ORIGINAL ARTICLE

Impact of COVID-19-related Stress on Glycaemic Control in Hospitalized Patients with Type 2 Diabetes Mellitus

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Abstract

Background: Evaluation of the impact of stress on glycaemic control in hospitalized type-2 diabetes (T2DM) patients with coronavirus disease (COVID-19).

Methods: In this retrospective study conducted at a single centre in Maharashtra from May to July 2020 on hospitalized COVID-19 patients with T2DM who reported having stress of pandemic; they were selected using purposive sampling. DASS-12 stress sub-scale was used to estimate the severity of their stress. Fasting blood glucose (FBG) and post-prandial blood glucose (PPBG) before admission and at the time of discharge were compared.

Results: One hundred and ninety-nine patients (mean age 54 years; 61.30% females) were included. Mean±SD FBG before admission was 168.4±30.6 mg/dl which increased to 195.9±28.8 mg/dl at the time of discharge (P<0.001). Also, Mean±SD PPBG before admission was 312±62.3 mg/dl which increased to 351.6±61.9 mg/dl (P<0.001). A total of 73 (36.7%) participants had perceived stress. Moderate and severe/extremely severe stress was found in 44 (27.1%) and 19 (9.6%) patients, respectively. A significant difference was observed in the mean FBG before and during discharge in patients who had no stress and those with moderate stress (P<0.001). There was no difference in FBG in patients with severe/extremely severe stress (P=0.43). Similar observations were seen for PPBG (no stress P<0.001; moderate stress P<0.001; severe/extremely severe stress P=0.06).

Conclusion: There was a rise in the glucose level in T2DM patients discharged after COVID-19 treatment. The increase was significant in T2DM without stress and those with moderate stress. In addition to traditional treatment, measures for psychological stress control should also be taken for such patients.

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Introduction

Diabetes mellitus is a challenging and prevalent chronic metabolic disorder from psychosocial and behavioural perspective. Untreated diabetes can result in serious short-term or long-term complications resulting in significant morbidity and mortality. According to global report of International Diabetes Federation (IDF 2017), there are 463 million people with diabetes.[1] In 2019, the global prevalence of diabetes was 9.3%. It is expected to rise to 10.2% and 10.9% by 2030 and 2045, respectively.[2] Overall type 2 diabetes (T2DM) prevalence in India is 8.9%.[1] Uncontrolled T2DM can result in several acute and chronic complications. Although traditional risk factors contribute to the high risk of T2DM development, its incidence continues to increase despite strategies to control traditional risk factors.[3]

Stress contributes to many pathological conditions and hormonal imbalance; during stress, situations can adversely affect the normal glycaemic control in people with diabetes.[4] Perceived stress can contribute to the risk of T2DM development.[3] A 12- year longitudinal study on women showed three years later stress levels were associated with a higher risk of diabetes.[3] Apart from traditional stress factors, during the last year corona virus disease (COVID-19) emerged and caused a significant stress on people, families and community. Diabetes is expected to have poor outcomes after COVID-19 infection.[5] Patients with diabetes are reported to have COVID-19-specific concerns regarding their disease.[6] A cross-sectional study from South India reported unhealthy dietary habits, mental stress, and sleep disturbances during COVID-19 lockdown period. However, the same study reported no major difference in overall glycaemic control among patients with T2DM during lockdown.[7] Therefore, we aimed to study the effect of stress on T2DM patients. The objective was to evaluate the impact of stress on glycaemic control in T2DM patients hospitalized for COVID-19 treatment.

Methods

A retrospective single-centre questionnaire based on a study in Maharashtra, with patients of both gender with T2DM who received anti-diabetes medications with a history of hospitalization for the treatment of COVID-19 from May to July 2020 and those whose readings for glycaemic parameters, i.e. fasting blood glucose (FBG) level and post-prandial blood glucose (PPBG) level were available were included in the study. Type 1 diabetes patients, newly diagnosed cases of T2DM who did not receive any anti-diabetic medication, patients with T2DM with no history of hospitalization for COVID-19 treatment, and those with gestational diabetes were excluded. Demographic details [gender, age, weight, body mass index (BMI)] and duration of T2DM were noted. DASS-12 stress sub-scale was used to estimate the severity of stress.[8] There are four items in the stress sub-scale which are rated as "Never (0), Sometimes (1), Often (2), and Almost Always (3)". Based on the stress scores, the patients were classified as (0-4) normal, (5) moderate, (6) severe and (≥7) extremely severe.[8] Face validity and content validity of the questionnaire were checked with an expert.

