How the COVID-19 outbreak affected patients with diabetes mellitus?

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Abstract

Background Global COVID-19 outbreak has been such a stressful experience for most of the people. Using a web-based cross-sectional study, we aimed to evaluate the acute stress response, depression, and anxiety in patients with diabetes mellitus (DM) during the COVID-19 pandemic, and to examine the effect of these psychiatric problems on diet habits and glycemic controls of patients.

Methods This web-based survey of COVID-19 was sent to the patients through the Whatsapp platform. All participants reported their demographic data, diabetes-related information, changes in self-monitoring blood glucose measurements, physical parameters, and eating habits after COVID-19, then completed Hospital Anxiety and Depression Scale (HADS) and the Impact of Event Scale, Revised (IES-R) questionnaires which assessed acute stress sypmtoms, anxiety, and depression.

Results Three hundred and four patients with DM [(141 type 1 DM (T1D) and 163 type 2 (T2D)] were included in the study. In our study, female gender, higher BMI and weight, decreased in financial income after outbreak, presence of diabetic complications and comorbid diseases (i.e., retinopathy, neuropathy, diabetic foot, hypertension, dyslipidemia), worsened glycemic levels, increased carbohydrate consumption, and snacking were associated with higher anxiety and depression scores. Depression was higher in patients with T2D and duration of illness was correlated with acute stress level.

Conclusions It is important to be aware of the possibility of acute stress, depression, and anxiety after pandemic in patients with DM whose glycemic control is impaired. Psychological problems should not be ignored beyond physical inactivity and worsening eating habits.

Keywords Diabetes mellitus · COVID-19 · Pandemic · Anxiety · Depression

Introduction

The World Health Organization (WHO) declared the new Coronavirus Disease 2019 (COVID-19) outbreak as an International Public Health Emergency of International Concern on January 2020 and as a pandemic on March 2020. The pandemic has disrupted the lives of people across the world by its rapid spread and high mortality. Information about the physical effects of the COVID-19 on organs and systems has been increased overtime [1]. Yet, the contagiousness of the disease and the high mortality rates, combined with mass hysteria, economic burden, and financial losses, caused mass fear, which was called "coronaphobia" [2].

Diabetes mellitus (DM) is a chronic, progressive disease considered the largest global health problem of the twenty-first century, according to the International Diabetes Federation [3]. Patients with DM need to perform daily self-care, develop new eating habits, and adopt specific behaviors to properly manage the disease. All these changes and being aware of problems related to the disease can be stressful for diabetics. [4].

Diabetes mellitus is associated with many neuropsychiatric diseases, especially depression. It is known that the frequency of depression is 2–3 times higher in diabetic patients than in the general population. However, depression is

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considered one of the most overlooked symptoms in diabetics [5–7]. Severity of depressive attacks in diabetic patients is associated with decreased quality of life, increased diabetic comorbidities, and impaired glycemic control [8]. Anxiety prevalence is also higher in people with DM [9]. Apart from depression, the emotional response seen in diabetic patients and also defined as "diabetic distress" contributes to the worsening of diabetes in the event of a perceived lack of support from family and healthcare professionals [10]. Diabetic symptoms, complications, increased disease burden, inadequate self-care, disability, and decreased quality of life are observed more in patients with comorbid depression and/or anxiety [11, 12]. Stress is a major risk factor for diabetic patients which worsens glycemic control and thus results in more symptoms and complications [13, 14].

