Association of Diabetes Mellitus with COVID-19 Severity and Prognosis

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Abstract

The global COVID-19 pandemic has posed a major health crisis, particularly affecting individuals with pre-existing chronic conditions such as diabetes mellitus. This retrospective cohort study aimed to explore the association between diabetes mellitus (both Type 1 and Type 2) and COVID-19 in the public of Pakistan. 1,514 diabetic patients were surveyed between October 2024 and April 2025 from various hospitals in Lahore, 635 were found to be co-infected with COVID-19. The study analyzed the prevalence of comorbidities such as cardiovascular, kidney, liver, pulmonary diseases, and neuropathy, along with factors such as BMI, smoking, and blood pressure. Results showed that COVID-19 prevalence was higher in males (57.6%) and primarily affected the 41–60 age group. Type 2 diabetes was predominant among co-infected patients (89.4%). Mortality was significantly higher in diabetic patients with COVID-19 (36.7%) compared to those without (5.2%). Chi-square analysis confirmed significant associations between COVID-19 in diabetics and risk factors such as pulmonary problems, smoking, liver disease, kidney disease, and cardiovascular conditions. These findings emphasize the critical need for focused healthcare strategies for diabetic patients during respiratory pandemics.

Keywords: *COVID-19, Diabetes Mellitus, Type 1 Diabetes, Type 2 Diabetes, SARS-CoV-2, Comorbidities, Pulmonary Disease, Cardiovascular Disease, Kidney Disease, Obesity, Smoking, Mortality, Pakistan, Retrospective Study.*

Introduction

Wuhan, Hubei, China, was the first place where coronavirus-2 was identified in December 2019 and associated with SARS family. An eruption of CoV2 was observed in broncho-alveolar lavage fluid for the very first time, and the International Committee on Virus Taxonomy designated it SARS-CoV-2. A new coronavirus was

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isolated from pneumonia patients, in February 2020 World Health Organization designated it as COVID-19 (Jeong et al., 2020). CoV2 is transmitted to others via direct contact, droplets or by infected person cough, sneeze (Rothan and Byrareddy, 2020). SARS-CoV-2 virus affects respiratory tract and lungs, it leads to coronavirus pneumonia (Zhu et al., 2020). During ongoing pandemic of Covid-19, many studies have been carried out in various nations reporting the increased risks of severe Covid-19 infection (Ou et al., 2020). The present study aims to find out the association of COVID-19 in diabetics in general public. Research of 4,880 patients with respiratory symptoms or SARS-CoV-2 at Wuhan hospital China shows that the Coronavirus rate in males and older people (>70 years) was considerably higher (Liu *et al.,* 2020). Males had 1.7 times higher risk of dying than females, according to recent findings (Scully et al*.,* 2020). The CoV-2 outbreak caused worldwide health disaster and ruined the economic, political and social components of life span. Numerous physicians, wellbeing experts, associations, researchers, and governments have beaten Coronavirus disease of 2019 and discuss their insight and encounters of the CoV2 (Jeong et al*.,* 2020).

Similarly, Diabetes mellitus has also become a serious prevalent health issue globally. Malfunctioning of carbohydrate metabolism in which blood glucose level is high due to under secretion or action of insulin by pancreas. It has been reported earlier that approximately 463 million people have diabetes worldwide, among them 90% are suffering from type 2 diabetes (Azeem et al*.,* 2022). It has been estimated that 33 million people of Pakistan have diabetes 2 (Bhutta et al*.,* 2022). The present study is a community survey. It aims to find out the prevalence of COVID-19 and diabetes mellitus type I and II. It involves the study of different age groups affected with COVID-19 and diabetes.

Methadology

Study Design

This is a retrospective cohort research/survey to study association of COVID-19 with *diabetes mellitus.* All patients were laboratory confirmed diabetics and were under treatment for diabetes. Some of the patients got COVID-19. This study was conducted in different hospitals including Mayo Hospital and Services Hospital, Lahore. The time duration of this study was October 2024 to April 2025.

Sampling of Subjects

A sample size of 1514 subjects was studied. Patients with diabetes were identified based on their documented medical history. Two types of patients were

under study type one included diabetics and a second type included those diabetics which were also suffering from COVID-19. The subjects were tested that either they were positive for COVID-19 or not. Both males and females were randomly selected for this study.

The information about the condition of the subjects was collected; either they were suffering from type 1 diabetes, it is called T1DM (type 1 diabetes mellitus) or type 2 diabetes, (T2DM) and duration of disease was also taken under consideration. The FBG (fasting blood glucose), RBG (random blood glucose) and HbA1C (hemoglobin A1C) levels were also accessed and the data was further classified for analysis.

