Current Science International
Volume: 12 | Issue: 02| April - June| 2023

EISSN:2706-7920 ISSN: 2077-4435
DOI: 10.36632/csi/2023.12.2.13
Journal homepage: www.curresweb.com
Pages: 132-140

Diabetes and COVID-19: Double Health Effect

Alaa Said Raslan[1], Engy A. Ibrahim[1], Ibrahim S. Eldin Ibrahim[2] and Mohamed Mokhtar Mabrouk [1]

[1]Department of Internal Medicine, Faculty of Medicine, Tanta University, Egypt.
[2]Department of Chest, Faculty of Medicine, Tanta University, Egypt.

Received: 12 March 2023 **Accepted:** 15 April 2023 **Published:** 30 April 2023

ABSTRACT

Background: Both diabetes mellitus and COVID-19 affect each other. Diabetic individuals have a greater risk for infection with high morbidity and mortality. Diabetes individuals with COVID-19 had worsening inflammatory markers and imagin g than COVID 19 individuals without diabetes. **Methods:** 60 individuals with COVID-19 infection were hospitalized to Tanta Chest University Hospital for a prospective case-control study based on positive PCR results of COVID-19 and were equally divided into 2 groups: study group: diabetic COVID-19 patients and control group: individuals with only COVID-19. All patients underwent history taking, clinical evaluation, laboratory investigations, and Radiological investigation. **Results**: Compared to the control group, the study group had substantially greater levels of RBS, HbA1C, CRP, D-Dimer, serum ferritin, liver enzymes, WBC, LDH, urea, Creatinine, procalcitonin, interleukin 6, the severity of COVID-19, and the need for Tocilizumab. **Conclusion:** diabetic COVID-19 individuals have greater blood pressure, RBS, HbA1C, CRP, D-dimer, Serum ferritin, liver enzymes, procalcitonin, LDH, urea, Creatinine, and interleukin 6 levels in addition to high risk of extreme COVID-19 course comparison to those who are not diabetic. Therefore, tight control of glucose levels is critical in patients with DM to decrease mortality and morbidity.

Keywords: Diabetes Mellitus, COVID-19, inflammatory markers, disease severity.

1. Introduction

In December 2019, the first COVID 19 infection was detected in the Wuhan area in China, initiating an international wave of a novel disease (Dong *et al.,* 2020). The World Health Organization proclaimed the disease, which is still spreading and has reached nearly all nations, a pandemic in March 2020. And since 23 October 2022, there were more over 624 million confirmed cases globally, resulting in more than 6.5 million fatalities (Pal and Bhadada, 2020).

Severe illness and outcomes are linked to risk factors such diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), cardiovascular disease, chronic renal disease, malignancies, and stroke Wu *et al.,* (2020).

DM Individuals are more likely to get infections and develop severe illness. Between diabetic and non-diabetic individuals, there were various laboratory results that were different, including greater white blood cells (WBC), D-dimer, lactate dehydrogenase (LDH), and C-reactive protein (CRP) levels in DM (Xu *et al.,* 2020).

Before admission, poor glycemic control, based on concentrations of HbAlC, was connected to a significant mortality risk (Bhaskaran *et al.,* 2021). At the time of admission, The greatest indicator of worse CT chest imaging was hyperglycemia (Iacobellis *et al.,* 2020). During hospitalization, individuals with COVID 19 who have hyperglycemia while undergoing hospital therapy have a poorer prognosis, Diabetics had a four times greater fatality rate (Wang *et al.,* 2020).

COVID-19 has a great impact on the glycemic control, as oral hypoglycemic drugs may need to be changed into insulin or increase the dose of insulin in insulin- dependent patients (Apicella *et al.,*

Corresponding Author: Alaa S. Raslan, Department of Internal Medicine, Faculty of Medicine, Tanta University, Egypt. E-mail: araslan636@gmail.com

2020). Corticosteroid use during the management of COVID-19 reduces mortality in non-diabetic individuals but worsens the glycemic state and leads to evident hyperglycemia (Unübol *et al.,* 2011).

Antiviral medications like Remdesivir may compromise glycemic control and cause Hyperglycemia (Unübol *et al.,* 2011).