Difference in glycaemic parameters (FBG and PPBG) before and at the time of discharge was estimated. Gender-wise and age-wise (<34 years, 35-49 years and >50 years) comparison was done for estimating the difference in the severity of stress.

The data were entered into MS-EXCEL sheet. Number and percentages are provided for categorical data whereas Mean±SD are provided for continuous data. With the use of paired t-test, the difference in glycaemic parameters before and after COVID-19-related admission was compared. Unpaired t-test was used to estimate the statistical difference in glycaemic parameters between different groups. Chi-square test was used for comparing the categorical variables among the two groups. Results were found statistically significant (P<0.05).

Results

A total of 199 patients with a Mean±SD age of 54±12.8 years were included, of whom 122 (61.30%) were female and 77 (38.7%) were male. The Mean±SD weight and BMI of patients were 78.1±14.6 kg and 30.9±7.5 kg/m^2. A total of 116 (58.3%) patients were from urban areas, whereas 83 (41.7%) were from rural areas (Table 1). A total of 114 (57.3%) patients were housewives.

Table 1: Demographics characteristics of the study participants

Parameter	Result
Mean±SD age	54±12.8 years
Age range (minimum, maximum)	30-92 years
Gender n (%)	
Male	77 (38.7%)
Female	122 (61.3%)
Mean±SD weight	78.1±14.6 kg
Range of weight	30-114 kg
Mean±SD BMI	30.9±7.5 Kg/m^2
Range of BMI	10.6-51.5 Kg/m^2
Residence n (%)	
Rural	83 (41.7%)
Urban	116 (58.3%)
Profession n (%)	
Business	7 (3.5%)
Service	10 (5.03%)
Housewife	114 (57.3%)
Other	68 (34.2%)
Mean±SD duration of diabetes	5±3.6 years
Range of duration of diabetes (minimum, maximum)	0.08-25 years

Mean±SD FBG before admission was 168.4±30.6 mg/dl which increased to 195.9±28.8 mg/dl after discharge (P<0.001). Similarly, Mean±SD PPBG before admission was 312±62.3 mg/dl which increased to 351.6±61.9 mg/dl (P<0.001), as shown in Table 2.

Overall, out of 199 participants, 54 (27.1%) patients had moderate stress. Severe or extremely severe stress was observed in 19 (9.6%) patients (Figure 1). Thus, out of 199 participants, 73 (36.7%) had perceived stress.

In the group of moderate stress, 23 out of 54 patients (42.6%) were females and 31 (57.4%) were male. In the group of patients with severe/extremely severe stress, 11 out of 19 patients (57.9%) were females and 08 (42.1%) were male. Gender-wise as well as age-wise comparison showed a significant difference in the severity of stress (P<0.05).

Comparison of glycemic parameters, weight, age, and BMI between the groups is shown in Table 3.

Table 2: Glycaemic parameters before and at the time of hospital discharge after COVID-19 treatment

	Before hospital admission	After discharge	P value
Mean±SD fasting blood glucose mg/dl	168.4±30.6	195.9±28.8	<0.001
Mean±SD post prandial blood glucose mg/dl	312±62.3	351.6±61.9	<0.001

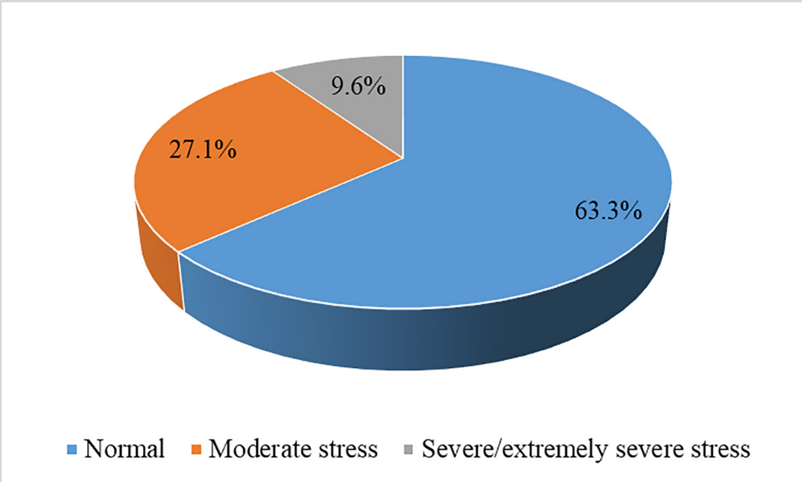

Figure 1: Distribution of patients based on the severity of stress as assessed by DASS-12 score (n=199)