Body Mass Index (BMI) Categories

The BMI value was calculated from the height and weight of the subjects. After the calculations of BMI, the subjects were divided into four categories i.e., overweight, normal weight, underweight and obese (Tabe 1).

The following formula was used for calculating the BMI (kg/m^2) (Sattar *et al.,* 2013)

$$\textbf{BMI (kg/m}^2\textbf{)} = \frac{\textbf{Weight in kilogram}}{\textbf{Height in meters}^2}$$

Table 1: *The Standard BMI (kg/m^2) Categories for BMI*

Categories	BMI (kg/m^2)
Under Weight	<18.5
Normal Weight	18.5- 24.9
Over Weight	≥ 23- 24.9
Obesity	25≥30
Stage 1	30-34.99
Stage 2	35-39.99
Stage 3	≥40.00

Blood pressure and Blood Parameters

The blood pressure of patients was recorded and they were considered hypertensive or pre-hypertensive according to criteria in Table 2.

Table 2: *Classification of Hypertension*

Categories	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Normal	< 120	<80
Pre-hypertensive	120-139	80-89
Stage 1	140-159	90-99
Stage 2	>160	>100

Parameters or variables assessed

The variables analyzed in diabetes patients were: Cardiovascular disorder, Kidney disease, Liver disease, Neuropathy, Obesity, Pulmonary problems, Retinopathy, Smoking.

Statistical Analysis

Microsoft excel 2016 and SPSS statistical software version 21were used for statistical analysis. All the data from the survey, screenings, psychological and medical evaluations were recorded on pre-coded forms, entered into a computerized database. Data were analyzed statistically and were presented in the form of graphs, tables, and charts. Continuous variables were presented as Mean, standard deviation (S.D.) and standard error mean (S.E.M.) and then mean values were converted into percentages. Chi square test was applied to evaluate linkage between diabetes and COVID-19. A p-value was account significant if the value is 0.05 or less. The accuracy of the data was checked and necessary corrections were made both before and after the data were entered into the database.

Chi-square Test

The Chi-square test is a parametric procedure typically used to correlate actual data with data which would be obtained in accordance with a particular assumption. This Chi-square tests what researchers call the null hypothesis, which claims that the predicted findings are not significantly different. The formula for calculating the chi-square is:

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Chi-square is a total of the square differences in all feasible divisions among the actual (O) and the supposed (e) data, divide by the supposed data. (William et al., 1952).

Results

The time duration of this study was October 2024 to April 2025. A sample size of 1514 diabetics and COVID-19 subjects were accessed include 56% male (n=850) and 44% female (n=664) respectively.

Prevalence of diabetes with and without COVID-19 in reference to gender

The diabetes prevalence with CoV2 in male was 57.6% (n=366) and female 42.4% (n=269). Similarly, the diabetes prevalence without CoV2 in male was 55.1% (n=484) and female 44.9% (n=395).

Prevalence of diabetes with and without COVID-19 in reference to diabetes types

The diabetics with CoV2 had T1DM 10.6% (n=67) and T2DM 89.4% (n=568). Similarly, the diabetics without CoV2 had Type I diabetes 7.8% (n=69) and Type II diabetes 92.2% (n=810).

Age wise percentage of diabetics with and without COVID-19

Total 1098 patients affected with diabetes belonged to age group 41-60 which contributed 72.6%. 19.6 % of diabetics belonged to age group of 61-80. The age group 21-40 contributed 7.8% of the diabetics. Most of the diabetics affected with COVID-19 belonged to age group of 41-60. The same age group was found be affected with diabetes mellitus only (see Table 1, and 2; Figure 1).

Prevalence of cardiovascular problems in diabetics with and without COVID-19 disease

The diabetics with CoV2 and cardiovascular problem were 20.5% (n=130). 79.5% (n=505) were the cases of diabetics with CoV2 free from any heart disease. Similarly, the diabetics without CoV2 but having cardiovascular problem were 16.3% (n=143). 83.7% (n=736) of people free from CoV2 and any heart ailment but were diabetic.

Prevalence of kidney disease in diabetics with and without COVID-19 disease

The diabetics with CoV2 having kidney problems contributed 8.2% (n=52). Diabetics with CoV2 which were not affected by any kidney ailment included 291.8%

(n=583). Similarly, the diabetics without CoV2 having kidney problems were 6.0% (n=53) and without any kidney problem were 94.0% (n=826).