2. Patients and Methods

On the basis of positive PCR findings for COVID-19, 60 individuals with COVID-19 infection were hospitalized to Tanta Chest University Hospital for a prospective case-control study. Cases of COVID-19 were identified by a positive real-time reverse transcriptase-polymerase chain reaction (RT-PCR) result on oropharyngeal or nasopharyngeal swab samples, as well as clinically by the symptoms and signs being present, contact with known affected persons, and radiographic indications of interstitial pneumonia. Patients with comorbidities other than diabetes like renal disease that is chronic, bronchial asthma, COPD, thyroid disorder, chronic liver disease, pregnant females, patients under 18 and older than 80 years, individuals who refused the consent were excluded from the study. The study was done after approval from the Ethical Committee of Faculty of Medicine, Tanta University, Egypt (approval code: 34558/3/21) and informed consent has been taken from each patient before the enrollment in this study.

60 participants enrolled in the trial, and they were split into two equal groups:

Group 1: Diabetic COVID-19 individuals and **Group 2:** individuals with only COVID-then study the effect of diabetes on COVID-19 as regards laboratory findings, CT chest, clinical course and mortality rate. On either side, examine COVID-19's impact and its medication on diabetes as regards random blood glucose level, HbAlC.

A pre-designed questionnaire form that was used to collect data from all patients had the following:

The following steps were applied to all patients:

1. **Taking history** (age, sex, residence, comorbidities)
2. Clinical evaluation (conscious level, O2 saturation, blood pressure, respiratory rate, temperature, pulse).
3. **Day 1 lab investigation** (CBC, CRP, serum ferritin, D-dimer, LDH, urea and Creatinine, HbA1C, random blood glucose, arterial blood gases, procalcitonin, interleukin 6). Laboratory investigations were repeated daily except for IL6 and procalcitonin.
4. **Radiological investigation** (portable X-ray or CT chest) if the patient is fit for transfer.

Duration of follow up: 3 months through 2021.

Statistical analysis

The SPSS v26 statistical analysis program was used. Mean and standard deviation (SD) were used to display quantitative data. Frequency and percentages (%) were used to illustrate qualitative data. Statistics were considered significant whether the P value ≤ 0.05.

3. Results

Our study included 60 individuals with COVID-19 infection were hospitalized to Tanta chest university hospital based on positive PCR results of COVID-19.

Participants in the study varied in age from 45 to 78, with such a mean age of (62.8 ± 8.23) years among the study group and ranged from 25-70 years with mean age of (50.7 ± 14.2) years among the control group. In our research, the study group consisted of 22 (73.33%) males with 8 (26.67%) females, whereas the control group consisted of 21 (70%) males with 9 (30%) females. In the study group in comparison to the control group, the age was considerably greater (P value < 0.001). Sex was insignificantly different between both groups. (Table 1).

Table 1: Age and sex of the studied groups

		Study group (n=30)	control group (n=30)	P value
Age (years)	**Mean ± SD**	62.8 ± 8.23	50.7 ± 14.2	<0.001*
	Range	45 - 78	25 – 70	
Sex	**Male**	22 (73.33%)	21 (70%)	0.775
	Female	8 (26.67%)	9 (30%)	

Regarding clinical examination of the two studied groups the study showed that Systolic BP, MAP, pulse and temperature, in comparison to the control group, were substantially greater in the study group. (P value = 0.008, 0.042, 0.047 and <0.001 respectively). Oxygen requirement was significantly different between both groups (P value= 0.017). Diastolic BP was insignificantly different between both groups. In comparison to the control group, the study group required more mechanical ventilation. (Table 2).

Table 2: Clinical examination of the studied groups

		Study group (n=30)	control group (n=30)	P value
Systolic BP (mmHg)	**Mean ± SD**	130.7 ± 13.63	121.7 ± 11.47	0.008*
	Range	100 - 150	100 - 150	
Diastolic BP (mmHg)	**Mean ± SD**	81 ± 10.94	77 ± 9.88	0.143
	Range	60 - 100	60 - 90	
MAP (mmHg)	**Mean ± SD**	97.6 ± 11.41	91.9 ± 9.62	0.042*
	Range	73.33 - 116.67	73.33 - 110	
Pulse (beats/min)	**Mean ± SD**	80.8 ± 7.41	77.2 ± 6.42	0.047*
	Range	68 - 97	66 - 89	
Temperature (°C)	**Mean ± SD**	38.3 ± 0.59	37.7 ± 0.43	<0.001*
	Range	37.5 - 39.6	37 - 38.8	
Oxygen requirement	**No need for oxygen**	1 (3.33%)	9 (30%)	0.017*
	Needed oxygen	27 (90%)	19 (63.33%)	
	Vent	2 (6.67%)	1 (3.33%)	

