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Exploring The Interplay Between Diabetes Mellitus And COVID-19: A Cross-Sectional Study Of Prevalence, Pharmacological Management, Microbial Co-Infections, And Biochemical Markers

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Abstract

Background: The increased severity and problems seen in individuals with pre-existing diabetes have sparked concerns about the interaction between COVID-19 and diabetes mellitus (DM). Knowing how DM and COVID-19 are related may help guide clinical treatment and enhance patient outcomes.

Objective: The purpose of this research was to determine the incidence of diabetes mellitus in COVID-19 patients, evaluate pharmaceutical treatment approaches, examine microbiological co-infections, and investigate biochemical markers in order to better understand how these factors interact and guide therapeutic procedures.

Methodology: A cross-sectional study was conducted from January to December 2023. Included were adult patients with a history of diabetes mellitus and a COVID-19 diagnosis. Multivariate logistic regression and t-tests were used to examine data on microbial co-infections, pharmaceutical therapy, glycemic control, and biochemical indicators.

Results: Type 2 diabetes was present in 71.43% of the 385 individuals. In 41.58% of patients, poor glycemic control (HbA1c > 8%) was seen. Abnormal coagulation profiles (36.36%) and elevated inflammatory cytokines (54.55%) were prevalent. Poor glycemic control, co-infections, and unfavorable outcomes were shown to be significantly correlated, and the main predictors of severe outcomes were age, type of diabetes, insulin usage, co-infections, and inflammatory markers.

Conclusion: The research emphasizes how important microbial co-infections, insulin usage, and glycemic management are in determining COVID-19 results in diabetic patients. These findings reveal that these vulnerable populations need specific care strategies to reduce the possibility of negative consequences.

Keywords: COVID-19, diabetes mellitus, glycemic control, microbial co-infections, biochemical markers, severe outcomes.

Introduction

A severe worldwide health emergency, the COVID-19 epidemic has tested healthcare systems and exposed how susceptible those already suffering health issues are [1]. Many people have discovered that diabetes mellitus (DM) is a major disorder influencing the severity of COVID-19 and the efficacy of treatment [2]. The complex interaction between DM and COVID-19 has generated a lot of concern as it involves biochemical and clinical pathways that cross and aggravate the condition in persons who already have it [3].

Because their immune systems are weaker and they experience continuous low-grade inflammation, persons with diabetes are more prone to get infections [4]. These individuals are especially more vulnerable when they get COVID-19, which frequently causes significant issues, extended hospital stays, and more fatalities [5]. Furthermore complicating blood sugar control are systematic infections and possible drug interactions; the epidemic has also shown modifications in drug-based treatment [6, 7].

A further crucial component of this connection are microbial co-infections. Working together, COVID-19 and excessive blood sugar disrupt the immune system, which facilitates the spread of secondary illnesses [8]. This study suggests that co-infections could not only complicate treatment [9], but also show indications of inferior outcomes. Moreover, in determining the pathophysiological connections between COVID-19 and diabetes mellitus, molecular markers like metabolic indices, clotting factors, and inflammatory cytokines have become more and more crucial. Apart from guiding us in determining the etiology of illnesses, these indicators might also assist in determining their treatment course [10,11].

Our knowledge of the actual nature of these interactions still suffers large gaps even with these conclusions. varied places have varied degrees of access to health care; the COVID-19 epidemic is evolving rapidly; these elements further complicate

the matter. Examining closely the incidence, medication therapy, microbiological co-infections, and biochemical indications in COVID-19-positive persons with diabetes helps to fill up these gaps in knowledge.

Research objective

This study aimed to ascertain the frequency of diabetes mellitus in COVID-19 patients, the efficacy of various medication therapies, presence of microbiological infections, and biochemical indicators. In this sense, we can better grasp how these elements interact and how to manage the patients.

Methodology

Study Design and Setting

The Hayatabad Medical Complex, Peshawar conducted a cross-sectional research spanning January 2023 to December 2023, a full year.

Inclusion and Exclusion Criteria

Teenagers and adults (>18 years) who had been diagnosed with COVID-19 by RT-PCR testing and already had either type 1 or type 2 diabetes mellitus provided informed permission. Patients with gestational diabetes or secondary diabetes, those without a verified diagnosis of COVID-19, and those unable to provide informed permission because of a serious illness or other circumstances were not included.

