalized patients; hence, we did not include mild to moderate cases. Therefore, our results were not representative of all T2DM patients.

Conclusions

In conclusion, the prevalence of T2DM in hospitalized COVID-19 patients was relatively high in Duhok, Iraqi Kurdistan. Furthermore, the mortality profile was high, partly as a consequence of delays in hospital arrivals, thus patients have had already developed a severe disease course with complications. Obesity and chronic lung diseases were significantly associated with COVID-19 severity and mortality. COVID-19 patients with poor DM control and on combined oral and insulin therapy were correlated with increased mortality. Therefore, achieving good glycemic control is an essential step to avoid disease complications. In contrast to recorded literature, the COVID-19 vaccination coverage was unsatisfactory. Therefore, raising awareness concerning health education of COVID-19 severity and mortality is mandatory toward better disease prognosis.

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