Al Ameen J Med Sci 2023;16(4):350-357 ● US National Library of Medicine enlisted journal ● ISSN 0974-1143

ORIGINAL ARTICLE CODEN: AAJMBG

Effects of pre-existing type-2 diabetes mellitus on COVID-19 disease outcomes: A retrospective study at a tertiary care hospital in central Karnataka

Basavaraj V. Savadi[1], Shrish Patil[2], Deepak Kadeli[3] and B.M. Rashmi[4*]

[1]Department of Biochemistry, Basaveshwara Medical College and Hospital, S.J.M Campus, N.H.4 (48) Bypass Road, Chitradurga-577502, Karnataka, India, [2]Department of Anatomy, Basaveshwara Medical College and Hospital, S.J.M Campus, N.H.4 (48) Bypass Road, Chitradurga-577502, Karnataka, India, [3]Department of General Medicine, Al Ameen Medical College and Hospital, Athani Road, Vijayapur-586108, Karnataka, India and [4]Department of Community Medicine, Basaveshwara Medical College and Hospital, S.J.M Campus, N.H.4 (48) Bypass Road, Chitradurga-577502, Karnataka, India

Received: 30th March 2023; ***Accepted:*** 10th July 2023; ***Published:*** 01st October 2023

Abstract: *Background:* COVID-19 disease has posed unprecedented challenges to patients and healthcare systems worldwide. Diabetes increases risk of hospitalization, admission to ICU and mortality from COVID-19. Present study was conducted to understand impact of diabetes mellitus on mortality and other clinical outcomes of COVID-19. *Methods:* It was a retrospective study based on review of medical records of COVID-19 patients aged ≥18 years treated on in-patient basis at a tertiary hospital. Patients' COVID disease severity and in-hospital outcomes, pre-existing comorbidities, course of disease during hospital stay, baseline glycaemic levels, laboratory findings and treatment provided at the hospital were noted. *Results:* Prevalence of DM was 26.8%. Severe COVID disease and mortality were significantly associated with DM. Systemic corticosteroids (92.7%), low molecular weight heparin (90.6%) and antiviral drug remdesevir (67.3%) were mainstay of treatment. d-dimer, CRP, LDH and Ferritin (Q2: 483ng/ml, 6.0mg/dl, 574.9U/L and 780.2 ng/ml respectively) were significantly elevated in diabetic COVID patients. Higher risk of severe COVID disease was found among patients with poor glycaemic control. *Conclusion:* Impaired glucose regulation in COVID-19 patients increases risk of mortality and morbidity in COVID-19. COVID patients with diabetes mellitus should be managed meticulously as per the standard guidelines to achieve good glycaemic control.

Keywords: Diabetes mellitus, Severe COVID-19 Disease, Mortality, HbA1c, Fasting Blood Sugar Levels.

Introduction

The coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus was declared by WHO as pandemic on 11th March 2020. This respiratory illness has affected millions of people worldwide with mortality rates ranging from 3.5% to 61%. The disease has posed unprecedented challenges and threats to patients and healthcare systems [1-4].

A significant determinant of mortality in COVID-19 is the presence of pre-existing comorbidities. Among various comorbidities, diabetes mellitus (DM) has emerged as critical risk factor for severe disease and mortality in COVID-19. Diabetes along with hypertension were major risk factors for COVID-19 deaths (48%) [2-6]. It is also known that diabetes increases the risk of hospitalization, admission to intensive care unit, and mortality from SARS-CoV2.7, 8 Globally there are around 537 million diabetic patients. India, termed as 'Diabetes Capital of the World' with around 77 million people suffering from diabetes (type 2) and nearly 25 million pre-diabetic population [7].

From 11th March 2020 to 2023, India has witnessed more than 40 million COVID-19 cases, 3.5million (8.5%) hospitalizations and 2.9 lakh (0.7%) COVID related deaths [3]. Scientific literature shows there is up-to three-

fold diabetes increase in the risk ICU admissions and fatal outcomes among COVID-19 patients compared to non-diabetic COVID patients [8].

Multiple pathophysiological mechanisms are implicated for increased association with COVID-19 severity in diabetes mellitus. Chronic hyperglycaemia compromises human immune system. In diabetics, there is greater expression of ACE2 in lungs, that increases susceptibility to viral entry & replication. Dysregulation of renin-angiotensin- aldosterone system in diabetes modulates COVID disease course and proinflammatory state characterized by inappropriate cytokine response [3, 8-9].