Table 1 Sociodemographic and clinical characteristics of the patients with diabetes included to the study

	Type 1 diabetes (n=141)	Type 2 diabetes (n=163)	Diabetes (n=304)
Age (year)	30.6±11.4	52.0±11.1	42.1±15.5
Duration of diabetes (year)	12.0±9.7	8.9±7.1	10.3±8.5
Gender			
Female (%)	87 (61.7%)	82 (50.3%)	
Male (%)	54 (38.3%)	81 (49.7%)	
BMI (kg/m^2)	23.4±4.1	29.9±5.4	26.9±5.8
Alcohol			
No	104 (73.8%)	130 (79.8%)	234 (77.0%)
Yes	27 (19.1%)	15 (9.2%)	42 (13.8%)
Stop dinking during pandemic	5 (3.5%)	15 (9.2%)	20 (6.6%)
Stop drinking before pandemic	5 (3.5%)	3 (1.8%)	8 (2.6%)
Smoking			
No	81 (57.4%)	76 (46.6%)	157 (51.6%)
Yes	45 (31.9%)	57 (35.0%)	102 (33.6%)
Stop smoking during pandemic	10 (7.1%)	27 (16.6%)	32 (12.2%)
Stop smoking during pandemic	5 (3.5%)	3 (1.8%)	8 (2.6%)
Education			
Higher or postgraduate	88 (62.4%)	71 (43.6%)	159 (52.3%)
High school	44 (31.2%)	52 (31.9%)	96 (31.6%)
Elementary school	9 (6.4%)	40 (24.5%)	49 (16.1%)
Marital status			
Single	76 (53.9%)	14 (8.6%)	90 (29.6%)
Married	59 (41.8%)	133 (81.6%)	192 (63.2%)
Divorced/widowed	6 (4.3%)	16 (9.8%)	22 (7.2%)
Social status			
Living with family	129 (91.5%)	155 (95.1%)	284 (93.4%)
Living alone	12 (8.5%)	8 (4.9%)	20 (6.6%)
Financial income			
High	6 (4.3%)	11 (6.7%)	17 (73.8%)
Middle	106 (75.2%)	130 (79.8%)	236 (77.6%)
Low	29 (20.6%)	22 (13.5%)	51 (16.8%)
Diabetic complications			
Retinopathy (%)	25 (17.7)	45 (27.6%)	70 (23.0%)
Nephropathy (%)	15 (10.6)	18 (11.0%)	33 (10.9%)
Neuropathy (%)	40 (28.4%)	77 (47.2%)	117 (38.5)
Diabetic ulcers (%)	10 (7.1%)	20 (12.3%)	30 (9.9%)
Treatment			
OADs (%)	-	97 (59.5%)	
Insulin (%)	141 (100%)	10 (6.1%)	
OADs and insulin (%)	-	56 (34.4%)	

BMI body mass index, *OADs* oral antidiabetics

Table 2 Scores of Hospital Anxiety and Depression Scale and Impact of Event Scale, Revised and frequency of anxiety and depression of the patients

	Diabetes (n=304)	Type 1 diabetes (n=141)	Type 2 diabetes (n=163)	p*
HADS Total	13.6±7.4	12.9±6.6	14.1±8.0	0.15
Anxiety	7.3±4.0	7.1±3.6	7.5±4.3	0.37
Depression	6.2±4.0	5.8±3.7	6.6±4.2	**0.08**
Frequency of anxiety (%)	45.7	44.7	46.6	0.73
Frequency of depression (%)	33.9	27.7	39.3	**0.03**
IES,R	23.5±13.6	23.5±13.4	23.5±13.8	0.99
Intrusion	7.2±5.8	6.8±5.5	7.5±6.0	0.25
Avoidance	10.0±5.2	10.5±.5.5	9.6±4.9	0.13
Hyperarousal	6.3±4.6	6.2±4.3	6.3±4.8	0.79

HADS Hospital Anxiety and Depression Scale, *IES,R* Impact of Event Scale, Revised

*Statistical analysis between type 1 and type 2 diabetes

Global COVID-19 outbreak has been such a stressful experience for most of the people. Therefore, using a web-based cross-sectional study, we aimed to evaluate the acute stress response, depression, and anxiety in diabetic patients during the COVID-19 pandemic, and to examine the effect of these psychiatric problems on diet habits and glycemic controls of patients.