Regarding laboratory investigations of the studied groups and follow up the study showed that the study group's RBS and HbA1C were considerably greater than the control group's values (P value < 0.001) and on follow- up of HbA1C, it was found to be above 6.5 % in 6 out of 30 patients in the previously non- diabetic control group. CRP was considerably greater in the study group than in the control group at both admission and follow-up (P value 0.007, 0.023 respectively), while CRP at discharge was insignificantly different between both groups. When compared to the control group, the study group's level of D. dimer was considerably greater (P value= 0.036). In comparison to the control group, serum ferritin levels in the study group were considerably higher (P value= 0.007). The study group's liver enzyme levels were substantially greater than those of the control group (P value < 0.05). (Table 3A) Hb and Platelet count were insignificantly different between both groups. When compared to the control group, the study group's T.L.C. and LDH levels were considerably greater (P value= 0.047, 0.03 respectively).

The study group's lymphocytic count was substantially less than that of the control groups (P value= 0.023). As a comparison with the control group, the study group's levels of urea and creatinine were substantially greater (P value< 0.05). In the study group as comparison to the control group, Interleukin 6, procalcitonin level, and the number of individuals who needed Tocilizumab were all substantially greater (P value<0.05). (Table 3b).

As compared to the control group, the study group's COVID-19 severity was substantially greater (P value 0.001). In the study group, mortality rates were greater. (Table 4).

Table 3A: Laboratory investigations of the studied groups

		Study group (n=30)	Control group (n=30)	P value
RBS (mg/dL)	**At admission**	235.03 ± 83.54 110 – 572	148.30 ±52.60 94 – 323	< 0.001*
	Follow up	287.30 ± 66.26 154 - 483	195.70 ± 65.20 102 - 424	< 0.001*
	At discharge	257.40 ± 64.28 117 - 400	172.10 ± 58.69 92 - 374	< 0.001*
HbA1C (%)	**At admission**	7.73 ± 0.80 6.2 – 10	4.90 ± 0.50 4 – 5.6	< 0.001*
	Follow up	8.88 ± 0.96 7.1 – 11.1	5.20 ± 0.95 4.2 – 7.9	< 0.001*
CRP (mg/L)	**At admission**	75.7 ± 56.99 6 – 243	41.5 ± 35.02 6 - 107	0.007*
	Follow up	60 ± 74.34 0 – 383	25.1 ± 34.95 0 - 135	0.023*
	At discharge	34.1 ± 51.53 0 – 242	19.9 ± 46.04 0 - 196	0.264
D. dimer		5.72 ± 9.61 0.06 – 31	1.76 ± 3.11 0.01 - 13	0.036*
Serum ferritin (mg/L)		764.9 ± 355.78 206 – 1542	502 ± 365.76 51 - 1430	0.007*
SGOT (U/L)	**At admission**	40.50 ± 23.48 9 – 131	30.17 ± 12.78 11 – 58	0.04*
	Follow up	77.43 ± 41.98 31 – 248	57.47 ± 32.90 17 - 154	0.04*
SGPT (U/L)	**At admission**	39.80 ± 21.17 12 – 125	29 ± 13.76 10 – 69	0.02*
	Follow up	80.77 ± 46.36 17 – 223	57.93 ± 38.37 16 - 179	0.04*