Thus, it is crucial to know the relationship between diabetes and severity of COVID 19 which can guide to form effective precautionary measures while handling COVID and COVID like illness in future. With the looming possibility of resurgence of COVID pandemic in future, we conducted the present study to understand the impact of diabetes mellitus on mortality and other clinical outcomes of COVID-19 infection at a tertiary care hospital located in central region of Karnataka.

Material and Methods

A retrospective study was conducted based upon the review of in-patient medical records of all COVID-19 diagnosed cases treated at Basaveshwara Medical College & Hospital, Chitradurga, Karnataka. Prior institutional ethics committee clearance was obtained for the intended study. The study included all the diagnosed cases of COVID-19 treated on In-Patient (IP) basis between 1st March 2021 and December 2022 at Basaveshwara Medical College & Hospital, Chitradurga district located in Central Karnataka.

Inclusion criteria consisted of COVID-19 patients aged ≥18 years who were diagnosed as per the Government of India guidelines, whose medical records had documented data of both clinical and laboratory parameters on the day of their admission. Exclusion criteria consisted of those patients who got discharged against medical advice and those referred to higher centres.

In-Patient (IP) medical records of such patients who fulfilled above mentioned study eligibility criteria were reviewed. The baseline clinical and laboratory parameters were extracted from these case records, in a pre-designed semi-structured proforma. Information included sociodemographic characteristics, baseline clinical features as well as laboratory and radiological findings. Details regarding patients' medical history, pre-existing comorbid conditions, clinical course during the hospital stay like intensive care unit (ICU)treatment, COVID-19 disease outcomes (cured or worsened) during the course of treatment including information about in-hospital deaths were noted.

Patients' clinical severity grade classification (mild, moderate or severe grade disease) was done according to guidelines by the Ministry of Health & Family Welfare, Government of India, given in the 'Clinical guidance for management of adult COVID-19 patients' [10].

a. *Mild disease:* Upper respiratory tract symptoms and/or fever without shortness of breath or hypoxia with SpO2: ≥93%;
b. *Moderate disease* included any one of the following:
    1. Respiratory rate >24/min, breathlessness
    2. SpO2: 90% to ≤ 93% on room air;
c. *Severe disease* included any one of the following:
    1. Respiratory rate >30/min, breathlessness
    2. SpO2 < 90% on room air [10].

Patients were categorized as per their diabetic status as diabetic and non-diabetic COVID patients. Assessment of risk of developing severe grade COVID disease and in-hospital mortality among these 2 patient groups was done.

Statistical Analysis: Data was compiled in Microsoft excel worksheet and analysed using SPSS software v:16 (Statistical Package for the Social Sciences version 16, SPSS Inc., SPSS for Windows, Chicago, USA). All characteristics were summarized descriptively. For continuous variables, summary statistics of N, mean, standard deviation about the arithmetic mean were used and Categorical data were represented as frequency and

percentages. To test significance of associations, chi-square tests (for categorical data), independent student t' test (for continuous independent variables with parametric distribution), Mann Whitney U test (for continuous variables with non-parametric distribution) were applied. Those associations with p-value of <0.05 were considered to be statistically significant at 95% confidence interval.

Results

A total of 358 COVID-19 patients who fulfilled the study criteria were included in this study. Among the study population, 26.8% patients had diabetes mellitus. (Table 1 and figure 1) and 18.2% had hypertension (HTN). (Table 1) Average age of patients was 50.7 ± 15.6 years and majority were males (64.2%). The average duration of hospital stay was 7.9 ±4.8 days.

The average age, duration of hospital stay, CT severity scores were significantly higher among diabetic COVID patients (59.5 ± 12.2years, 9.6 ± 4.3 days, 17.2 ±3.3 respectively) compared to non-diabetic COVID patients (47.5 ± 15.5years, 7.34 ±4.8 days and 13.8±6.6 respectively. The proportion of comorbidities such as hypertension and cardiovascular disease (43.8% and 5.2% respectively) were also significantly higher among diabetic group compared to non-diabetic group (8.8% and 1.5% respectively). The average saturation levels among diabetic COVID patients (83.0±12.1%) were significantly lower compared to non-diabetic COVID group (87.4±7.3%) (Table 1).