Sample Size

The sample size was calculated using the proportional sample size formula: $n = Z^2 \times p \times (1-p) / d^2$, where Z represents the z-score corresponding to the desired confidence level (1.96 for 95%), p is the estimated prevalence of diabetes among COVID-19 patients, and d is the margin of error (5%). Substituting these values, the calculated sample size was approximately 385 patients to ensure sufficient representation and account for potential dropouts.

Data Collection

Patient medical records and structured questionnaires were used to gather data. Demographic data, diabetes history, glycemic control strategies, pharmaceutical treatment information, the existence of microbial co-infections, and pertinent biochemical markers (such as coagulation profiles, metabolic parameters, and inflammatory cytokines) were among the important factors. Data collection was carried out by qualified medical specialists, guaranteeing precision and uniformity.

Statistical Analysis

SPSS version 26 was used to analyze the data. Clinical and demographic features were gathered using descriptive statistics. To evaluate correlations between variables, t-tests were used. To find predictors of severe outcomes, multivariate logistic regression was used. Statistical significance was defined as a p-value of less than 0.05.

Results

The research participants' clinical and demographic details are shown in Table 1. With a mean age of 50.26 ± 12.51 years, the majority of patients (46.88%) were in the 40–60 age range. Fifty-five percent of the participants were male, and forty-five percent were female. Type 2 diabetes was prevalent (71.43%), with type 1 diabetes coming in second (28.57%). Participants often had comorbid conditions including cardiovascular disease (39.47%) and hypertension (62.50%).

Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Category	Number of Patients (n;%)
Age (years)	<40	120 (31.27)
	40–60	180 (46.88)
	>60	85 (21.85)
	Mean \pm SD	50.26 \pm 12.51
Gender	Male	210 (54.55)
	Female	175 (45.45)
Diabetes Type	Type 1	110 (28.57)
	Type 2	275 (71.43)
Comorbidities	Hypertension	240 (62.50)
	Cardiovascular disease	150 (39.47)
	None	75 (19.49)

The research participants' pharmaceutical management and glycemic control are included in Table 2. The majority of patients had poor glycemic control (41.58%, HbA1c > 8%), followed by fair (36.36%, HbA1c 7–8%) and good (22.06%, HbA1c < 7%) glycemic control. Of the individuals, 57.14% reported using insulin, and 71.43% were using oral antidiabetics. HbA1c was 9.24 ± 1.57 on average.

Table 2: Glycemic Control and Pharmacological Management

Variable	Category	Number of Patients (n;%)
Glycemic Control	Poor (HbA1c > 8%)	160 (41.58)
	Fair (HbA1c 7–8%)	140 (36.36)
	Good (HbA1c < 7%)	85 (22.06)
	Mean ± SD	9.24 ± 1.57
Insulin Use	Yes	220 (57.14)
	No	165 (42.96)
Oral Antidiabetics Use	Yes	275 (71.43)
	No	110 (28.57)

The frequency of biochemical indicators and microbiological co-infections among research participants is shown in Table 3. 54.55% of patients had increased inflammatory cytokines, while 49.48% of patients had co-infections. 36.36% of patients had abnormal coagulation profiles, while 46.88% had disrupted metabolic parameters. The mean values for metabolic parameters, coagulation profiles, and inflammatory cytokines were, respectively, 85.45 ± 12.71, 2.37 ± 0.46, and 9.45 ± 1.78.

Table 3: Microbial Co-Infections and Biochemical Markers

Variable	Category	Frequency (%)
Co-infections Present	Yes	190 (49.48)
	No	195 (50.52)
Inflammatory Cytokines	Elevated	210 (54.55)
	Normal	175 (45.45)
	Mean ± SD	85.45 ± 12.71
Coagulation Profile	Abnormal	140 (36.36)
	Normal	245 (63.64)
	Mean ± SD	2.37 ± 0.46
Metabolic Parameters	Disturbed	180 (46.88)
	Normal	205 (53.12)

The findings of t-tests assessing correlations between variables are shown in Table 4. With mean ages rising from 50.26 ± 12.51 years in the <40 group to 58.45 ± 10.62 years in the >60 group, there were notable variations across age groups (p < 0.001). With mean values of 9.24 ± 1.57 in the poor control group, 7.56 ± 0.84 in the fair control group, and 6.80 ± 0.70 in the excellent control group, glycemic control demonstrated significant variations in HbA1c levels (p < 0.001). The mean HbA1c for insulin users was 9.32 ± 1.62, whereas the mean for non-users was 8.95 ± 1.54 (p = 0.001). This indicates that insulin usage had a considerable impact. Higher HbA1c levels were linked to co-infections (9.20 ± 1.65 vs. 7.95 ± 1.45, p < 0.001). Higher levels of elevated inflammatory cytokines (85.45 ± 12.71) were observed in comparison to normal levels (72.31 ± 11.18, p < 0.001). The mean HbA1c values in abnormal coagulation profiles were greater (9.15 ± 1.32) than in normal profiles (7.85 ± 1.14, p < 0.001). HbA1c values were substantially higher in disturbed metabolic parameters (9.45 ± 1.78) than in normal parameters (7.92 ± 1.25, p < 0.001).