Prevalence of liver problems in diabetics with and without COVID-19 disease

Liver problems were observed in 19.4% (n=123) of diabetics who were also affected by CoV2. 80.6% (n=512) cases have been listed which were diabetics fighting against CoV2 without any liver disease. Similarly, the diabetics without CoV2 liver problems were 8.4% (n=74) and without liver issues cases were 91.6% (n=805).

Prevalence of neuropathy in diabetics with and without COVID-19 disease

The diabetics with CoV2 had neurologic conditions 5.2% (n=33) and the cases without neurological ailment were 94.8% (n=602). Similarly, 4.3 % (n=38) people were affected with neurologic conditions fighting with diabetics without CoV2. About 95.7% (n=841) people were diabetics without CoV2 and any neuropathy.

Prevalence of obesity in diabetics with and without COVID-19 disease

The diabetics with CoV2 facing obesity were19.7% (n=125) and without obesity were 80.3% (n=510). Similarly, the obese diabetics without CoV2 were 20.3% (n=178). The diabetics free from CoV2 and obesity contributed 79.7% (n=701).

Prevalence of pulmonary problems in diabetics with and without COVID-19 disease

The diabetics suffering from both COVID-19 and some pulmonary diseases were 33.1% (n=210). 66.9% (n=425) were the diabetics affected with COVID-19 but free from any pulmonary disease. Similarly, the diabetics without CoV2 having pulmonary problem were 19.1% (n=168). 80.9% (n=711) of diabetics were free from both CoV2 and pulmonary diseases.

Prevalence of smoking in diabetics with and without COVID-19 disease

42.5% (n=270) smokers were diabetics with CoV2 while non-smoker included 57.5% (n=365). The diabetics without CoV2 who were smokers included 27.5% (n=242) and non-smokers cases were 72.5% (n=637).

Prevalence of retinopathy in diabetics with and without COVID-19 disease

The cases of diabetics with CoV2 and retinopathy were 11.5% (n=73) and without retinopathy cases were 88.5% (n=562). Similarly, the diabetics without CoV2 but affected with retinopathy were 14.1% (n=124). 85.9% (n=755) of diabetics were not affected by both COVID-19 and retinopathy.

Table 1: *Overall age wise distribution of diabetics*

Age wise distribution	No. of patients (N)	Percentage (%)
21- 40	118	7.8
41- 60	1098	72.6
61- 80+	298	19.6
Total	1514	100%

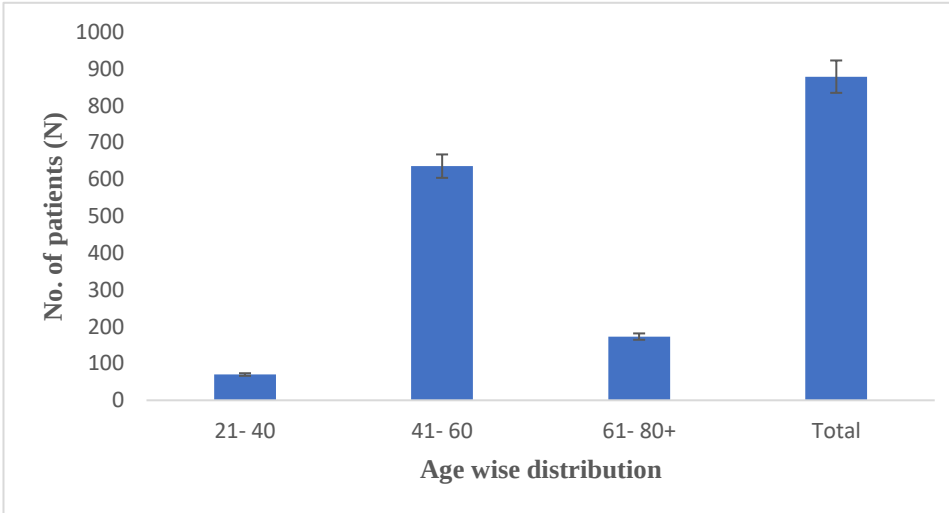
Table 2: *Age wise distribution of diabetics with COVID-19*

Age wise distribution	No. of patients	Percentage (%)
21- 40	48	7.6
41- 60	462	72.7
61- 80+	125	19.7
Total	635	100%

Table 3: *Age wise distribution of diabetics without COVID-19*

Age wise distribution	No. of patients (N)	Percentage (P)
21- 40	70	7.9
41- 60	636	72.4
61- 80+	173	19.7
Total	879	100%

