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Original Article

The effect of Covid-19 'stay home process' on metabolism parameters in diabetes mellitus patients: A single center, cross-sectional study

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Abstract

Aim: We aimed to investigate the impact of quarantine (stay home process) on laboratory parameters (fasting blood glucose, HbA1c), diet, exercise and medication compliance in patients with diabetes mellitus (DM) during the COVID -19 pandemic.

Materials and Methods: This study included 93 diabetes mellitus patients, who presented to our outpatient clinic. Biochemical parameters (glucose, HbA1c, lipid profile), dietary and exercise compliance of the patients were evaluated before and after the three-month quarantine in Turkey. Frequency of blood glucose measurement, medication compliance, hypoglycemia/hyperglycemia, need for hospitalization, and whether patients had an infection were self-reported.

Results: The mean age of the 93 patients included in the study was 56.70 ± 13.51 years. 55.9% (n = 52) of patients were female and 44.1% (n = 41) were male. 89.2% (n = 83) of participants were type 2 DM and 10.8% (n = 10) were type 1 DM. 82.8% (n = 53) of patients were aged between 18 and 64 years. It was found that 78.5% (n = 73) of patients had dietary compliance. We found that 41.9% (n = 39) of the patients exercised at home, 53.8% (n = 50) took their medications regularly, and 43.0% (n = 40) checked their blood glucose daily. When biochemical values were compared before and after the study, a statistically significant decrease in fasting glucose (pre-post 141-121 mg/dl) (p=0.026) and body mass index (pre-post 32.00-31.86 kg/m2) (p=0.008) was observed. There was no statistically significant difference in HbA1c and lipid levels in our analysis.

Conclusion: In this study, patients who adhered to their diet and monitored their blood glucose at home during quarantine had more stable blood glucose levels. In the future, prevention strategies should be considered for patients with chronic diseases during possible quarantines.

Keywords: COVID -19; diabetes mellitus; quarantine

INTRODUCTION

After a new strain of coronavirus (Co V) emerged in Wuhan, China, in December 2019, coronavirus 2 (SARS CoV-2), which causes severe acute respiratory syndrome, began to spread rapidly around the world (1). Many countries have ordered various restrictions on their citizens to prevent the spread of COVID -19. In Turkey, a lockdown was ordered for people under 18 and over 65 years of age, while a restricted lockdown was initiated for people in other age groups after March 11, 2020, the date of the first case diagnosed in Turkey. The ordered lockdown was in effect until June 2020, after which restrictions were relaxed due to the decreasing number of cases. This period led to changes in the daily routine habits of the people. The changes in dietary habits resulted in less physical activity, more difficult access to medications, and increased rates of mental disorders (2,3). The effects of these factors on glycemic control and metabolic outcomes of diabetic patients were observed.

Patients with uncontrolled diabetes mellitus (DM) are at higher risk of developing pneumonia because of easier adherence to lung epithelial cells due to impaired lymphocyte and leukocyte function (4). Routine care and follow-up of patients is important because SARS-CoV-2 infection is a significant cause of mortality and morbidity in diabetic patients (5). Some studies reported that the lockdown period causes impaired glycemic control in diabetic patients (6). On the other hand, a study by Tornase et al. suggests that home exercise improves glycemic control (7).

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The treatment of diabetes mellitus requires a multidisciplinary approach. In addition to drug treatment, diet and exercise play an important role. Medical nutrition therapy is an indispensable therapeutic component in the prevention and treatment of diabetes and diabetes-related complications. Regular physical activity is recommended for all patients with diabetes mellitus and is planned according to the patients' presenting complications.

The aim of this study was to investigate the effects of lockdown orders on patients with diabetes mellitus who did not have SARS CoV-2 infection during the COVID -19 pandemic. This study emphasizes the importance of individualized treatment, diabetes mellitus education, diet, and home exercise in patients with diabetes mellitus.

MATERIALS and METHODS

This study was conducted on diabetes mellitus patients presenting to our outpatient clinic. Biochemical parameters (glucose, HbA1c, lipid profile), diet and exercise were evaluated before and after the period of three months of quarantine in Turkey.