Table 3B: Laboratory investigations of the studied groups

		Study group (n=30)	Control group (n=30)	P value
Hb (g/L)	**Mean ± SD**	12.96 ± 1.68	12.68 ± 1.60	0.695
	Range	9.50 – 17.60	9.20 ± 16	
Platelet (*103cells/mL)	**Mean ± SD**	224.33 ± 113.29	210.80 ± 101.06	0.627
	Range	90 - 660	95 - 618	
T.L.C (*103cells/ µL)	**Mean ± SD**	15.17 ± 7.64	11.33 ± 7.02	0.047*
	Range	3.60 - 41	2.50 - 30	
Lymphocytic count (*103cells/ µL)	**Mean ± SD**	6.87 ± 4.24	10.05 ± 6.14	0.023*
	Range	2 - 19	2.2 - 28	
LDH (U/L)	**Mean ± SD**	368.77 ± 162.97	284.53 ±127.92	0.03*
	Range	120 - 865	166 - 748	
Urea (mg/dL)	**At admission**	44.1 ± 21.16	34.1 ± 13.61	0.032*
		15 - 100	17 - 70	
	Follow up	74.6 ± 28.28	53.7 ± 17.65	0.001*
		34 - 140	27 - 91	
Creatinine (mg/dL)	**At admission**	1 ± 0.25	0.8 ± 0.19	0.002*
		0.5 - 1.4	0.5 - 1.2	
	Follow up	1.3 ± 0.32	1.1 ± 0.32	0.009*
		0.7 - 2	0.09 - 2	
Procalcitonin (ng/mL)		1.19 ± 1.94	0.31 ± 0.70	0.023*
		0.01 – 7	0.01 – 3.1	
Interleukin 6 (pg/ml.)	**Mean ± SD**	32.4 ± 31.92	17.7 ± 24.18	0.049*
	Average	1.8 - 115	2.2 - 94	
Tocilizumab		20 (66.67%)	11 (36.67%)	0.02*

Table 4: Severity of disease and mortality of the studied groups

		Study group (n=30)	Control group (n=30)	P value
Severity	**Mild**	5 (16.67%)	24 (80%)	<0.001*
	Moderate	16 (53.33%)	5 (16.67%)	
	Severe	9 (30%)	1 (3.33%)	
Mortality		2 (6.67%)	1 (3.33%)	1.00

4. Discussion

With numerous cases, a greater number of hospital admissions, and a higher mortality rate (120), the COVID-19 infection is displaying the hallmarks of a pandemic disease. A common co-morbidity of COVID-19 infection is diabetes mellitus (Young *et al.,* 2020). Numerous studies compared the Covid-19 infection severity in diabetic and non-diabetic patients and came to the conclusion that D.M. should be taken into consideration as a significant risk factor in Covid-19 patients because patients with D.M. showed a more aggressive course with higher morbidity and mortality (Reshad *et al.,* 2021; Ortega *et al.,* 2021).

Many patients with COVID-19 infection developed D.M during the course of disease, so with this research, we want to consider the effect of both diabetes and COVID-19 on each other as regards the glycemic state of diabetic patients and the course and progress of infection with COVID-19.

In this research, the study group's age was considerably greater than that of the control group (P value <0.001).

Sex was insignificantly different between both groups. In line with these results, A study estimated the outcomes of COVID-19 infection. In the trial, 110 participants (90 without diabetes and 20 with diabetes) were included.

The diabetes group's mean age was greater than that of the non-diabetic patients (64 versus 53 years) (p=0.02) (Gunturk *et al.,* 2021).

It is generally known that people with DM have a greater prevalence of HTN than those without diabetes. As insulin is known to induce salt retention and increase sympathetic nervous system activity, it is likely that Insulin resistance and hyperinsulinemia are a contributing factor to high blood pressure. The improper Renin- Angiotensin-Aldosterone System (RAAS) activation is linked to insulin resistance (Zhou *et al.,* 2014).

Systolic blood pressure, pulse, MAP and temperature in this research's study group were all considerably greater than they were in the control group (P value = 0.008, 0.042, 0.047 and <0.001 respectively). Oxygen requirement was substantially greater in the study group (P value= 0.017). This was in line with a single-center retrospective
research that examined the medical files of people who were hospitalized and had COVID-19 confirmation.

Results and clinical, radiological, and serological data were documented and analyzed. Hypertension was the most common comorbidity (42.6%), and DM patients had substantially greater systolic blood pressure than non-DM patients (p = 0.018) (Alguwaihes *et al.,* 2020).
In the current study, as a comparison with the control group, the study group's RBS and HbA1C were considerably greater (P value < 0.001). a research that included 63 COVID-19 patients in total, comprising 16 within diabetic group and 47 within non-diabetic group, produced findings that were comparable to those of the current study.

Individuals with diabetes exhibited greater fasting glucose levels than those without diabetes (8.81± 2.42 mmol/L versus 6.01 ± 1.89 mmol/L, P= 0.000) (Wu, and Gao, 2022). In a different investigation, the COVID-19 infection severity in T2DM patients was compared to their HbA1c levels. Individuals with T2DM and confirmed COVID-19 infection were enrolled in the retrospective analysis utilizing observational data from the National COVID-19 Cohort Collaboration. The main result was death 30 days after the COVID-19 diagnostic date. Among included 39.616 patients, the mean ± SD HbA1c was 7.6% ± 2.0 which is comparable to our recorded mean ± SD 7.73 ± 0.80 in the study group (Wong *et al.,* 2022).