Figure 1: *Age wise distribution of diabetics without COVID-19*



Prevalence of diabetes with and without COVID-19 in reference to mortality

The diabetics with CoV2 had mortality rate 36.7% (n=233) and survival rate 63.3% (n=402). Similarly, the diabetics without CoV2 had mortality rate 5.2% (n=46) and survival rate 94.8% (n=833). Chi-square was applied on different variables like gender differences, mortality in non-diabetic groups and diabetic groups with Covid-19, kidney diseases and cardiovascular problems. The p-value showed non-significant results between control and experimental groups regarding obesity, diabetic neuropathy, retinopathy and gender (Table 4). P value showed a highly significant differences between diabetics and diabetics with Covid-19 groups regarding mortality, pulmonary problems, smoking and lung diseases. Significant differences have been observed in control and experimental groups regarding diabetics, kidney disease and cardiovascular problems.

Table 4: *Chi-square for risk factors for CoV2*

Variables	**Pearson Chi-square**	**Df**	**p-value**
Gender	0.993[a]	1	0.173[ns]
Diabetes	3.291[a]	1	0.043*
Mortality	228.210[a]	2	< 0.001**
Kidney disease	2.664[a]	1	0.051*
Cardiovascular problems	4.408[a]	1	0.021*

Obesity	0.074[a]	1	0.419[ns]
Pulmonary problems	38.342[a]	1	< 0.001**
Liver issues	39.064[a]	1	< 0.001**
Diabetic retinopathy	2.220[a]	1	0.078[ns]
Diabetic neuropathy	0.630[a]	1	0.250[ns]
Smoking	37.005[a]	1	< 0.001**

Alpha value ≤ 0.05 is significant, Alpha value < 0.01 is highly significant, ns represents non-significant, Df represents degree of freedom.

Discussion

In the present study, we have observed the 1514 diabetes and Covid-19 patients having preexisting chronic comorbidities and prognosis. It was observed that diabetes mellitus was prevalent more in males as compared to females. Some previous studies have shown 9-14% prevalence of diabetes in Covid-19 patients (Chen et al., 2020; Wang et al., 2017; Shi et al., 2020 and Zhang et al., 2020). An analysis in sighted higher pooled estimate of diabetes in males as compared to females (Adnan and Aasim, 2020). In the present study, it was observed that type II diabetes was prevalent as compared to diabetes type I. A previous study gives support to our finding. It reports the prevalence of type II diabetes with 3201 subjects affected (Aamir et al*.,* 2019). Diabetic people are more likely to have serious COVID-19 infection (Wang et al., 2020). A broad worldwide survey shows that 20% to 50% of Coronavirus patients had diabetes, highlighting the relationship between SARS-CoV2 and diabetes mellitus (Bornstein et al., 2020).

Out of our total 1514 subjects, 1098 diabetics belonged to age group 41-60. A similar pattern was observed in age wise distribution of diabetics with and without COVID-19. Diabetics with and without COVID-19 belonged to age group 41-60. Second prevalent age group was 61-80+. The age group 21-40 was least affected with diabetes as well as COVID-19. A previous study has reported median age of all participants of the study with 64-year-old (Zhang[2] et al., 2020). The diabetes prevalence with CoV2 in male was 57.6%. It was a bit high as compared to female. This result gets support from a similar study which reported 53.5% of males affected (Zhang et al., 2020; Wang et al., 2019). Our study shows that patients with Covid-19 also had prevalence with cardiovascular diseases and chronic kidney ailments. A similar pattern was reported earlier Zhang et al., 2020). The diabetics with CoV2 and cardiovascular problem were 20.5%. Although an earlier study concludes that patients with diabetes hospitalized due to Covid-19 had an increased risk of cardiovascular diseases (Jung and Choi, 2023).

We have found that the diabetics with CoV2 facing obesity were 19.7%. Although a study reports that patient with diabetes and Covid-19 appear to be obese and of older age (Abdelhafiz *et al*.,2021). In the present study, the cases of diabetics with CoV2 and retinopathy were 11.5%. The similar pattern was reported earlier in a study with patients of Covid-19 getting diabetic retinopathy is low in a year (Seshadri, 2024).

Conclusion

The study concludes that diabetics have an association with COVID-19, 41.9% CoV2 prevalence and 15.33% mortality was reported in diabetics. Male subjects were more exposed to COVID-19 disease as compared to female. Uncontrolled state of hyperglycemia, kidney diseases, cardiovascular problems, pulmonary issues, liver problems, smoking, BMI, high CRP, and high neutrophil count were risk factors for COVID-19 disease and its severity in diabetic subjects. Severity in diabetic's risk factors enhances the SARS-CoV2 negative impact that leads to patient's death.

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