Table 3: Comparison of glycemic parameters based on the severity of stress

	No stress (n=126)	Moderate stress (n=54)	Severe/Extremely severe stress (n=19)
Mean±SD age in years	52.6±13	57.3±12.5	54.2±10.6
Mean±SD weight in Kg	80±13.9	74±15.1	77.2±16.5
Mean±SD BMI in kg/m^2	32.6±7.3	27.8±6.7	28.3±7.5
Gender n (%)			
Male	38 (30.16%)	23 (42.59%)	8 (42.11%)
Female	88 (69.84%)	31 (57.41%)	11 (57.89%)
Mean±SD fasting blood glucose (mg/dl)			
Before admission	164.7±30	171.3±24.5	185±43.2
After admission	195.1±27.8	198.3±30.8	194.2±30.8
P value	<0.001	<0.001	0.43
Mean±SD post-prandial blood glucose (mg/dl)			
Before admission	309.2±62.3	315.8±59	319.7±72.8
After admission	347.3±64.7	359±52.6	358.7±68.1
P value	<0.001	<0.001	0.06

Table 4: Comparison of glycemic parameters in three groups with different levels of stress

	Without stress versus moderate stress	Moderate versus severe/ extremely severe stress	Without stress versus severe/ extremely severe stress
Fasting blood glucose before admission	0.15	0.09	0.01
Fasting blood glucose at the time of discharge	0.497	0.68	0.98
Post-prandial blood glucose before admission	0.51	0.82	0.50
Post-prandial blood glucose at the time of discharge	0.24	0.99	0.48

There was a significant difference in the mean FBG before and after admission in patients without stress and those with moderate stress. There was no significant difference in the mean FBG in patients with severe/extremely severe stress (P=0.43). Similar observations were seen for PPBG (without stress P<0.001; moderate stress P<0.001; severe/extremely severe stress P=0.06) (Table 3).

There was no difference in the FBG or PPBG in patients without stress versus moderate stress, moderate versus severe/extremely severe stress, no stress versus severe/extremely severe stress before admission or after discharge (Table 4).

In patients with stress, there was significant difference in the FBG and PPBG based on their residence, i.e. urban versus rural population (P<0.001).

Discussion

COVID-19 pandemic has impacted every individual's life, resulting in significant changes in their lifestyle. A study on 435 patients has reported increase in perceived stress among patients with diabetes.[9] In the current study, we investigated the impact of perceived stress on glycaemic control in 199 T2DM patients discharged after their COVID-19 treatment. Generally, male patients are at higher risk of complications related to COVID-19 disease as compared to female. Similarly, male predominance is observed among hospitalized diabetic patients with COVID-19.[10] However, in our study there was female predominance. Our observations are in accordance with those of Yoshida et al. who conducted a study to evaluate the gender differences in clinical presentations and outcomes in hospitalized patients for COVID-19. In their study, there were 61.4% females, and women had a significantly higher prevalence of diabetes as compared to males (38.2% vs. 31.8%).[11] We focused only on patients with diabetes.

In our study, out of 73 patients with stress, 46.6% patients were female. A study from urban slums of Bangalore reported higher prevalence of diabetes in females as compared to males.[12] In our study, the prevalence of severe stress was more common in females.

Negative effect of stress on glycaemic control in patients with diabetes is known. Direct as well as indirect effects both contribute to the glycaemic impairment in patients with diabetes. Direct effects are related to the stress hormones, and indirect ones are due to changes in the lifestyle and behaviour.[4] Chronic stress can lead to neuroendocrine changes and dysregulation of physiological systems.[13]

A study from South India reported no major change in the overall glycaemic control among patients with T2DM due to lockdown after COVID-19 pandemic.[7] We observed a significant increase in the mean FBG and PPBG in T2DM patients at the time of discharge as compared to before admission for COVID-19 treatment. Suboptimal glycaemic control during infectious diseases is known.[14] However, we analysed the data at the time of discharge from the hospital.