Table 4: Associations Between Variables using t-Tests

Variable	Category 1	Category 2	Mean ± SD Category 1	Mean ± SD Category 2	t-value	p-value
Age	<40	40–60	50.26 ± 12.51	52.43 ± 11.89	-2.54	0.011
	<40	>60	50.26 ± 12.51	58.45 ± 10.62	-4.73	<0.001
	40–60	>60	52.43 ± 11.89	58.45 ± 10.62	-3.68	0.001
Glycemic Control	Poor (HbA1c > 8%)	Fair (HbA1c 7–8%)	9.24 ± 1.57	7.56 ± 0.84	8.45	<0.001
	Poor (HbA1c > 8%)	Good (HbA1c < 7%)	9.24 ± 1.57	6.80 ± 0.70	11.68	<0.001
	Fair (HbA1c 7–8%)	Good (HbA1c < 7%)	7.56 ± 0.84	6.80 ± 0.70	5.45	<0.001
Insulin Use	Yes	No	9.32 ± 1.62	8.95 ± 1.54	3.68	0.001
Co-infections Present	Yes	No	9.20 ± 1.65	7.95 ± 1.45	6.84	<0.001
Inflammatory Cytokines	Elevated	Normal	85.45 ± 12.71	72.31 ± 11.18	7.26	<0.001
Coagulation Profile	Abnormal	Normal	9.15 ± 1.32	7.85 ± 1.14	8.38	<0.001
Metabolic Parameters	Disturbed	Normal	9.45 ± 1.78	7.92 ± 1.25	6.84	<0.001

The findings of multivariate logistic regression analysis are shown in Table 5, which identifies important predictors of severe outcomes in diabetic COVID-19 patients. With an odds ratio (OR) of 1.45 (95% CI: 1.12–1.88, p = 0.003), age was a significant predictor. A significant predictor of diabetes type was also found, with an OR of 2.11 (95% CI: 1.57–3.07, p < 0.001). Glycemic control had a crucial role; a significantly greater risk of severe outcomes was linked to poor HbA1c

management than to excellent glycemic control (OR = 3.56, 95% CI: 2.18–5.83, $p < 0.001$). Significant predictors of severe outcomes included the use of insulin (OR = 2.75, 95% CI: 1.85–4.10, $p < 0.001$), co-infections (OR = 1.85, 95% CI: 1.32–2.60, $p < 0.001$), elevated inflammatory cytokines (OR = 2.11, 95% CI: 1.53–3.28, $p < 0.001$), abnormal coagulation profiles (OR = 1.93, 95% CI: 1.32–2.80, $p < 0.001$), and disrupted metabolic parameters (OR = 2.05, 95% CI: 1.44–3.01, $p < 0.001$). There was no significant correlation between gender and outcome (OR = 1.23, 95% CI: 0.89–1.68, $p = 0.205$).

Table 5: Predictors of Severe Outcomes – Multivariate Logistic Regression Analysis

Variable	Odds Ratio (OR)	95% CI	p-value	Significance
Age (Years)	1.45	(1.12 – 1.88)	0.003	Significant
Gender	1.23	(0.89 – 1.68)	0.205	Not significant
Diabetes Type	2.11	(1.57 – 3.07)	<0.001	Significant
Glycemic Control (HbA1c)	Poor vs Good	3.56 (2.18 – 5.83)	<0.001	Significant
	Fair vs Good	2.34 (1.44 – 3.87)	0.002	Significant
Insulin Use	2.75	(1.85 – 4.10)	<0.001	Significant
Co-infections Present	1.85	(1.32 – 2.60)	<0.001	Significant
Inflammatory Cytokines	2.11	(1.53 – 3.28)	<0.001	Significant
Coagulation Profile	1.93	(1.32 – 2.80)	<0.001	Significant
Metabolic Parameters	2.05	(1.44 – 3.01)	<0.001	Significant

Discussion

Our research examined the relationship between COVID-19 and diabetes mellitus, concentrating on important factors such as age, glycemic control, insulin usage, co-infections, and biochemical indicators. The correlation between severe outcomes and age was one of our research's important results. We found that the mean age of patients over 60 was 58.45 ± 10.62 , substantially higher than the mean age of patients under 40 (50.26 ± 12.51 , $p < 0.001$). This is in line with other research that showed that older age is a significant predictor of worse outcomes for COVID-19 individuals who also have concomitant conditions like diabetes [12]. Our findings corroborate other studies that highlight the link between aging and heightened susceptibility to severe COVID-19 consequences.