Fig-1: Prevalence of Diabetes Mellitus among COVID-19 patients

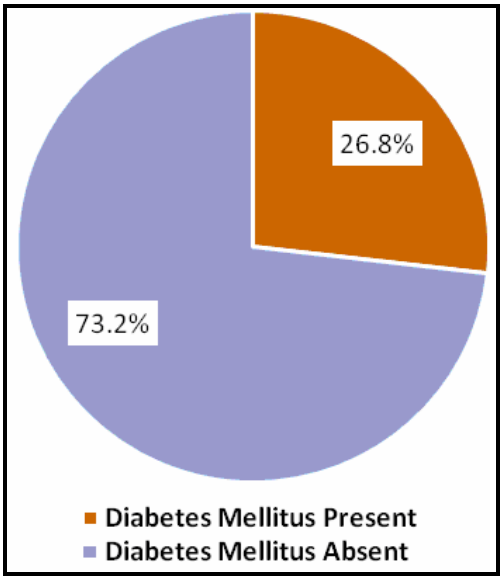


Table-1: The distribution of socio-demographic and baseline clinical parameters among diabetic and non-diabetic COVID patients

Characteristics	Non-Diabetic COVID-19 group	Diabetic COVID-19 group	Total	p-value
Age (in years) (Mean ± SD)	47.5 ± 15.5	59.5 ± 12.2	50.7 ± 15.6	0.0001
Sex				
Males n (%)	166 (63.4%)	64 (66.7%)	230 (64.2%)	0.563
Females n (%)	96 (36.6%)	32 (33.3%)	128 (35.8%)	
Duration of hospital stay (in days) (Mean ± SD)	7.34 ±4.8	9.6 ± 4.3	7.9 ±4.8	0.001
CT severity score (Mean ± SD)	13.8±6.6	17.2 ±3.3	14.9±5.89	0.001
CORAD score (Mean ± SD)	4.78±0.8	4.85 ± 0.5	4.8±0.7	0.499
SPO2 (%)	87.4±7.3	83.0±12.1	86.3±9.1	0.001
Hypertension n (%)	23 (8.8%)	42 (43.8%)	65 (18.2%)	0.001
Cardiovascular disease n (%)	4 (1.5%)	5 (5.2%)	9 (2.5%)	0.049
Asthma / COPD	05 (%)	1(1.0%)	06(1.7%)	0.571
Hypothyroidism n (%)	5 (1.9%)	3 (3.1%)	8 (2.2%)	0.490
Total	262 (100.0%)	96 (100.0%)	358 (100.0%)	

Fig-2a: Association of Diabetes mellitus with COVID disease severity

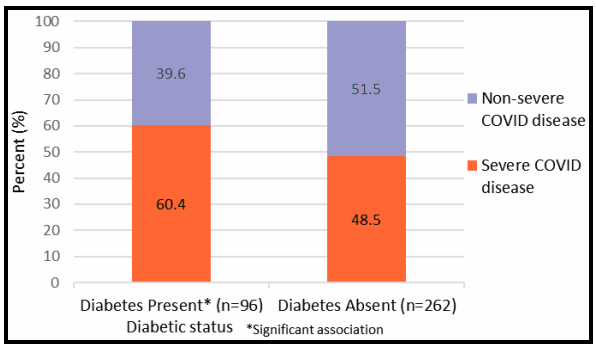
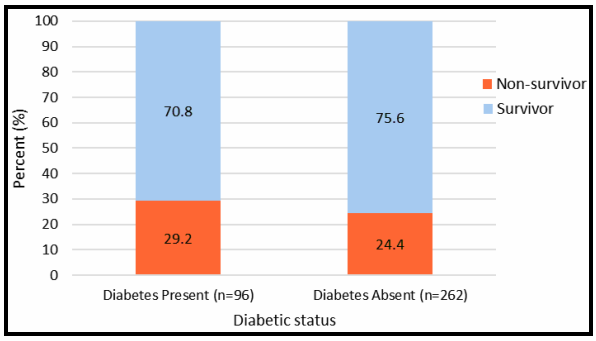


Fig-2b: Association of Diabetes mellitus with COVID disease mortality



Association of Diabetes mellitus with COVID disease severity and in-hospital mortality were assessed as described in figures 2a and 2b. It was found that majority of diabetic patients had severe COVID disease (60.4%) compared to non-diabetic patients (48.5%) and this association was found to be statistically significant. Also, a higher percentage of diabetic COVID patients had in-hospital mortality (29.2%) compared to non-diabetic COVID patients (24.4%). Whereas, this association was not found to be statistically significant.