Depending on the duration of exposure to stressors, patients with diabetes may be exposed to acute or chronic stress. Acute stress, because of its short duration, may not affect HbA1c which indicates glucose control over several weeks.[13] Considering this, we did not focus on changes in HbA1c. However, a retrospective study from Japan reported a significant rise in HbA1c levels after the outbreak of COVID-19 as compared to before the pandemic. There have been changes in the physical and psychological health of patients during this period. Behavioural changes have been suggested to affect the level of HbA1c in these patients.[15] Although not specifically examined, stress contributing to glycaemic derangement cannot be ruled out. In the same study, when compared by age, a significant increase in HbA1c was observed in patients with age more than 65 years. Also, there was a significant increase in HbA1c in patients with BMI more than 25 kg/m^2, but not in those with lower BMI. We focused on T2DM patients hospitalized for the treatment of COVID-19, unlike outpatients in a study by Tanji et al.[15]

Faulenbach et al. evaluated the effect of acute stress on glycaemic control in 30 patients with T2DM with a mean age of 60 years. In this study, experience of stress after the meals resulted in a significant increase in the post-prandial blood glucose level.[16] Another cross-sectional study from Chennai, India, has reported a positive correlation between both FBS and PPBG levels and the stress levels.[17] Another study has reported the association of increased stress with difficulty in glycaemic control.[9]

Perceived intensity of stress can also vary between different individuals. To categorise the patients into different levels of stress, we used DASS-12 stress scale. In our study, 36.7% had stress, of whom 74% had moderate stress and 26% had severe or extremely severe stress. In our study, a significant difference was observed in the mean FBG before admission and at the time of discharge in patients with moderate stress. However, there was no significant difference in the mean FBG in patients with severe/extremely severe stress. Similar observations were seen for PPBG (moderate stress $P<0.001$; severe/extremely severe stress $P=0.06$). We could not findany study on the effects of severity of stress on glycaemic control in T2DM patients. Furthermore, deterioration in HbA1c values has been reported, in particular among women, patients aged more than 65 years, those with body mass index of more than 25 kg/m^2, and those that were not using insulin.[15] Further studies on evaluation of the effect of stress on glycaemic parameters in these subgroups are recommended.

Intergroup analysis showed no difference in the FBG or PPBG in patients without stress versus moderate stress, moderate versus severe/extremely severe stress, no stress versus severe/extremely severe stress before admission or after discharge.

Diabetes is a known risk factor for hospitalization and mortality due to infections.[18] It has also been reported as a risk factor for severity and mortality in patients with COVID-19.[19, 20] Patients with diabetes may get frustrated with experience of hyperglycemia despite the lifestyle modifications.[21] Stress may further add to the impairment of glycaemic control. Thus, it is essential to address psychological issues of vulnerable groups during the COVID-19 pandemic.[22] Considering the adverse impact on glycaemic control, patients with diabetes should be counselled effectively to control stress.

This was a retrospective study; hence, a definite cause and effect relationship between stress and glycaemic parameters cannot be ascertained. The single centre study with limited sample size is another limitation. COVID-19 may contribute to the development of hyperglycaemia.[23] Moreover, steroids used in the treatment of COVID-19 can also contribute to the hyperglycaemia. Because of lack of pharmacotherapy details in these patients, we could not conduct separate analysis of patients who received steroids versus those who did not. Larger prospective studies are recommended to be conducted to confirm our observations.

Conclusion

Overall, the study population showed a rise in fasting and postprandial glucose level in T2DM patients discharged after COVID-19 treatment. The rise was significant in T2DM without stress and those with moderate stress. Studies with larger sample size on T2DM patients with stress may be needed to provide more insights regarding the difference between those without stress and moderate to severe/extremely severe stress. In addition to traditional treatment of diabetes, measures for control of psychological stress should also be taken in patients with COVID-19.

Conflicts of interest*:* None declared.

References

1 IDF SEA members. https://idf.org/our-network/regions-members/south-eastasia/members/94-india.html assessed on 4th April 2021.

2 Saeedi P, Petersohn I, Ssalpea P, Malanda B, Karuranga S, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9 th edition. Diabetes Res Clin Pract. 2019;157:107843.

3 Harris ML, Oldmeadow C, Hure A, Luu J, Loxton D, et al. Stress increases the risk of type 2 diabetes onset in women: A 12-year longitudinal study using causal modelling. PLoS One. 2017;12: e0172126.

