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High prevalence of diabetes and other comorbidities in hospitalized patients with COVID-19 in Delhi, India, and their association with outcomes

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ABSTRACT

Background and aims: To study the prevalence and impact of diabetes mellitus and other comorbidities among hospitalized patients with COVID-19.
Methods: In a prospective, observational study including consecutive adults hospitalized with COVID-19, clinical outcomes and inflammatory markers were compared in those with and without diabetes. Participants were classified as having mild or severe COVID-19 disease using the WHO ordinal scale.
Results: 401 patients (125 females) with median age of 54 years (range 19–92) were evaluated. Of them 189 (47.1%) had pre-existing diabetes and21 (5.2%) had new-onset hyperglycaemia. Overall, 344 (85.8%) and 57 (14.2%) cases had mild and severe COVID-19 disease respectively. The group with diabetes had a higher proportion of severe cases (20.1% vs 9%, p-0.002), mortality (6.3 vs 1.4%, p-0.015), ICU admission (24.3 vs 12.3%, p-0.002), and oxygen requirement (53.4 vs 28.3%, $p < 0.001$). Baseline Hba1c ($n = 331$) correlated significantly with outcome severity scores (r 0.136, p-0.013) and 12/15 (80%) of those who succumbed had diabetes. Hypertension, coronary artery disease, and chronic kidney disease were present in 164 (40.9%), 35 (8.7%) and 12 (2.99%) patients respectively. Hypertension was associated with a higher proportion of severe cases, mortality, ICU admission and oxygen administration.
Conclusions: We report a high prevalence of diabetes in a hospitalized COVID-19 population. Patients with diabetes or hypertension had more severe disease and greater mortality.

1. Introduction

The association of adverse outcomes of COVID 19 with the presence of comorbidities has been reported frequently [1–3]. Diabetes is one of the commonest comorbidities, and people with diabetes (PWD) who contract SARS-CoV-2 infection have been shown to have poorer outcomes including a greater mortality rate [3]. The prevalence of diabetes in COVID-19 in different studies varies from 7.3% in China [4] to more than 30% in Europe [5]. Furthermore, SARS-CoV-2 infection can aggravate diabetes [1], or cause new-onset hyperglycemia [6].

Over 5000 cases were being reported daily at Delhi at the time of writing of this article [7,8]. India is home to the world's second-largest population of diabetes (77 million) [9,10]. Interestingly the overall case fatality rate (CFR) of COVID-19 has remained low in India [11].

There is limited Indian data [12,13] on the prevalence of diabetes and other comorbidities in COVID-19, as well as on the impact of these comorbidities on outcomes of COVID-19. The purpose of our study was to determine the prevalence of diabetes and other comorbidities in hospitalized COVID-19 patients and their impact on outcomes. We report here the results of a prospective study on 401 consecutive adults hospitalized with proven SARS-CoV-2 infection from a designated COVID-19 center in Delhi.

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2. Subjects, materials and methods

2.1. Study design

This prospective, observational, cross-sectional study was approved by the Institutional Ethics Committee of Max Hospital(MH), Saket, New Delhi. A waiver of consent was approved as de-identified data was used. Patients were enrolled from July 9, 2020, to August 8, 2020. MH is a tertiary care corporate hospital designated for admissions of patients with COVID-19. The patients were enrolled from two of the hospitals of MH, situated in New Delhi, India. The hospital predominantly caters to patients from the middle or upper socioeconomic group from the National Capital Region (NCR) of India.

2.2. Participants

Consecutive adult (>18 years of age) patients hospitalized with COVID-19 infection as proven by positive nasopharyngeal swab for SARS-CoV2 by RT-PCR method were included. In general, asymptomatic or mildly symptomatic patients were not hospitalized except for a few cases (n = 17) who were either from the hospital staff or could not effectively self- isolate at home for different reasons.