Our research revealed that the study group's CRP, D-Dimer, and serum ferritin levels were considerably greater than those of the control group. These results were consistent with a research that used a meta-analysis to look at the relationship between COVID-19 severity in diabetes and non-diabetic individuals and blood CRP and D-dimer concentrations. In their systematic review and meta-analysis, studies reporting on 15.282 individuals (4.733 diabetes and 10.549 non-diabetics) were taken into account. The findings showed that COVID-19 diabetic individuals had considerably higher blood CRP (P< 0.0001) and D-dimer (P < 0.0001) concentrations than did those without diabetes (Debi *et al.,* 2022). Different research compared D-dimer, glutamic pyruvic transaminase (GPT), glutamic-oxaloacetic transaminase (GOT), and CRP levels in COVID-19 individuals with and without diabetes.

They discovered that diabetic COVID-19-infected individuals had higher average blood concentrations of D- dimer, GOT, and CRP than non-diabetic patients (980.66 ng/mL, 67.71 U/L, and 27.06 mg/L, correspondingly) (Khan *et al.,* 2022).
In this study, Procalcitonin and liver functions (SGPT and SGOT) were substantially greater in the study group than in the control group (P value<0.05). In line with these conclusions, 193 individuals with severe COVID-19 had their clinical and laboratory data gathered in retrospective observational research. Diabetes was present in individuals with severe COVID-19, but not in 145 patients (the controls). Procalcitonin levels were greater in diabetic patients (0.16 ng/mL versus 0.09 ng/mL) than in control cases (Yan *et al.,* 2020).

Another study retrospectively gathered information from 350 COVID-19 positive cases, including demographic information, clinical manifestations, blood tests, radiographic evaluations, and COVID-clinical outcomes.
According to the results, diabetic COVID-19 patients had substantially higher levels of blood tests like Procalcitonin, AST, ALT, and ALP than non-diabetic COVID-19 patients had (diabetics: 1.587 ± 5.974, non- diabetics: 0.4242 ± 1.474, p<0.01) (Elemam *et al.,* 2021).

As a comparison with the control group, TLC and LDH were considerably greater in the study group (P values = 0.047 and 0.03, respectively). The study group's lymphocytic count was considerably lower than the control group's (P = 0.023). These findings were in line with a a research evaluated the lymphocyte count in individuals with Covid-19 who were diabetic and those who weren't and found that the lymphocyte count was relatively low in the diabetic group in comparison to the non-diabetic group (0.67 ± 0.36 * 109/L versus 1.30 ± 0.54 * 109/L, adjusted P = 0.001) (Wu, and Gao, 2022).

In this study, when compared with control, the study group's creatinine level was considerably greater (P value< 0.05). In a similar line, retrospective research examined 258 COVID19 hospitalized patients, both with and without diabetes. Data on clinical characteristics, therapeutic approaches, and prognosis were gathered and analyzed, they highlighted that patients with diabetes had significantly higher serum Creatinine at admission compared with those without diabetes (P<0.05) (Zhang *et al.,* 2020).

Interleukin-6 (IL-6) is known to be hazardous in COVID-19 because of its involvement in driving cytokine storm.

A humanized antibody called tocilizumab binds to the interleukin 6 receptor, suppressing interleukin 6 (Du *et al.,* 2021). Most observational studies, but not all, indicate that tocilizumab has a positive impact on clinical outcomes (Veiga *et al.,* 2021).

According to the current research, IL-6 levels and the number of patients using Actemra (tocilizumab) were considerably greater in the study group than in the control group (P value<0.05) suggesting more aggressive course in patients with D.M. In line with our findings many research's found that the Interleukin-6 levels in diabetic COVID-19 individuals were substantially greater than those in non-diabetic COVID-19 patients ((Yan *et al.,* 2020; Varikasuvu *et al.,* 2021). Diabetes is linked to an increased prevalence and seriousness of COVID-19, so diabetic patients should receive more intensive care in order to prevent rapid deterioration. Oral antidiabetic medications, particularly biguanide, should not be used instead of the more frequently advised insulin injection or intravenous infusion (Zhou *et al.,* 2020).