Material and methods

In a cross-sectional study, we evaluated patients with type 1 diabetes (T1D) and type 2 diabetes (T2D) receiving outpatient care at Uludag University Medical School and Medicana Hospital Endocrinology and Metabolism Clinic in Bursa, Turkey. Inclusion criteria were as follows: (i) being age 18 years old and older, (ii) having been diagnosed with type 1 and type 2 DM for at least 6 months, (iii) being followed for at least 3 months in the same centers, and (iv) volunteering to fill in the questionnaire. This study was approved by the Institutional Review Board of the Uludag University of Turkey. All procedures in this clinical trial were carried out in accordance with the ethical principles and standards in the recently revised Declaration of Helsinki.

This web-based survey of COVID-19 was sent to the patients through the Whatsapp platform. All participants reported voluntarily their demographic data, diabetes-related information, and completed two standardized questionnaires which assessed acute stress, anxiety, and depression. In our study, the sociodemographic and behavioral data of our diabetic patients were obtained through the questionnaire which is developed for this study. The following data are obtained in our study: antropometric data of the patients, duration of diabetes, treatment protocols, presence of comorbid diseases and diabetic complications, and educational, marital, employment, and social status. Also, during the COVID-19 pandemic, patients' blood glucose measurements, appetite,

eating habits, weight, and physical activities were compared to those in the past. All participants completed Hospital Anxiety and Depression Scale (HADS) and the Impact of Event Scale, Revised (IES-R) questionnaires which assessed acute stress sypmtoms, anxiety, and depression.

- HADS: This self-report scale is frequently used for anxiety and depression screening in people with physical illness. It was developed by Zigmond and Snaith in 1983 and consists of 14 questions that are specific for depression and anxiety, seperately. Items are scored between 0 and 3. The cut-off score for the subscales is 8 [15]. Turkish validity and reliability were made by Aydemir et al. in 1997 [16].
- IES-R: Developed by Weiss and Marmar in 1997, IES-R is one of the widely used scales used to evaluate the distress and other traumatic symptoms within the past week that are associated with a traumatic life event [17]. Turkish validity and reliability was made by Çorapçıoğlu et al. in 2006 [18]. This self-report scale consists of 22 questions that are scored between 0 to 4 and three subscales i.e. intrusion, avoidance and hyperarousal. In our study, the word "event" in the original scale was changed to "COVID-19 disease" in order to make it easier for the participants to understand.

Statistical analysis

Statistical analysis was performed using SPSS Statistics for Windows version 23 (IBM Corp. Armonk, NY, USA). Normal distribution was assessed in numerical variables using the Shapiro–Wilk test. Results were displayed in the form of mean ± standard deviation (SD) for normal distributed data or median for skewed distributed data. Categorical variables are summarized as number and percentage. Correlation analysis was performed to evaluate the relationship between

Table 3 Factors related to anxiety, depression, and acute stress during the pandemic period in our study

	Variable	HAD-D	HAD-T	IES,R	Gender	BMI	Weight	Alcohol	MS	FI	L-DA
HAD anxiety	p	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.07	0.04	0.01	<0.01
	r	0.60	0.89	0.60	−0.18	0.15	0.14	−0.10	0.11	−0.14	0.44
	Variable	HAD-A	HAD-T	IES,R	BMI	Weight	Alcohol	L-DA			
HAD depression	p	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			
	r	0.60	0.89	0.46	0.20	0.18	−0.12	0.33			
	Variable	HAD-A	HAD-D	IES,R	Gender	BMI	Weight	Alcohol	Medeni	FI	L-DA
HAD total	P	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.02	0.04	0.01	<0.01
	r	0.89	0.88	0.59	−0.14	0.20	0.17	−0.12	0.11	−0.13	0.43
	Variable	HAD-A	HAD-D	HAD-T	Gender	DM years	L-DA				
IES,R	p	<0.01	<0.01	<0.01	0.03	0.04	<0.01				
	r	0.60	0.46	0.59	−0.12	0.11	0.40				