4 Marcovecchio ML, Chiarelli F. The effects of acute and chronic stress on diabetes control. Sci Signal. 2012;5:pt10.

5 Schofield J, Leelarathna L, Thabit H. COVID-19: Impact of and on diabetes. Diabetes Ther. 2020;11:1429-1435.

6 Joensen LE, Madsen KP, Holm L, Nielsen KA, Rod MH, et al. Diabetes and COVID-19: psychosocial consequences of the COVID-19 pandemic in people with diabetes in Denmark-what characterizes people with high levels of COVID-19-related worries?. Diabet Med. 2020;37:1146-1154.

7 Sankar P, Ahmed WN, Koshv VM, Jacob R, Sasidharan S. Effects of COVID-19 lockdown on type 2 diabetes, lifestyle and psychosocial health: A hospital-based cross-sectional survey from South India. Diabetes Metab Syndr. 2020;14:1815-1819.

8 Yusoff MSB. Psychometric Properties of the Depression Anxiety Stress Scale in a Sample of Medical Degree Applicants. Int Med J. 2013; 20: 295-300.

9 Ruissen MM, Regeer H, Landstra CP, Schroijen M, Jazet I, Nijhoff MF, et al. Increased stress, weight gain and less exercise in relation to glycemic control in people with type 1 and type 2 diabetes during the COVID-19 pandemic. BMJ Open Diab Res Care 2021;9:e002035. doi:10.1136/ bmjdrc-2020-002035

10 Kautzky-Willer A. Does diabetes mellitus mitigate the gender gap in COVID-19 mortality? European Journal of Endocrinology 2021; 185:C13–C17

11 Yoshida Y, Gillet SA, Brown MI, Zu Y, Wilson SM, Ahmed SJ, et al. Clinical characteristics and outcomes in women and men hospitalized for coronavirus disease 2019 in New Orleans. Biol Sex Differ 2021;12:20

12 Dasappa H, Fathima FN, Prabhakar R, Sarin S. Prevalence of diabetes and pre-diabetes and assessments of their risk factors in urban slums of Bangalore. J Family Med Prim Care. 2015;4:399-404.

13 Hilliard ME, Yi-Frazier JP, Hessler D, Butler AM, Anderson BJ, et al. Stress and A1c among people with diabetes across the lifespan. Curr Diab Rep. 2016;16:67.

14 Peric S, Stulnig TM. Diabetes and COVID-19. Disease—Management—People. Wien Klin Wochenschr. 2020; May 20 : 1–6.

15 Tanji Y, Sawada S, Watanabe T, Mita T, Kobayashi Y, Murakam T, et al. Impact of COVID-19 pandemic on glycemic control among outpatients with type 2 diabetes in Japan: A hospital-based survey from a country without lockdown. Diabetes research and clinical practice 2021; 176: 108840

16 Faulenbach M. Uthoff H, Schwegler K, Spinas GA, Schmid C, Wiesli P.Effect of psychological stress on glucose control in patients with Type 2 diabetes. Diabetes Med 2012;29:128-31

17 Vasanth R, Ganesh A, Shanker R. Impact of stress on type 2 diabetes mellitus management. Psychiatr Danub. 2017;27 (Suppl 3):416-421.

18 Abdi A, Jalijian M, Sarbarzeh PA, Vlaisavlievic Z. Diabetes and COVID-19: A systematic review on the current evidences. Diabetes Res Clin Pract. 2020;166:108347.

19 Singh AK, Gupta R, Ghosh A, Misra A. Diabetes in COVID-19: Prevalence, pathophysiology, prognosis and practical considerations. Diabetes Metab Syndr. 2020;14:303-310.

20 Wong H, Singh J, Go RM, Ahluwalia N, Guerrero-Go MA. The effects of mental stress on non-insulin-dependent diabetes: Determining the relationship between catecholamine and adrenergic signals from stress, anxiety, and depression on the physiological changes in the pancreatic hormone secretion. Cureus. 2019;11:e5474.

21 Salari N, Hosseinian-Far A, Jalali R, Vaisi-Raygani A, Rasoulpoor S, et al. Prevalence of stress, anxiety,

depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. Global Health. 2020;16:57.

22 Lim S, Bae JH, Kwon H-S, Nauck MA. COVID-19 and diabetes mellitus: from pathophysiology to clinical management. Nat Rev Endocrinol. 2021;17:11-30.

23 Erener S. Diabetes, infection risk and COVID-19. Mol Metab. 2020; 39: 101044.