The study included 93 patients whose informed consent was obtained. In order to evaluate the early effects of the situation when the patients who did not apply to the hospital during the full lockdown period and applied during the controlled normalization period, the patients who applied in the first 6 months were selected. Patients over 18 years of age who had been previously diagnosed with DM (type 1 and type 2 diabetes) and who had visited our clinic for follow-up within the 6 months prior to the quarantine period were included in the study. Patients under 18 years of age, patients with gestational diabetes, and patients whose first application was after quarantine were not included in the study. A ten-minute interview was conducted face-to-face during outpatient admissions. Dietary compliance was assessed as complete, partial, and non-compliant based on the patients' responses to the questions asked. Patients' physical activity status was questioned. Those who performed aerobic exercises, such as walking in or around the house, stair climbing, and running, for at least 20-30 minutes on at least 3 days per week were accepted as actively exercising. The frequency of blood glucose measurement was asked by the number of weekly measurements. Hypoglycemic and hyperglycemic states were also evaluated weekly according to blood glucose measurement results. It was accepted as hypoglycemia if blood glucose was below 70 mg / dl, as hyperglycemia if fasting blood glucose was above 130mg/dl and postprandial blood glucose was above 180 mg/dl (8). The frequency of medication use was determined according to the patient's response to the questions as always, usually, sometimes and never. The need to apply to the hospital and whether the patients had an infection were questioned. Patients who had flu-like symptoms were asked if throat swabs were taken to rule out COVID-19 and influenza infections. Patients with positive results were recorded. Medications taken by patients and their body mass indexes were recorded. Biochemical parameters were analyzed from plasma samples. Plasma glucose levels were measured using the enzymatic reference hexokinase method (Beckman Coulter AU5800), and plasma HbA1c levels were measured using the high-performance liquid chromatography and mass spectroscopy method (Premier HB9210). Lipid levels were measured using the enzymatic calorimetric (Beckman Coulter AU5800) method.

Study data were analyzed using statistical software IBM SPSS (version 25). Frequency, percentages, median, 25-quartile and 75-quartile values, mean and standard deviation were used to present the descriptive data. Chi-square test was used for statistical analysis of categorical data. After analyzing the normality distributions of the data groups with hypothesis tests, the Wilcoxon Signed Rank Test was used to analyze the paired groups. A value of $p< 0.05$ was accepted as statistically significant.

Ethics committee approval was granted on 24/07/2020 with the number 24237859/500 and the study was done in accordance with the Helsinki Declaration.

RESULTS

The mean age of the 93 patients included in the study was 56.70 ± 13.51 years and 55.9% of patients (n=52) were female and %44.1 (n=41) were male. 9.7% (n=9) of the study group were illiterate, 46.2% (n=43) were primary school graduates, 36.6% (n=34) were high school graduates and 7.5% (n=7) had university degrees. 89.2% (n=83) of the participants were type 2 DM, 10.8% (n=10) were type 1 DM. The mean duration of DM was 9 years (range 3.00-15.00 years).

According to patients' answers to the questionnaire, 32.3% (n = 30) of the group used oral anti-diabetic drugs and 67.8% (n = 63) used an insulin treatment regimen. When the distribution by comorbidities was examined, 36.6% (n = 34) of the group had no additional disease, while the most common comorbidities were hypertension (HT) and coronary artery disease (CAD). It was found that 78.5% (n = 73) of the patients had dietary compliance and 82.8% (n = 53) of these patients were between 18 and 64 years old. It was found that 41.9% of patients (n = 39) exercised, 53.8% (n = 50) took their medications regularly, and 43.0% (n = 40) checked their blood glucose daily. It was found that 84.9% of patients (n = 79) experienced hypoglycemia and 58.1% (n = 54) experienced hyperglycemia less than once a week. During the COVID -19 quarantine, 60.2% (n = 56) of the study group did not contact a medical doctor by telephone or in person, 17.2% (n = 16) saw a primary care doctor, 10.8% (n = 10) saw an internal medicine specialist, and 11.8% (n = 11) contacted an endocrinologist. Influenza infection was detected in 15.1% (n = 14) of the group, with the COVID 19 test being positive in only one patient. The distribution of some sociodemographic and clinical characteristics of the patients is shown in Table 1.

In the study, it was found that some biochemical parameters such as HbA1c, creatinine, alanine transaminase (ALT), total cholesterol, triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), High-density lipoprotein cholesterol (HDL-C), estimated glomerular filtration ratio (EGFR)

did not differ in the analysis before and after COVID -19 quarantine (p<0.05 for each parameter). It was observed that the measurements of glucose (pre-post 141-121 mg/dl) (p=0.026) and body mass index (BMI) (pre-post 32.00-31.86 kg/m2) (p=0.008) decreased significantly after the quarantine (p <0.05 for each) (Table 2).

In the study sample, no difference was observed between groups in terms of hypoglycemia frequency, which was monitored with blood glucose measurements during the COVID -19 quarantine (p=0.221), while blood glucose measurements was more frequent in the group that reported experiencing a hyperglycemic attack at least once per week (p=0.001). When home exercise and diet compliance status were evaluated by education level, it was observed that individuals with higher education levels had a higher frequency of home exercise (p=0.042), but no statistically significant difference was observed between education level and diet compliance (p=0.09).