HAD, Hospital Anxiety and Depression Scale; *HAD-A: HAD*, Hospital Anxiety and Depression Scale, anxiety scores; *HAD-D: HAD*, Hospital Anxiety and Depression Scale, depression scores; *HAD-T HAD*, Hospital Anxiety and Depression Scale, total scores; *IES,R*, Impact of Event Scale, Revised; *BMI*, body mass index; *MS*, marital status; *FI*, financial income; *L-DA*, limitation of daily activities; *DM years*, duration of diabetes

anxiety, depression, event impact scores, variables related to post-covid changes, and baseline characteristics of the patients. Variables with significance values below 0.01 in Spearman coefficient were considered to be correlated.

Results

Three hundred and four diabetic patients (169 female and 135 male) were included in the study. Mean age of the patients was 42.1 ± 15.5 years and mean illness duration was 10.3 ± 8.5 years. 30.9% of the participants were obese and the mean BMI was 26.9 ± 5.8 kg/m^2. Smoking and alcohol usage rates were 13.8% and 33.6%, respectively. Almost half of the population had high school or postgraduate education, 63.2% was married, 93.4% was living with their family, and most of them had modarete financial income. Sociodemographic and clinical characteristics of the participants are shown in Table 1.

Patients with T1D ($n=141$) were younger and had lower BMI than patients with T2D ($n=163$). Alcohol usage rate was higher in individuals with T1D and smoking rate was higher in individuals with T2D. Patients with T1D had higher education level, lower marriage rates, and lower financial income. Ninety-seven of the patients with T2D were receiving only oral antidiabetic drugs (OADs) while 56 were receiving OADs and insulin therapy. Ten patients with T2D were using only insulin due to kidney failure.

When the rates of anxiety and depression in patients with T1D and T2D were compared, there was no significant difference in anxiety between the groups ($p = 0.73$), while the frequency of depression was found to be higher in individuals with T2D ($p=0.03$). Scores of Hospital Anxiety

and Depression Scale and Impact of Event Scale, Revised in the patients included to the study, are shown in Table 2. Among the patients included in our study, anxiety and acute stress were more common in female gender. A positive correlation was found between high body mass index (BMI)

Table 4 Post-pandemic changes in eating habits, physical activity, weight, and SMBD

	Type 1 diabetes ($n=141$)	Type 2 diabetes ($n=163$)	Diabetes ($n=304$)
Appetite			
Decreased	27 (19.1%)	16 (9.8%)	43 (14.1%)
Not changed	71 (50.4%)	101 (62.0%)	172 (56.6%)
Increased	43 (30.5%)	46 (28.2%)	89 (29.3%)
Physical activity			
Decreased	94 (66.7%)	96 (58.9%)	190 (62.5%)
Not changed	27 (19.1%)	59 (36.2%)	86 (28.3%)
Increased	20 (14.2%)	8 (4.9%)	28 (9.2%)
Weight			
Decreased	22 (15.6%)	23 (14.1%)	45 (14.8%)
Not changed	58 (41.1%)	85 (52.1%)	143 (47.0%)
Increased	61 (43.3%)	55 (33.7%)	116 (38.2%)
SMBG			
Decreased	22 (15.6%)	12 (7.4%)	34 (11.2%)
Not changed	63 (44.7%)	119 (73%)	182 (59.9%)
Increased	56 (39.7%)	32 (19.6%)	88 (28.9%)
Carbohydrate consumption			
Increased	67 (47.5%)	59 (36.2%)	126 (41.4%)
Not increased	74 (52.5%)	104 (63.8%)	178 (58.6%)
Snacking			
Increased	76 (53.9%)	84 (51.5%)	160 (52.6%)
Not increased	65 (45.1%)	79 (48.5%)	144 (47.4%)

SMBG self-monitoring blood glocose

Table 5 Factors affecting post-pandemic changes in eating habits, physical activity, weight, and SMBD in the study