2.3. Definitions and measures

Data collected from the client-patient record system (CPRS) included age, sex, presenting symptoms, duration of symptoms, comorbid conditions, anthropometry, blood pressure, baseline oxygen saturation (SpO_2), results of laboratory evaluation including glycated hemoglobin (HbA1c), total and differential cell counts, alanine and aspartate transaminases, renal function, thyroid function, C-reactive protein (CRP), interleukin-6 (IL-6), ferritin, lactate dehydrogenase (LDH), D-dimer, procalcitonin and the treatment received. Patients with a prior history of diabetes or HbA1c $\geq$ 6.5% [14]were categorised as diabetes. Those who did not meet the criteria for diabetes but required insulin to maintain normoglycemia were classified as new-onset hyperglycemia. The severity of COVID-19 was assessed using the WHO ordinal scale for clinical improvement [15]. Patients were scored as follows- hospitalized with mild disease (3-no oxygen therapy, 4- oxygen by mask or nasal prongs) and hospitalized with severe disease (5- non-invasive ventilation or high flow oxygen, 6- intubation and mechanical ventilation, 7-ventilation plus other organ support like inotropes/ renal replacement therapy (RRT)/extra corporeal membrane oxygenation (ECMO), 8-death). Severity scoring was assessed at admission and the highest score during hospital stay was taken as a measure of outcome severity.

2.4. Outcome measures

The outcomes of those with and without diabetes were compared for the proportion of severe cases, the proportion of cases requiring oxygen therapy, admission to intensive care units (ICU), inotropic support, and RRT. The number of deaths in each group and differences in the markers of inflammation (CRP, IL-6, D-dimer, ferritin, LDH, procalcitonin) were also compared.

2.5. Statistical methods

Statistical analysis was done using IBM SPSS statistics software version 22.0 (IBM Corp, Armonk NY). Categorical variables were presented as frequency and percentages, whereas continuous variables were described either as mean and standard deviation (SD) or standard error (SE) for mean or median and range. Chi-square test was used to compare differences between categorical variables and the student's 't' test was used to compare continuous variables. A 'p' value of <0.05 was considered as significant. Bivariate correlation of HbA1c with outcome severity scores was studied with the Pearson method. Multivariate analysis was done using binomial logistic regression using the forward LR method to identify factors independently predicting severe disease and mortality. Factors showing significant correlation in univariate analysis (age, sex, presence of diabetes, hypertension, respirstory diseases, chronic kidney disease (CKD), baseline severity scores, D-dimer, ferritin, CRP, IL-6, and LDH) were included in multivariate analysis. The fitness of the model was tested using the Hosmer-Lemeshow test.

3. Results

3.1. Baseline patient characteristics

The study population consisted of 401 patients, of whom 125 were women. The median age of the population was 54 years (range 19–92 y), mean BMI (n = 133) was 27.5 ± 4.4. and mean baseline SpO2 was 95.5 ± 4.1 mm of Hg. Systolic and diastolic blood pressure at admission were 129.8 ± 14.6 and 78.2 ± 9.8 mm of Hg respectively. The median symptom duration was 5 days (range 1–20 d) and median duration of hospital stay was 8 days (1–44 d).

At hospitalization, majority (n = 381, 95%) of patients had mild disease with no oxygen requirement (n = 309, 77.1%) or low flow oxygen requirement (n = 72, 18%) and 17 (4.2%) patients were asymptomatic. Severe disease was present in 20 (5%) patients at the time of admission in the hospital (high flow oxygen-18, intubation, and intubation + other organ support in one each). Comorbid conditions other than diabetes/hyperglycemia included hypertension (164, 40.9%), coronary artery disease (CAD) (35, 8.7%), respiratory disease (24, 6%), chronic kidney disease (CKD) (12, 3%), cancer (11, 2.7%) and hypothyroidism (61,15.2%). Pre-existing respiratory diseases included bronchial asthma in 17 patients, chronic obstructive pulmonary disease in 3, tuberculosis and obstructive sleep apnea in 2 each, interstitial lung disease, chronic lymphoproliferative disease and bronchiectasis in 1 each. Three patients had 2 co-existing respiratory conditions.

3.2. Overall outcomes of COVID-19 in the study population

Mild and severe disease was present in 344 (85.8%) and 57 (14.2%) patients respectively. Out of a total of 401 patients in the study, 239 (59.6%) did not require any oxygen treatment and 105 (26.2%) were treated with low-flow inhaled oxygen. Severe cases included those with requirement of high flow oxygen or non-invasive ventilation (38, 9.5%), intubation and intubation with other organ support (2, 0.5% each) and those who died (15, 3.7%). Inhaled oxygen administration, inotropic support and renal replacement therapy was required in 161 (40.1%), 19 (4.7%) and 7 (1.7%) cases respectively. A total of 72 (18%) patients were admitted in ICU for a median of 8 days (range 1–34 days).