The study hospital followed the standard treatment methods as per the clinical guidelines for management of adult COVID-19 patients' by AIIMS/ ICMR-COVID-19 National Task Force/ Joint Monitoring Group (Dte. GHS), Ministry of Health & Family Welfare, Government of India [10].

The table 2 shows the differences in the various medical line of treatments administered by physicians among diabetic and non-diabetic COVID patients. It was found that, majority of times, the clinical condition of COVID-19 patients with diabetes had warranted for treatment with steroids (92.7%), low molecular weight heparin (90.6%). These associations were found to be statistically significant. (Table 2)

Table-2: The distribution of treatment modalities among the diabetic and non-diabetic COVID patients

Treatment provided	Non-Diabetic group n (%)	Diabetic group n (%)	Total n (%)	p-value
Steroids	223 (85.1%)	89 (92.7%)	312 (86.2%)	0.057
LMW Hep	208 (79.4%)	87 (90.6%)	295 (82.4%)	0.013
Remdesevir given	170 (64.9%)	71 (74.0%)	241 (67.3%)	0.105
NRBM / BiPAP	81 (30.9%)	34 (35.4%)	115 (31.7%)	0.419
Total	262 (100.0%)	96 (100.0%)	358 (100.0%)	

*LMW: Low Molecular Weight Heparin; BiPAP: Bilevel Positive Airway Pressure; NRBM: Non-rebreather mask

The table 3 enumerates the distribution of average levels of inflammatory marker and haematological parameters among diabetic and non-diabetic COVID-19 study groups. Among diabetic COVID group, the median levels of D-dimer (Q2: 483.0ng/ml IQR:282.0,908.0), C-reactive protein (Q2: 6mg/dl IQR:2,9) were significantly higher compared to that of non-diabetic group respectively (d-dimer:277.0ng/ml IQR 191.0; CRP: 5mg/dl IQR 2,7). Median levels of LDH were significantly lower among Diabetic COVID group (Q2: 574.9 U/L, IQR: 366.6, 590.1) compared to that among Non-diabetic COVID group (Q2: 584.2U/L IQR: 366.2, 595.6).

Among haematological parameters, the median levels of absolute lymphocyte counts were significantly reduced among diabetic COVID group (Q2: 923 cells/cu.mm IQR:

671,1400) compared to non-diabetic COVID group (1100 cells/cu.mm IQR: 758,1677). The median levels of platelet: lymphocyte ratio (PLR) was significantly higher among diabetic COVID group (Q2: 207.2 IQR: 128.9,384.3) compared to non-diabetic COVID group (Q2:184.7 IQR: 114.7,290.8). Although median level of Neutrophil: Lymphocyte ratio (NLR) among diabetic group (6.1 IQR: 3.5,8.8) was higher compared to non-diabetic group, this association was not found to be statistically significant (5.6 IQR: 3.1,8.6) (Table 3).

Table-3: The distribution of biochemical and haematological parameters among diabetic and non-diabetic COVID patients

Laboratory Parameters	Non-Diabetic group Median (Q1,Q3)	Diabetic group Median (Q1,Q3)	Total Median (Q1,Q3)	p-value
D-dimer (ng/ml)	277.0 (191.0,605.8)	483.0 (282.0,908.0)	324.5 (200.0,674.0)	0.001
CRP (mg/dl)	5 (2, 7)	6 (2,9)	5.0 (2.0,8.0)	0.057
LDH (U/L)	584.2 (366.2, 595.6)	574.9 (366.6, 590.1)	579.9 (368.2,594.9)	0.032
Ferritin (ng/ml)	784.9 (736.0, 853.4)	780.2 (615.0, 847.9)	783.9 (713.0,853.6)	0.214
Haemoglobin (g/dl)	13.7 ± 2.1	13.4 ±2.3	13.6±2.2	0.299
WBC (cells/cu.mm)	8270 (5900,11010)	7690 (5777.5, 11097)	8215.0 (5892.5,11015.0)	0.598
Absolute neutrophil count (cells/cu.mm)	6220.0 (4216.5,9029.5)	6085.5 (4431.8,8290.3)	6142.5 (4285.5,8985.5)	0.943
Absolute lymphocyte count (cells/cu.mm)	1100 (758.5,1677.8)	923 (671.3,1400.5)	1052.5 (731.5,1619.5)	0.048
Absolute platelet count (lakhs/cu.mm)	2.16 (1.60,2.89)	2.15(1.67,2.93)	2.145 (1.6,2.89)	0.925
N:L Ratio	5.6 (3.1,8.6)	6.1 (3.5,8.8)	5.8 (3.17,8.69)	0.228
P:L Ratio	184.7 (114.7,290.8)	207.2 (128.9, 384.3)	193.6 (116.8,311.5)	0.047