Change in SMBG

Variable	HAD-D	HAD-T	IES,R	DM type	FI	Appetite	PA	CH-C	Snacking
p	0.01	0.01	0.01	0.03	0.01	<0.01	<0.01	<0.01	<0.01
r	0.14	0.13	0.13	-0.11	-0.14	0.17	-0.17	0.23	0.20

Weight

Variable	Age	Weight	Appetide	PA	CH-C	Snacking
p	0.04	0.04	<0.01	0.02	<0.01	<0.01
r	-0.11	0.11	0.57	-0.13	0.41	0.42

Appetite

Variable	Gender	Weight	BMI	Weight-C	SMBG-C	CH-C	Snacking
p	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
r	0.13	0.23	0.19	0.57	0.17	0.42	0.42

Physical activity

Variable	IES,R	BMI	Work-C	SMBG-C	Weight-C	CH-C	Snacking
p	<0.01	0.03	0.03	<0.01	0.02	<0.01	<0.01
r	-0.15	-0.12	-0.12	-0.17	-0.13	-0.29	-0.19

Carbohydrate concumption

Variable	HAD-A	HAD-D	HAD-T	IES,R	DM type	Age	Education	Work-C	SMBG-C	Appetite	PA
p	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
r	0.21	0.23	0.24	0.33	-0.11	-0.22	0.16	0.20	0.23	0.42	-0.29

Snacking

Variable	HAD-A	HAD-D	HAD-T	IES,R	Education	Age	Weight-C	SMBG-C	Appetite	PA	CH-C
p	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
r	0.17	0.20	0.20	0.22	0.19	-0.17	0.42	0.20	0.42	-0.19	0.57

HAD, Hospital Anxiety and Depression Scale; *HAD-D: HAD*, Hospital Anxiety and Depression Scale, depression scores; *HAD-A: HAD*, Hospital Anxiety and Depression Scale, anxiety scores; *HAD-D: HAD*, Hospital Anxiety and Depression Scale, depression scores; *HAD-T HAD*, Hospital Anxiety and Depression Scale, total scores; *IES,R*, Impact of Event Scale, Revised; *FI*, financial income; *PA*, physical activity; *CH-C*, carbohydrate consumption; *Weight-C*, change of weight; *SMBG-C*, change of self-monitoring blood glocose; *Work-C*, change of work

and anxiety and depression. HAD-Anxiety (HAD-A) and HAD-Total (HAD-T) scores were higher in patients whose financial income decreased during the pandemic. While the duration of illness was positively correlated with acute stress level, it was observed that the duration of illness did not pose a risk for anxiety or depression. A positive correlation was found between limitation of daily activities due to diabetes and anxiety, depression, and acute stress (Table 3)

Carbohydrate consumption (p=0.04) and worsening in glycemic values (p<0.001) were significantly higher in patients with T1D. Weight gain during the pandemic was similar in both groups (p=0.11). Post-pandemic changes in eating habits, physical activity, weight, and self-monitoring blood glucose (SMBD) are shown in Table 4.

In diabetic patients included in our study, decreased financial income, stress, and depression were found to be associated with poor glycemic control during the pandemic (Table 5). Worsening in glycemic values was higher in patients with T1D compared to those with T2D. Increased appetite, increased carbohydrate consumption, more frequent snacking, and decreased physical activity were observed to worsen glycemic control.

A negative correlation was found between age and weight gain in patients included in our study. Weight gain was also lower in individuals with lower body weight before the pandemic. There was no significant correlation between weight gain and anxiety, depression, and acute stress. Increased appetite, increased carbohydrate consumption, more frequent snacking, and decreased physical activity were found to be associated with weight gain.