3.3. Glycemic abnormalities in the study population

Among the entire study population, 210 (52.4%) patients had abnormal glycemic parameters. This included patients with self reported pre-existing diabetes (152, 37.9%), patients with no prior history of diabetes but who fulfilled study criterion for pre-existing diabetes (37, 9.2%), and patients who did not meet the criteria for pre-existing diabetes, but required insulin to maintain normoglycemia during the hospital stay (21.5,2%). One hundred and ninety

one (47.6%) patients did not have any glycemic abnormality. Two patients with known type 2 diabetes presented with ketoacidosis. None of the patients with diabetes was labelled as 'type 1' diabetes by the treating teams.

Baseline characteristics at the time of admission into the hospital differed between those with preexisting diabetes (n=189) and those without (N=212) . Those with pre-existing diabetes were significantly older (mean age 59.8 vs 47.7 years), and had was a higher proportion of males (74.6% vs 63.7%). They also had a higher prevalence of hypertension (58.7% vs 25.0%), CAD (13.8% vs 4.2%) and CKD (5.3% vs 0.9%). The baseline SpO_2 (94.9 vs. 96.1) was significantly lower and mean baseline severity scores (3.4 vs. 3.2) significantly higher in those with pre-existing diabetes, although the symptom duration did not differ between the two groups (Table 1).

3.4. Comparison of outcomes of patients with or without pre-existing diabetes

Group 1 had a significantly higher proportion of severe cases (20.1% vs 9%) and higher mortality (6.3% vs 1.4%). A higher proportion of this group required oxygen administration (53.7 vs 28%), ICU admission (24.3% vs 12.3%), glucocorticoid therapy (78.3% vs 54.2%), convalescent plasma therapy (31.2%vs. 18.4%), inotropic support (7.4% vs 2.4%), and RRT (3.7% vs 0). The mean duration of hospital stay was about 1–1.5 days more in this group (10.4 vs 9.1 days) (Table 2).

Baseline Hba1c (n = 331) showed a significant positive correlation with outcome severity scores (r = 0.136, p = 0.013). Markers of the inflammatory response – CRP, Ferritin, IL6, LDH were significantly higher in the group 1. Procalcitonin and D-dimer did not differ significantly (Table 3). Hemoglobin, white cell counts, absolute lymphocyte count, alanine and aspartate transaminases, urea, creatinine, albumin, and thyroid function tests were not significantly different. Median SGPT levels were 38 IU/L (range 8–801) whereas median SGOT levels were 39.5 IU/L (range 12–373). Raised SGOT (≥35 IU/L) and raised SGPT (≥35) were seen in 235 (58.6%) and 218 (54.4%) cases respectively. In mild and severe cases SGPT (52.7 ± 50.6 vs. 65.5 ± 108.9, p-0.394) and SGOT (50.2 ± 40.4 vs. 53.8 ± 38.7, p-0.544) were not significantly different.

In the univariate analysis, age, male gender, presence of diabetes, hypertension and CKD were significantly associated with more severe disease. There was also a significantly higher level of CRP, Ferritin, D Dimer, IL6, LDH, Procalcitonin in those with more severe COVID-19 disease. In the multivariate analysis, binomial logistic regression analysis revealed three factors to be significantly and independently associated with more severe COVID- 19 disease. These were age (OR 1.04, 95% CI, 1.01–1.08, p value - 0.01), male gender (OR 2.91, 95% CI, 1.10–7.71, p value - 0.03), and baseline severity score (OR 11.46, 95% CI, 6.02-21.84 p value-0.00). Diabetes was present in a significantly greater proportion of those with severe disease as compared to those with mild disease (66.7% vs. 43.9%) Among those requiring oxygen, and those requiring ICU care, 62.7% and 63.9% had diabetes. Of those who died, 12/15 (80%) had diabetes. In the multivariate analysis however, there was no significant association between presence of diabetes and severe COVID-19 infection.