The line diagram of Figure 3 depicts the distribution of severe COVID-19 according to fasting blood sugar level ranges as recorded at the time of admission of the study patients. It is evident that, highest proportion of severe COVID disease were among those diabetic patients with FBS levels of >140mg/dl (76.3%). The 2nd highest proportion of severe COVID disease is noted among those diabetics with FBS of less than 105mg/dl (68.2%). Lowest percentage of severe COVID disease (23.1%) were found among diabetic patients with FBS 105-127mg/dl.

Fig-3: Distribution of severe COVID disease according to Fasting Blood Sugar Levels

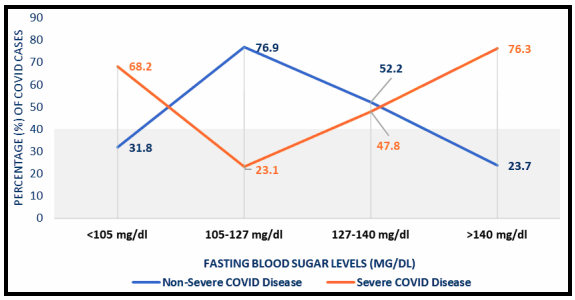


Table 4 enumerates association of HbA1c with the COVID disease severity. 35.7% of patients with baseline HbA1c levels of 7-8% had severe COVID disease. 62.1% of patients with 8-9% HbA1c levels had severe COVID disease and 76.9% of patients with more than 9% HbA1c levels had severe COVID disease.

Table-4: Association of HbA1c with the COVID clinical severity

HbA1c (%)	Non-severe group n (%)	Severe group n (%)	Total N (%)
7-8	18 (64.3%)	10 (35.7%)	28 (100.0%)
8-9	11 (37.9%)	18 (62.1%)	29 (100.0%)
>9	09 (23.1%)	30 (76.9%)	39 (100.0%)
Total	38 (39.6%)	58 (60.4%)	96 (100.0%)

The association of fasting blood sugar levels and HbA1c levels with severe COVID disease

were analysed among diabetic COVID patients (N=96). It was found that, diabetic patients who had baseline FBS levels of <105mg/dl had 7.1 times higher risk of developing severe COVID disease and diabetic patients who had baseline FBS levels of >140 mg/dl had 10.7 times higher risk of developing severe COVID disease. Diabetic patients with HbA1c levels of 8-9% had 2.9 times higher risk of severe COVID disease and patients with baseline HbA1c value of >9% were having 6 times more risk of severe COVID disease. All these associations were found to be statistically significant (Table 5).

Table-5: The association of fasting blood sugar and HBb1c levels with severe COVID disease among diabetics (n = 96)

Independent variable	Odd's Ratio	p-value	95% C.I. for OR
Fasting Blood Sugar Levels			
105-127 mg/dl	1 (Reference Category)		
<105 mg/dl	7.143	0.014	1.484-34.384
127-140 mg/dl	3.056	0.152	0.663-14.079
>140 mg/dl	10.741	0.002	2.418-47.719
HbA1c Levels (%)			
7-8%	1 (Reference Category)		
8-9%	2.945	0.049	1.003-8.649
>9%	6.010	0.001	2.051-17.554

Discussion

The present study has showed an overall prevalence of 26.8% diabetes mellitus among COVID-19 patients who were treated on in-patient basis at tertiary care hospital situated in the central region of Karnataka. (Table 1 and Fig 1). Also, severe COVID disease and mortality were significantly associated with diabetes mellitus. (Fig: 2) Hyperglycaemia is an independent risk factor for severe COVID-19 disease and mortality as shown by many of the previous studies [11-13].