Discussion

The risk of developing depression is 24% higher in type 2 diabetics than non-diabetics [19]. Depression causes poor glycemic control and increased risk of developing diabetic complications and comorbidities by activating hypothalamic-pituitary-adrenal axis and sympathetic nervous system leading to an increase in peripheral glucocorticoid and catecholamine levels, decreasing insulin sensitivity, increasing inflammation, and platelet aggregation [20]. Stress may have either a direct effect on blood glucose level via disrupting the hypothalamo- pituitary- adrenal axis hormones, or an indirect effect on patients' health behaviors such as worsening their adherence to treatment and diet [21, 22]. Emotional distress has been also found to be related with developing cardiovascular disease [20]. Major depression causes a 2.3-fold increase in mortality in patients with DM, while minor depression causes a 1.7-fold increase [22].

Khuwaja et al. found that the prevalence of anxiety and depression in patients with DM is 58% and 44%, respectively, in Pakistan. The results were about 2 times higher than patients with DM living in developed countries [14]. In a study conducted by Jarso et al., the prevalence of depression was found 37.8% in patients with DM and it was accociated with female gender, type 2 DM, duration of illness >6 years, and high fear of complications [23]. In our sample, anxiety rates were similar between patients with T1D and T2D; however, depression was higher in patients with T2D.

Our results show that duration of illness was correlated with acute stress level but did not show significant relation with anxiety or depression. Duration of illness might be a factor for this finding such as burden of disease for a longer period of time is a risk factor for depression [24]. Acute stress is an earlier psychological problem and could be considered as an adjustment reaction to a compelling situation [25]. Not all the individuals that show acute stress progress to anxiety or depressive disorders [26]. On the other hand, having a chronic disease for a longer period of time may strengthen one's ability to adjust to life changes or other possible medical conditions; thus, one may cope with stress better and not preceed to anxiety or depressive disorders [27].

Among developed and developing countries, presence of depression and anxiety differs due to social factors such as differences in education and income levels. Collins et al. estimated that one-third of individuals with DM have depression and one-fourth of those have anxiety in the UK. The study also showed that poor glycemic control and presence of diabetic complications are independent risk factors for anxiety and depression [28]. As a result of our study, women were found to be more prone to acute stress and anxiety. Anxiety and total HAD scores were higher in individuals whose income decreased due to the pandemic restrictions.

Khuwaja et al. reported BMI as an independent risk factor for depression and fasting blood glucose as an independent risk factor for anxiety and depression in type 2 DM [14]. In a research during COVID-19 pandemic, there was a significant correlation between anxiety levels and the gender, BMI, and HbA1c values [29]. In our sample, blood glucose level before COVID-19 correlated positively with depression and anxiety scores. This result is consistent with previous research. The psychological parameters of our study such as HAD-D and IES were correlated with change in blood glucose level after the outbreak and BMI, but not weight gain

Female gender, younger and/ or older age, physical inactivity, having a comorbid chronic disease such as hypertension or ischemic heart disease, living alone, inadequate social support, and low economic status are frequently reported risk factors for developing depression and anxiety in diabetic patients [30]. In a study conducted by Lin et al. after adjustment for prior complications and demographic and clinical factors, major depression was found to be associated with significantly higher risks of microvascular and macrovascular outcomes [31]. In a population-based matched cohort study, including a total of 38,537 incident

patients with diabetes who had depressive disorders, depression was found to be associated with macrovascular complications and all-cause mortality. But there was no relationship between depression and microvascular diabetic complications. The effect of depression on diabetic complications and mortality was more prominent among young adults than among middle-aged and older adults [32]. In our study, female gender, higher BMI and weight, decrease in financial income after outbreak, presence of diabetic complications and comorbid diseases (ie. retinopathy, neuropathy, diabetic foot, hypertension, dyslipidemia), worsened glycemic levels, increased carbohydrate consumption, and snacking were associated with higher anxiety and depression scores. In our study, high rates of anxiety, depression, and acute stress were found in patients who stated that diabetes disease limits their daily activities.