3.5. Outcomes in patients with new-onset hyperglycemia

Twenty-one patients (18 males, median age 58 years, range 31–82 years) patients had new-onset hyperglycemia. The median Hba1c in this group was 5.9%, (range 5.3–6.4). Seven of them had accompanying hypertension, 4 had an underlying respiratory disease, and 3 had hypothyroidism. Mean hospital stay in this group was 12.9 ± 6.5 days. Nineteen of 21 patients had hyperglycemia following glucocorticoid administration. Two patients, age 31 and 40 years, with baseline Hba1c values 6.1 and 6.3%, developed hyperglycemia requiring insulin without being administered glucocorticoids. Both had concomitant hypertension. When compared with other categories of glycemic status the new-onset hyperglycemia group had a significantly higher proportion of severe cases (9, 42.9%), mortality (2, 9.5%), oxygen requirement (14, 66.7%), and ICU admission (10, 47.6%) (Table 4). None of the 21 patients developed ketoacidosis.

3.6. Comparison of outcomes of patients with pre-existing diabetes alone versus those with diabetes and hypertension

Table 5 shows the comparison of patients with diabetes alone (n = 78) and those with both diabetes and hypertension (n = 111). Patients with both diabetes and hypertension were significantly older in age and had higher prevalence of CKD. Baseline BMI,

Table 1
Baseline characteristics of COVID-19 patients with and without pre-existing diabetes.

Parameter	Diabetes (n = 189)	No diabetes (n = 212)	P value
Age	59.8 (12.1)	47.7 (16.5)	<0.001
Males	141 (74.6)	135 (63.7)	0.023
Height, cm(n = 133)	164.2 (9.3)	164.5 (8.1)	0.864
Weight, kg (n = 144)	77.5 (14.4)	71.6 (12.8)	0.01
BMI (n = 133)	28.5 (4.6)	26.5 (3.9)	
SBP	132.5 (14.1)	127.3 (14.6)	<0.001
DBP	79.2 (9.5)	77.4 (10.0)	0.078
Hypertension	111 (58.7)	53 (25)	<0.001
CAD	26 (13.8)	9 (4.2)	0.001
Respiratory disease	10 (5.3)	14 (6.6)	0.675
CKD	10 (5.3)	2 (0.9)	0.016
Cancer	7 (3.7)	4 (1.9)	0.362
Hypothyroidism	33 (17.5)	28 (13.2)	0.266
Asymptomatic patients	3 (1.6)	14 (6.6)	0.013
Symptom duration	5.9 (3.3)	5.7 (3.3)	0.540
Baseline SpO2	94.9 (4.3)	96.1 (3.8)	0.004
Baseline severity score	3.4 (0.7)	3.2 (0.5)	<0.001
Glycosylated Hb% (n = 331)	7.8 (1.6)	5.5 (0.5)	

Data expressed as number(percentage) for categorical variables and mean (SD) for continuous variables. Diabetes refers to pre-existing diabetes- known or newly diagnosed based on A1c. New onset hyperglycemia is included in the "No diabetes" group. BMI- body mass index, SBP- systolic blood pressure, DBP- diastolic blood pressure, CKD- chronic kidney disease, CAD- coronary artery disease, ICU – intensive care unit.

Table 2
Comparison of clinical outcomes in COVID-19 patients with or without pre-existing diabetes.

Parameter	Diabetes (n = 189)	No diabetes (n = 212)	P value
% of severe cases	38 (20.1)	19 (9)	0.002
Mortality	12 (6.3)	3 (1.4)	0.015
Inhaled oxygen therapy	101 (53.4)	60 (28.3)	<0.001
ICU admission	46 (24.3)	26 (12.3)	0.002
Inotropic support	14 (7.4)	5 (2.4)	0.02
Renal replacement	7 (3.7)	0 (0)	0.005
Glucocorticoid therapy	148 (78.3)	115 (54.2)	<0.001
Convalescent plasma therapy	59 (31.2)	39 (18.4)	0.004
Hospital stay	10.4 (5.9)	9.1 (5.4)	0.016

Data presented as number (percentage).

Table 3
Comparison of inflammatory markers in COVID 19 patients with or without pre-existing diabetes[a].

Parameter (reporting units)	Normal range	n	Diabetes (n = 189)	No diabetes (n = 210)	P value
CRP (mg/L)	0–5	385	59.3 (4.7)	28.7 (3.2)	<0.001
IL-6 (pg/mL)	0–7	339	65.6 (11.7)	26.9 (4.4)	0.002
D-Dimer (ng/mL)	0–243	396	392.5 (54.9)	388.6 (109.8)	0.976
Ferritin (ng/mL)	23.9–336.2	383	404.8 (41.6)	258.7 (40.2)	0.012
LDH (IU/L)	<248	365	321.8 (10.1)	286.8 (8.4)	0.008
Procalcitonin (ng/mL)	<0.5	345	1.1 (0.8)	0.2 (0.1)	0.251

[a] Data presented as mean (SE_{mean}).