Increased blood glucose directly enhances replication of SARS-CoV-2 and glycolysis sustains replication of SARS-CoV-2 through the generation of ROS in mitochondria and hypoxia-inducible factor 1α activation. DM is responsible for slow destruction of the patient's immune response. This DM-induced destruction of the immune response has potential to enhance dysregulation of immune modulators. Immunological dysregulation is considered a risk factor for COVID disease severity [11-13].

Systemic corticosteroids (92.7%), low molecular weight heparin (90.6%) and antiviral drug remdesevir (67.3%) were mainstay of treatment among COVID-19 patients with DM. (Table 2) Glucotoxicity, endothelial damage by inflammation, oxidative stress and cytokine production lead to high risk of thromboembolic complications and injury to vital organs in diabetes patients. Further, drugs used for treatment of COVID-19 disease such as systemic corticosteroids or antiviral agents also contribute to worsening hyperglycaemia [12, 14].

The present study found that inflammatory markers levels like d-dimer, CRP, LDH and Ferritin (Q2: 483ng/ml, 6.0mg/dl, 574.9U/L and 780.2 ng/ml respectively) were significantly higher in diabetic COVID patients and also absolute lymphocyte counts were significantly reduced and PLR was significantly increased among diabetic COVID patients (Table 3).

Scientific literature has shown that ACE-2 receptors are present in the upper respiratory tract and lungs (type I and II alveolar epithelial cells), pancreas, heart, endothelium, renal tubular and intestinal epithelium. The entry of SARS-CoV-2 induces an inflammatory reaction with T helper cells and interferon γ are produced. This initiates an inflammatory cascade resulting in 'cytokine storm' which is directly related to the severity

of COVID-19 pneumonia and to subsequent death [13, 15-18].

Diabetic patients with poor diabetic control were found to be suffering from severe COVID disease (Table 4 and 5). Patients with fasting blood sugar levels of <105mg/dl or >140mg/dl had significantly higher odds of severe COVID disease (OR: 7.1 and 10.7 respectively) compared to patients with FBS range of 105-127mg/dl. Patients with HbA1c levels of 8-9% or>9% had significantly higher odds of severe COVID disease (OR: 2.9 and 6.0 respectively) (Table 4 and 5). These results are comparable with the studies conducted by Azar WS et al, Shauly-Aharonov M al., and Merzon E et al [12, 16-18]. Therefore, it is prudent to monitor glucose levels and to treat worsening hyperglycaemia in patients with progression to severe states of COVID-19 [12].

Conclusion

The presence of DM and related comorbidities exert a significant negative impact on the outcome of COVID-19 infected patients. Impaired glucose regulation in COVID-19 patients have increased odds for mortality and morbidity during hospitalization. This study suggests that diabetes is a significant risk factor for severe COVID disease and mortality.

It also demonstrated that, strict glycaemic control in diabetic patients can change the course of a COVID disease towards recovery in diabetic patients. Hence, the newer guidelines must be prepared for management of diabetic patients with COVID 19 infection to prevent morbidity and mortality. COVID patients with diabetes mellitus should be managed meticulously as per the standard guidelines to achieve good glycaemic control.

Acknowledgement

The authors are grateful to the Head of Institution and Management of Basaveshwara Medical College & Hospital for the valuable support in provision of medical record data of COVID-19 patients.

Financial Support and sponsorship: Nil

Conflicts of interest: There are no conflicts of interest.