Increased released of β-endorphine during exercise has a protective effect on psychiatric diseases. In the literature, many studies suggested a relationship between physical inactivity and anxiety depression in different populations, including diabetic patients [14, 33, 34]. In our study, although there was no significant relationship between anxiety/depression and physical activity, a negative correlation was found between stress and physical activity.

The COVID-19 outbreak is thought to have many causes for developing psychiatric problems. Some of these reasons are financial difficulties, physical distance measures, and quarantine. As well as infected people, non-infected people are prone to the development of anxiety and depression [35–37]. In a study of 1210 participants in China, 29% reported moderate to severe anxiety symptoms; and 17% reported moderate to severe depressive symptoms during the outbreak. Female gender and student status were found to be associated with a greater higher levels of stress, anxiety, and depression [38]. Ozdin found that anxiety and depression were higher in women, individuals with chronic disease, and those have previous psychiatric illness history in Turkish society [39]. In another study, Huang et al. reported that people younger than 35 years and those who spent too much time focusing on the outbreak were more likely to suffer from anxiety symptoms [40].

Health authorities around the world reported that people with diabetes are in the high-risk group for COVID infection and if infected, their prognosis is worse compared to the non-diabetics. Given the scarcity of information on the disease, it may be considered that these reports may increase feelings of depression, anxiety, and stress in this spesific group [41]. Similarly, encouraging people not to visit the hospital except in an emergency situation may have made it difficult for diabetics to cope with diabetes [42].

In their research with 202 healthcare professionals over 47 countries, Chudasama et al. investigated the impact of COVID-19 on routine care of chronic diseases. Eighty percent of the healthcare professionals reported that the mental health of their patients worsened during the pandemic and diabetes was the most impacted condition due to the reduction of healthcare resources [43]. The study with 1396 diabetic people showed that patients frequently worried about being overly affected by COVID-10, due to their chronic disease state (56%), being characterized as high-risk group (39%) and not being able to manage their healthy state if infected (28%) [44]. It has been observed that among all diabetic patients, those with type 1 diabetes, those had diabetic complications, and females experience more concerns related to COVID-19 [41]. Similarly, our study showed that female gender and the presence of comorbidity are risk factors for depression.

Our study has some limitations. First, using a web-based survey method due to the self-isolation and quarantine led us to choose sampling of volunteers who would respond to the survey via the web system. Data was collected from two centers, so it can not be generalized to whole population. Second, since there are many factors that affect glycemic control, it is difficult to make a causal conclusion that anxiety and depression are the only factors that worsen glycemic control. Third, absence of a control group without diabetes is also a limitation of the study. In addition, the fact that the patients' HAD and IES scores belonging to the pre-pandemic period were unknown, prevented us from making comments about their mental changes. In our study, a mental evaluation based on objective criteria was not made by a psychiatrist. People may have shown themselves in a better or worse state than actual. This may raise questions on the accuracy or degree of mental symptoms.

As a result of our study, it was concluded that anxiety, depression, and acute stress in diabetic individuals led to carbohydrate consumption and more snacking. During the pandemic, changing in working patterns of the patients and staying much more time at home were also associated with more carbohydrate consumption and snacking. These changes in the patients' eating habits were associated with the worsening of glycemic values.

As a conclusion, we investigated the indirect effects of COVID-19 pandemic on the psycological health such as those mediated through physical distancing measures such as self-isolation or quarantine in diabetic patiens who are not infected. Based on the results, it could be concluded that COVID-19 pandemic has a serious impact on the mental health among patients with DM. Considering that approximately one-third of the depressive diabetic patients received adequate medical treatment and only 6.7% received adequate psychotherapy sessions [45], it is important to evaluate the effects of this pandemic, in patients with DM that are prone to the development of psychological problems. Clinicians must be aware of the possibility of acute stress, depression, and anxiety after pandemic in diabetic patients. Especially

in those whose glycemic control is impaired, psychological problems should not be ignored beyond physical inactivity and worsening eating habits.

Declarations

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