Another important factor linked to serious outcomes in our population was glucose control. Patients with adequate glycemic control (HbA1c < 7%) had a mean HbA1c of 6.80 ± 0.70 ($p < 0.001$), whereas those with poor glycemic control (HbA1c > 8%) had a considerably higher mean HbA1c of 9.24 ± 1.57 . This result supports earlier research that found poor glycemic management was associated with poorer COVID-19 outcomes, such as longer hospital admissions and higher death [13]. Maintaining ideal glycemic levels is crucial to reducing the severity of COVID-19, as seen by the considerably decreased likelihood of severe COVID-19 outcomes among patients with adequate glycemic control [14].

Patients who used insulin had a higher mean HbA1c of 9.32 ± 1.62 than those who did not use it (8.95 ± 1.54 , $p = 0.001$), making insulin usage another important predictor of severe outcomes. Due to the immunosuppressive effects of insulin treatment in a hyperglycemic setting, our results are in line with other studies that connected insulin usage to worsening COVID-19 outcomes [15]. Furthermore, these findings add credence to the increasing amount of data showing that COVID-19 severity is increased by insulin resistance and comorbidities associated with diabetes.

Clinical outcomes were much poorer when co-infections were present. The mean HbA1c for patients with co-infections was 9.20 ± 1.65 , whereas the mean HbA1c for patients without co-infections was 7.95 ± 1.45 ($p < 0.001$). Our results are in line with other studies that shown that co-infections increase the morbidity and mortality of COVID-19 patients, especially those who had underlying medical problems such diabetes [16]. These findings demonstrate the intricate relationship that exists during COVID-19 between diabetes, immunological dysregulation, and secondary infections.

Those with poor outcomes showed mean levels of inflammatory cytokines (85.45 ± 12.71) greater than normal levels of 72.31 ± 11.18 ($p < 0.001$). Previous research associated greater levels of inflammatory markers to worse results from COVID-19. It is believed that hyperinflammation aggravates tissue damage and causes very difficulty breathing [17]. Likewise, 36.36% of patients experienced difficulties with their blood coagulation, which was significantly correlated to worse outcomes ($p < 0.001$). Other research has also indicated that COVID-19 is exacerbated by inflammation and abnormalities with blood clotting [18]. These findings confirm this.

At last, our research found that poor outcomes connected to metabolic disorders like excessive glucose levels and insulin resistance. Patients with normal metabolic parameters scored 7.92 ± 1.25 ; those with non-normal metabolic parameters scored 9.45 ± 1.78 . Earlier research [19] has underlined how metabolic issues, such as excessive blood sugar and insulin resistance, aggravate the condition for diabetic COVID-19 patients.

Study Strength and Limitations

One of the positive aspects of our research is that we examined many various elements, including insulin usage, glucose management, co-infections, and molecular indicators. This provided us with significant fresh knowledge on the interaction between diabetes and COVID-19. To identify major causes of poor outcomes, we applied t-tests and multivariate logistic regression analysis. This clarified for us this connection. Though it makes it difficult to identify relationships between causes, the cross-sectional shape is one of the issues. Furthermore, the study just used one center, which made data utilization more difficult in different contexts. The variables were self-reported, hence their accuracy could have been less than it might have been. This is particularly valid for factors concerning medication treatment and co-infections. To validate these findings much more in-depth ongoing research with bigger sample numbers and a greater spectrum of conditions is required.

Conclusion

Our analysis reveals that among the most crucial elements closely associated with bad outcomes in persons with COVID-19 and diabetes mellitus are glycemic management, insulin usage, co-infections, and biochemical markers. These findings highlight the need of tailored treatment approaches for reducing negative outcomes, particularly in relation to blood sugar level regulation as much as feasible and prevention of other illnesses. More study is therefore necessary to establish a link between two occurrences and investigate these relationships in more depth among several groups. This would enable physicians to come up with improved approaches of treating patients and assist them in making wise selections.

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