In this research, the study group's COVID-19 severity was noticeably greater than that of the control group (P value <0.001). In the study group, mortality rates were greater. In a large meta-analysis research that included trials comprising 31,067 COVID-19 patients, patients with DM had higher case-mortality and severe infection rates than those without DM (21.4 versus 10.6% and 28.5 versus 13.3%, correspondingly; all p <0.01) (Shang *et al.,* 2020).

Retrospective cohort research on 178 diabetic individuals admitted with COVID-19 revealed that these patients had a 2x greater mortality rate, a 59% higher chance of ICU admission, and a 97% higher risk of mechanical ventilation (Seiglie *et al.,* 2020).

Another factor that seems to be extremely unique to COVID-19 is SARS-CoV-2 binding to the ACE2 receptor, which is enhanced in uncontrolled hyperglycemia and encourages the incursion of SARS-CoV2 into cells, resulting in a "cytokines storm." (Brufsky, 2020).

5. Conclusion

Our data support that COVID-19 patients with diabetes have higher blood pressure, RBS, HbA1C, CRP, D-dimer, serum ferritin, liver enzymes, procalcitonin, creatinine, and interleukin 6 levels in addition to the risk of severe COVID-19 course compared to non-diabetic patients. Therefore, tight control of glucose levels is critical in patients with diabetes mellitus to decrease mortality and morbidity.

Statements & Declarations:
Funding: No funding was received for this research.
Conflict of Interest: All authors have no conflict of interest.
Acknowledgements: Nothing to declare.
Availability of data and material: The datasets used and/or analyzed during the current study are available as MS Excel files (.xlsx) from the corresponding author upon reasonable request.

Ethical approval and protocol registration: The study was done after approval from the Ethical Committee of Faculty of Medicine, Tanta University, Egypt (approval code: 34558/3/21) and informed consent has been taken from each patient before the enrollment in this study.

Author Contributions: Conceptualization, AR, EA, MM; data curation, AR, MM, EA, IS; formal analysis, MM; investigations, IS, MM, EA; methodology, AR, MM, IS, EA; supervision, IS, MM, EA; writing original draft, AR, MM; writing review &editing, AR, MM, EA. All authors have read and agreed to the published version of the manuscript.

References

Alguwaihes, A., M. Al-Sofiani, M. Megdad, et al., 2020. Diabetes and Covid-19 among hospitalized patients in Saudi Arabia: a single-centre retrospective study. Cardiovasc Diabetol., 19(1):205-9.

Apicella, M., M.C. Campopiano, M. Mantuano, et al., 2020. COVID-19 in people with diabetes: understanding the reasons for worse outcomes. Lancet Diabetes Endo.,15(9):782-90.

Bhaskaran K., S. Bacon, S. Evans, et al., 2021. Factors associated with deaths due to COVID-19 versus other causes: population-based cohort analysis of UK primary care data and linked national death registrations within the Open Safely platform. Lancet Reg Health Eur., 6(10):2211-6.

Brufsky, A., 2020. Hyperglycemia, hydroxychloroquine, and the COVID-19 pandemic. J Med Virol., 92(7):770-5.

Debi, H., Z. Itu, M. Amin, et al., 2022. Association of serum C-reactive protein (CRP) and D-dimer concentration on the severity of COVID-19 cases with or without diabetes: a systematic review and meta- analysis. Expert Rev Endocrinol Metab., 17(1):83-90.

Dong, E., H. Du and L. Gardner, 2020. An interactive web-based dashboard to track COVID-19 in real time. Lancet Infect Dis., 20(5):533-40.

Du, P., J. Geng, F. Wang, et al., 2021. Role of IL-6 inhibitor in treatment of COVID-19-related cytokine release syndrome. Int J Med Sci., 18(6):1356-62.

Elemam, N., H. Hannawi, I. Salmi, et al., 2021. Diabetes mellitus as a comorbidity in COVID-19 infection in the United Arab Emirates. Saudi Med J., 42(2):170-80.

Gunturk, A., A. Kavurmaci, F. Kartufan, et al., 2021. Presentation of Covid 19 Patients with and without Diabetes. Nov Res Sci., 7(2):3-9.