Table 4
Outcomes of COVID-19 patients based on glycaemic status.

Outcome	No diabetes/hyperglycemia	Hyperglycemia without pre-existing diabetes	Previously unknown DM	Known DM	p value
	n = 191	n = 21	n = 37	n = 152	
Severe cases	10 (5.2)	9 (42.9)	9 (24.3)	29 (19.1)	<0.001
Mortality	1 (0.5)	2 (9.5)	0 (0)	12 (7.9)	
Inhaled Oxygen therapy	46 (24.1)	14 (66.7)	20 (54.1)	81 (53.3)	
ICU admission	16 (8.4)	10 (47.6)	9 (24.3)	37 (24.3)	

Data presented as number (percentage).

Table 5
Comparison of outcomes in COVID-19 patients with pre-existing diabetes alone versus those with diabetes and hypertension.

Parameter	Diabetes (n = 78)	Diabetes with hypertension (n = 111)	P value
Age	52.7 (12.4)	62.7 (10.9)	<0.001
Males	62 (79.5)	79 (71.2)	0.236
BMI (n = 70)	28.4 (4.2)	28.6 (4.8)	0.883
SBP	132.5 (13.3)	132.5 (14.7)	0.996
DBP	79.3 (10.3)	79.1 (9.0)	0.911
Baseline severity score	3.5 (0.7)	3.4 (0.6)	0.357
CKD	0 (0)	10 (9)	0.006
CAD	7 (9)	19 (17.1)	0.135
Glycosylated Hb (n = 109)	7.9 (1.7)	7.7 (1.6)	0.308
Mortality	1 (1.3)	11 (9.9)	0.016
% of severe cases	16 (20.5)	22 (19.8)	1.000
Inhaled oxygen therapy	38 (48.7)	63 (56.8)	0.302
ICU admission	17 (21.8)	29 (26.1)	0.606
Inotropic support	3 (3.8)	11 (9.9)	0.160
Mortality	12 (6.3)	3 (1.4)	0.015
Renal replacement	0 (0)	7 (6.3)	0.043

Data presented as number (percentage) and mean (SD).

systolic and diastolic BP, HbA1c and severity scores were not different in the two groups. The group with both comorbidities had significantly higher mortality (n = 11) compared to those with diabetes alone (n = 1). The requirement of RRT was higher with co-existence of diabetes and hypertension. There was no difference in the proportion of severe cases, need for oxygen administration, ICU admission or the levels of the inflammatory markers in the two groups.

3.7. Impact of other comorbidities on outcomes in COVID-19

Hypertension was present in 40.9% patients. Higher proportions of individuals with hypertension as compared to those without had severe disease (18.9% vs. 11%, p-0.029), required ICU admission (24.4% vs. 13.5%,p-0.008), oxygen administration (53.7% vs. 30.8%, p<.001), renal replacement therapy(4.3% vs. 0%; p-.002), and inotropic support (8.5% vs. 2.1%,p-0.004). 13/15 who died had

hypertension.

There was no significant difference in the occurrence of severe disease(17.1% vs. 13.9%), ICU admission(25.7% vs. 17.2%), renal replacement therapy(0% vs 1.9%), oxygen administration(57.1% vs. 38.5%) or mortality (8.6% vs. 3.3%) among those with underlying CAD. However a significantly higher proportion of these patients required inotropic support as compared to those without CAD(14.3% vs. 3.8%, p-0.018).

A significantly higher proportion of those with CKD in contrast to those without CKD had severe disease (41.7% vs. 13.4%, p-0.018), ICU admission (50% vs 17%, p-0.010), oxygen administration (83.3% vs. 38.8%, p-0.004) and renal replacement therapy (33.3% vs. 0.8%, $p < 0.001$). There was no significant difference in the mortality (16.7% vs. 3.3%) or need for inotropic support (16.7% vs. 4.4%) in these two groups.

4. Discussion

India has the second-largest number of PWD in the world [9], with an overall prevalence of 7.3% [10]. The overall prevalence in Delhi was reported to be 13.1% in the ICMR -INDIAB study [10]. The take-off point in the prevalence of diabetes in Delhi was in the age group 34–44 years, reaching more than 25% in urban Delhi beyond the age of 50. A recent community study has described the prevalence of diabetes in urban East Delhi to be 18.3%, (known 10.8% and newly detected 7.5%) [16].