References

1. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19 - 22 April 2020. (Accessed March 16, 2023). Available from *https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19--22-april-2020*
2. Singh P, Bhaskar Y, Verma P, Rana S, Goel P, Kumar S, Gouda KC, Singh H. Impact of comorbidity on patients with COVID-19 in India: A nationwide analysis. *Front Public Health.* 2023; 10:1027312.
3. Mittal N, Dhooria HP, Arora S, Kumar V, Bansal E, Singh P et al. The effect of diabetes mellitus on outcomes of patients admitted with COVID-19: A single-center experience from a tertiary hospital in India. *Indian J Endocr Metab*. 2022; 26:376-383.
4. Prashanth G, Kauser MM, Savadi B, Rashmi BM. (2022). Accuracy of Quick Covid-19 Severity Index and Brescia-Covid Respiratory Severity Scale in Predicting ICU Admission and Mortality. *Int J of Preclinical & Clinical Research.* 2022; 3(2):37-44.
5. Zhang JJ, Dong X, Cao YY, Yuan YD, Yang YB, Yan YQ et al. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. *Allergy*. 2020; 75:1730-1741.
6. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective cohort study. *Lancet*. 2020; 395:1054-1062.
7. Pradeepa R, Mohan V. Epidemiology of type 2 diabetes in India. *Indian J Ophthalmol.* 2021; 69(11):2932-2938.
8. Kumar B, Mittal M, Gopalakrishnan M, Garg MK, Misra S. Effect of plasma glucose at admission on COVID-19 mortality: Experience from a tertiary hospital. *Endocr Connect*. 2021; 10:589-598.
9. Chan JW, Ng CK, Chan YH, Mok TY, Lee S, Chu SY et al. Short term outcome and risk factors for adverse clinical outcomes in adults with severe acute respiratory syndrome (SARS). *Thorax*. 2003; 58:686-689.
10. AIIMS/ICMR-COVID-19 National Task Force/ Joint Monitoring Group (Dte. GHS) Ministry of Health and Family Welfare GOI. Clinical Guidance for Management of Adult Covid-19 Patients; 22nd April 2021. Available from: *https://healthindiatpa.com/Downloads/ClinicalGuidelinesForManagementToAdultCovidPatient.pdf*
11. Sen S, Chakraborty R, Kalita P, Pathak MP. Diabetes mellitus and COVID-19: Understanding the association in light of current evidence. *World J Clin Cases.* 2021; 9(28):8327-8339.
12. Lim S, Bae JH, Kwon HS, Nauck MA. COVID-19 and diabetes mellitus: from pathophysiology to clinical management. *Nat Rev Endocrinol.* 2021; 17(1):11-30.

13. Lin X, Xu Y, Pan X, Xu J, Ding Y, Sun X, Song X, Ren Y, Shan PF. Global, regional, and national burden and trend of diabetes in 195 countries and territories: an analysis from 1990 to 2025. *Sci Rep*. 2020; 10:14790.
14. Tang N, Li D, Wang X & Sun Z. Abnormal coagulation parameters are associated with poor prognosis in patients with novel corona virus pneumonia. *J. Thromb. Haemost.* 2020; 18: 844-847.
15. Zheng M, Wang X, Guo H, Fan Y, Song Z, Lu Z, et al. The Cytokine Profiles and Immune Response Are Increased in COVID-19 Patients with Type 2Diabetes Mellitus. *J Diabetes Res*. 2021; 2021: 9526701.
16. Azar WS, Njeim R, Fares AH, Azar NS, Azar ST, El Sayed M, Eid AA. COVID-19 and diabetes mellitus: how one pandemic worsens the other. *Rev Endocr Metab Disord.* 2020; 21:451-463.
17. Shauly-Aharonov M, Shafrir A, Paltiel O, Calderon-Margalit R, Safadi R, Bicher R, Barenholz-Goultschin O, Stokar J. Both high and low pre-infection glucose levels associated with increased risk for severe COVID-19: New insights from a population-based study. *PLoS One.* 2021; 16(7):e0254847.
18. Merzon E, Green I, Shpigelman M, Vinker S, Raz I, Golan-Cohen A et al. Haemoglobin A1c is a predictor of COVID-19 severity in patients with diabetes. *Diabetes Metab Res Rev.* 2021; 37(5):e3398.

Cite this article as: Savadi BV, Patil S, Kadeli D and Rashmi BM. Effects of pre-existing type-2 diabetes mellitus on COVID-19 disease outcomes: A retrospective study at a tertiary care hospital in central Karnataka. *Al Ameen J Med Sci* 2023; 16(4): 350-357.

*All correspondences to: Dr. Rashmi B.M. Associate Professor, Department of Community Medicine, Basaveshwara Medical College and Hospital, S.J.M Campus, N.H.4 (48) Bypass Road, Chitradurga-577502, Karnataka, India. E-mail: dr.rashmi.bgm@gmail.com