Iacobellis, G., C. Penaherrera, L. Bermudez, et al., 2020. Admission hyperglycemia and radiological findings of SARS-CoV2 in patients with and without diabetes. Diabetes Res Clin Pract., 164(5):119-22.

Khan, M., B. Ali, H. Mohammed, et al., 2022. Serum level estimation of some biomarkers in diabetic and non-diabetic COVID-19 infected patients. Appl Nanosci., 10(2):1-8.

Ortega, E., R. Corcoy, M. Gratacòs, et al., 2021. Risk factors for severe outcomes in people with diabetes hospitalised for COVID-19: a cross-sectional database study. BMJ Open, 11(7):512-37.

Pal, R. and S. Bhadada, 2020. COVID-19 and diabetes mellitus: An unholy interaction of two pandemics. Diabetes Metab Syndr., 14(4):513-17.

Reshad, R., S. Riana, M. Chowdhury, et al., 2021. Diabetes in COVID-19 patients: challenges and possible management strategies. Egypt J Bronchol., 15(1):53-66.

Seiglie, J., J. Platt, S. Cromer, et al., 2020. Diabetes as a Risk Factor for Poor Early Outcomes in Patients Hospitalized with COVID-19. Diabetes Care, 43(12):2938-

Shang, L., M. Shao, Q. Guo, et al., 2020. Diabetes Mellitus is Associated with Severe Infection and Mortality in Patients with COVID-19: A Systematic Review and Meta-analysis. Arch Med Res., 51(7):700-9.

Unübol, M., M. Ayhan and E. Guney, 2011. Hypoglycemia induced by hydroxychloroquine in a patient treated for rheumatoid arthritis. J Clin Rheumatol., 17(1):46-7.

Varikasuvu, S., S. Varshney and N. Dutt, 2021. Markers of coagulation dysfunction and inflammation in diabetic and non-diabetic COVID-19. J Thromb Thrombolysis, 51(4):941-50.

Veiga, V., J. Prats, D. Farias, et al., 2021. Effect of tocilizumab on clinical outcomes at 15 days in patients with severe or critical coronavirus disease 2019: randomised controlled trial. BMJ., 372:55-

Wang, F., Y. Yang, K. Dong et al., 2020. Clinical Characteristics of 28 Patients with Diabetes and Covid-19 In Wuhan, China. Endocr Pract., 26(6):668-7.

Wong, R., M. Hall, R. Vaddavalli, et al., 2022. Glycemic Control and Clinical Outcomes in U.S. Patients with COVID-19: Data from the National COVID Cohort Collaborative (N3C) Database. Diabetes Care.,15(3):222-9.

Wu, C., X. Chen, Y. Cai, et al., 2020. Risk Factors Associated with Acute Respiratory Distress Syndrome and Death in Patients with Coronavirus Disease 2019 Pneumonia in Wuhan, China. JAMA Intern Med., 180(7):934- 40.

Wu, D. and S. Gao, 2020. Analysis of the lymphocyte count in type 2 diabetic patients with coronavirus disease (COVID-19): A retrospective study in a centralized treatment center. Diabetes Res Clin Pract., 166(3):118-99.

Xu, Z., Z. Wang, S. Wang et al., 2020. The impact of type 2 diabetes and its management on the prognosis of patients with severe COVID-19. J Diabetes,12(12):909-8.

Yan, Y., Y. Yang, F. Wang, et al., 2020. Clinical characteristics and outcomes of patients with severe covid-19 with diabetes. BMJ Open Diabetes Res Care., 2020;8(1):130-40.

Young, P., C. Nickson and A. Perner, 2020. When Should Clinicians Act on Non-Statistically Significant Results from Clinical Trials? JAMA., 2323(22):2256-57.

Zhang, Y., H. Li, J. Zhang, et al., 2020. The clinical characteristics and outcomes of patients with diabetes and secondary hyperglycaemia with coronavirus disease 2019: A single-centre, retrospective, observational study in Wuhan. Diabetes Obes Metab., 22(8):1443-54.

Zhou, M., A. Wang and H. Yu, 2014. Link between insulin resistance and hypertension: What is the evidence from evolutionary biology? Diabetol Metab Syndr., 6(1):12-5.

Zhou, W., S. Ye, W. Wang, et al., 2020. Clinical Features of COVID-19 Patients with Diabetes and Secondary Hyperglycemia. J Diabetes Res., (15):155-60.

.