Our data shows that in a high diabetes prevalence population, almost half (47.1%) of COVID-19 cases requiring hospitalization had pre-existing (known or newly detected) diabetes. This is much higher than the prevalence of diabetes in the general population and provides indirect evidence that PWD are more prone to contract COVID-19 that requires hospitalization. This high prevalence could, however, be due to the sensitization of the general public and physicians through the general guidelines by the governmental agencies, media, and scientific reports regarding the possible role of diabetes as a risk factor for severe COVID-19. This could have lead to the hospitalization of a greater number of PWD diagnosed with COVID-19. However, higher severity scores and similar symptom duration at admission points to the likelihood of more symptomatic and severe disease in PWD necessitating hospitalization rather than admission bias.

The prevalence of diabetes in COVID-19 has been reported by several authors, although there are wide variations, possibly related to the selection of the patient population and the geographical region studied. Pooled data from 10 Chinese studies showed an 11% prevalence of diabetes [17]. In a meta-analysis of 8 trials that included 46,248 COVID-19 patients, Yang et al. reported an 8% prevalence of diabetes [18], while in another large Chinese study that included 20,982 COVID-19 patients the diabetes prevalence was reported to be 5% [19]. In studies from the CDC, United States, the prevalence was 11% from data of 7162 patients [20]. A recent meta-analysis, based on a total of 23007 patients from 43 studies found the pooled prevalence of diabetes in patients with COVID-19 to be 15% [21].

Despite the wide variability in different studies, data from hospitalized patients with COVID-19 has generally revealed a higher diabetes prevalence than that in the local population. This could be reflective of differences in guidelines for hospitalization in different locations and at different periods of the pandemic in addition to intrinsic ethnic and racial differences in populations included. A meta-analysis of observational studies that included 83 studies with 78,874 patients reported pooled prevalence of established diabetes to be 14.3% [22]. There was a significant difference in prevalence among non-Asian and Asian (predominantly China) countries (23.34% [95% CI 16.40–30.28] vs. 11.06% [95% CI 9.73–12.39]) [22]. The prevalence of diabetes among hospitalized COVID-19 patients was also influenced by age and was significantly greater in those over 60 years of age (23.30% vs. 8.79%). [22]. In a study of 6650 hospitalized COVID patients from 38 units in Italy, 1264 (19%) had diabetes [23].

Two studies from Jaipur, Rajasthan, India done in the early days of the pandemic reported a much lower prevalence of diabetes than our study. In a study in 522 patients diabetes was present in 5.5% [12]. In the second study, 4.7% diabetes prevalence was noted amongst 234 young adults hospitalized for mild COVID-19[24]. Like Jaipur, Indore in Central India was also hit early by the pandemic. Data on hospitalized patients from a COVID referral center in Indore showed a 25.18% prevalence of diabetes, more in line with our observations [13].

Our study shows a higher prevalence of pre-existing diabetes than previously reported from across the world. This could be related to the overall higher prevalence of diabetes in the Delhi region. Importantly 37(9.2%) had preexisting diabetes which had not been diagnosed previously. Such a high proportion being diagnosed for the first time underscores the need for regular screening programs in high prevalence populations.

Overall, 91% of those without diabetes and 79.9% of those with diabetes were classified as mild based on the WHO ordinal scale. (The WHO ordinal scale does not have a moderate disease category). However, people with pre-existing diabetes had poorer outcomes as compared to those without diabetes. The proportion of severely affected patients was more than double, and the mortality was about 4 times greater in the diabetes group. Notably 11/12 patients with diabetes who died also had concurrent hypertension. A significantly higher proportion of the diabetes group required ICU admissions, glucocorticoid therapy, oxygen administration, inotropic support, and renal replacement therapy and had longer hospital stay. This trend broadly agrees with previous observations and meta-analyses, although figures vary considerably between studies. In a report of 44,672 patients of COVID-19, the Chinese Center for Disease Control and Prevention reported a CFR of 2.3%. However, the CFR was as high as 10.5% in patients with CVD, 7.3% in diabetes, and 6.0% in hypertension [25], which translates into a greater than 3-fold increased mortality in diabetes.

A study on 1122 patients hospitalized with COVID-19 from 88 centers across the USA found diabetes to be associated with a more than fourfold increase in mortality, similar to that found in the present study [27]. Among 570 patients who died or were discharged, the mortality rate was 28.8% in 184 diabetes and/or uncontrolled hyperglycemia patients, compared with 6.2% of 386 patients without diabetes or hyperglycemia [27]. In a study of 6650 patients in Italy, the mortality rate in COVID patients with or without diabetes were 20.5% and 14%, respectively [23].

In the present study, markers of inflammation and severity were also more profoundly impacted in the preexisting diabetes group and could contribute to poor outcomes.

One study on COVID19 patients reported higher levels of C-reactive protein, serum ferritin, and IL-6, and a higher erythrocyte sedimentation rate, in PWD compared to those without diabetes [29]. In a Chinese COVID19 patient population of diabetes, a higher incidence of lymphopenia elevated CRP, and procalcitonin was seen in the diabetes group [30].

When we analyzed our data based on COVID19 severity, diabetes was significantly more prevalent in those with severe disease- 44.2% of those with mild disease and 66.7% of those with severe disease had diabetes. 63.4% of those who required oxygen and 63.9% of those needing ICU care had diabetes. Among those who died, a very high proportion –80% (12/15) -had diabetes. In data from Italy, 31% of those who died had diabetes [28].

Comorbidities were expectedly more prevalent in the diabetes

group and could have been significant contributors to the adverse outcomes seen, as indicated by the finding of higher mortality in patients with concurrent hypertension. There were more males in the diabetes group. PWD were older, had a greater prevalence of hypertension, CAD, CKD, all of which are known to impact outcomes significantly. BMI data were available for 133 patients and expectedly showed a higher BMI in PWD. In multivariate analysis, diabetes was not independently associated with severe COVID-19 infection or mortality. This suggests that poorer outcomes in patients with diabetes could be a result of a combination of several risk factors, as is also indicated from the finding that 11/12 patients from the diabetes group who died had concomitant hypertension. A study from France included 433 COVID patients of which 115 (26.6%) had diabetes. Multivariate analyses showed that diabetes was not associated with mortality but was associated with ICU admission and a longer length of hospital stay [26].

New-onset hyperglycemia (defined as requiring insulin treatment) was seen in 21 patients, 19 of whom received glucocorticoids. Two young patients (ages 31, 40) who had HbA1c in the prediabetic zone at admission developed hyperglycemia despite no glucocorticoid administration. New-onset hyperglycemia has been reported in COVID-19[6]. The future course and follow-up will enable the distinction between "stress" hyperglycemia or true 'new-onset" diabetes. The intriguing possibility of SARS-CoV-2 directly causing diabetes has been suggested by some workers [31].

Our finding of a high prevalence of hypertension and its correlation with numerous adverse outcomes (Table 5), is in agreement with published literature [1,2]. Of the 15 people who died, 12 had diabetes and 13 had hypertension. Advanced age, male gender and worse baseline severity scores were independently associated with the occurrence of more severe COVID-19 infection. Other factors like the presence of diabetes, hypertension, CKD and inflammatory markers were significantly associated with severity. However the significance disappeared when all factors were considered together.

4.1. Limitations

Our study has some limitations in addition to the limitations of an observational study. In hospital blood glucose monitoring data were not available and thus the impact of glycemic control could not be assessed. HbA1c values were not available for about 70 patients, although all of these had blood glucose values available. Obesity has been shown to play important role in COVID-19 outcomes but in our study, BMI was available only for a limited number of patients.

5. Summary and conclusions

In summary, our study shows a higher prevalence of diabetes in hospitalized COVID-19 patients than previously reported. This indirectly suggests that PWD may be more prone to serious forms of COVID, requiring hospitalization. It also shows that hospitalized patients with diabetes are more prone to severe disease and have poorer outcomes including increased mortality. Our data re-emphasize the importance of treating the SARS-CoV-2 pandemic as a "syndemic" [32]. Unless serious efforts are taken to combat the epidemic of non-communicable diseases (NCD) which threatens to overwhelm countries like India, the battle to reduce the adverse outcomes of the COVID-19 pandemic will be incomplete. The pandemic offers us a unique opportunity to reboot chronic care/NCD programs. The immediate impact and the concern generated by the pandemic may facilitate behaviour change in the population and should spur authorities to boost care for NCDs.

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