Table 1. The distribution of some socio-demographic and clinical characteristics of the patients

		Median (Q1-Q3) N (%)
Age		57.00 (48.00-68.50)
Gender		
Female		52 (55.9)
Male		41 (44.1)
Marital status		
Married		83 (89.2)
Single		10 (10.8)
Education status		
İlliterate		9 (9.7)
Primary School		43 (46.2)
High School		34 (36.6)
University		7 (7.5)
Working Status		
Working		23 (24.7)
Not Working		70 (75.3)
Type of Diabetes		
Type-1		10 (10.8)
Type-2		83 (89.2)
Duration of diabetes (year)		9.00 (3.00-15.00)
	N	**%**
Drugs used		
Oral Anti-diabetics	30	32.2
Oral + Basal Insulin	42	45.2
Only Insulin	21	22.6
Comorbidities		
Hypertension	22	23.7
CKD[1]	11	11.7
Malignancy	6	6.5
COPD[2]	2	2.2
CAD[3]	18	19.3
None	34	36.6
Dietary compliance		
Yes	18	19.4
Partial	55	59.1
None	20	21.5
Home exercise		
Yes	39	41.9
No	54	58.1

Use of drugs		
Always	50	53.8
Usually	35	37.6
Sometimes	5	5.4
Never	3	3.2
Blood sugar monitoring		
7 days a week	40	43.0
3-4 days a week	16	17.2
1-2 days a week	20	21.5
Less than 1 a week	17	18.3
Did you consult any physician?		
No one	56	60.2
Family Practitioner	16	17.2
Internal Medicine Specialist	10	10.8
Endocrinologist	11	11.8
Flu-like infection?		
Yes	14	15.1
No	79	84.9
If yes, were you tested for COVID-19?		
Yes, positive result	1	7.1
Yes, negative result	3	21.5
No	10	71.4

[1]Chronic Kidney Disease, [2]Chronic obstructive pulmonary disease, [3]Coronary Artery Disease

Table 2. The comparison of the measured biochemical parameters of the participants before and after the COVID-19 lockdown

	Initial value Median (Q1-Q3)	Last value Median (Q1-Q3)	P
HbA1c[1](%)	7.70 (6.60-9.20)	7.30 (6.60-8.70)	0.361
Glucose(mg/dl)	141.00 (114.00-76.00)	121.00(102.00-161.00)	**0.026**
Creatinine(mg/dl)	0.76 (0.63-0.93)	0.76(0.64-0.95)	0.119
ALT[2](U/L)	18.00 (11.00-27.00)	17.00 (13.00-24.00)	0.667
Total Chol[3](mg/dl)	178.00 (148.00-218.00)	169.00 (148.00-228.00)	0.491
TG[4](mg/dl)	130.00 (92.00-180.00)	129.00(93.00-180.00)	0.698
LDL-C[5](mg/dl)	108.00 (85.00-142.00)	102.00 (83.00-139.00)	0.716
HDL-C[6](mg/dl)	46.00 (38.00-53.00)	44.00 (38.00-52.00)	0.658
EGFR[7](mL/dk/1.73m^2)	96.00 (76.00-106.00)	95.00 (78.00-105.00)	0.060
BMI[8](kg/m^2)	32.00 (27.48-35.16)	31,86 (27.20 -34.62)	**0.008**

Analyzed with Wilcoxon Signed Rank Test
[1]Hemoglobin A1C, [2]Alanine transaminase, [3]Total cholesterol, [4]Triglyceride, [5]Low- density lipoprotein cholesterol, [6]High- density lipoprotein cholesterol [7]Estimated glomerular filtration ratio, [8]Body mass index

When HbA1c level difference was examined before and after the quarantine period in the study group, it was found that the HbA1c level was higher in those who did not adhere to the diet and checked their blood glucose measurements "less than once a week" comparing to those who adhered to the diet and performed frequent measurements (p = 0.001 and p = 0.015, respectively). No difference was found between the groups in terms of changes in glucose levels.

When the changes in HDL-C and non-HDL-C levels were examined in the study group before and after the quarantine period, there was no statistically significant difference in HDL-C levels. It was observed that the increase in Non-HDL-C level was higher in the group that did not adhered to diet and did not exercise than in the group that adhered to diet and did exercise. (p = 0.047 and p = 0.037, respectively). The distribution of changes in HbA1c, HDL-C and non-HDL-C before and after the

pandemic period according to adherence to diet, home exercise and blood glucose monitoring is shown in Table 3.

It was found that the increase in HbA1c level in patients who did not adhere to diet or exercise was statistically significant when diet and exercise status of the study participants were evaluated together (p=0.003). The change after combining diet and exercise is shown in Table 4.

Table 3. TThe distribution of HbA1c, HDL-C and non-HDL-C changes before and after the pandemic period according to dietary compliance, home exercise and blood glucose monitoring

	HDL Change		P value	Non-HDL Change		P value	Hba1c Change		P value
	Yes	No		Yes	No		Yes	No	
	N	N		N	N		N	N	
	%	%		%	%		%	%	
Dietary Compliance									
Yes	10	10	0.582	12	8	**0.047**	17	3	**0.001**
	50.0	50.0		60.0	40.0		85.0*	15.0	
Partial	23	27		28	27		27	28	
	41.8	58.2		50.9	49.1		49.1	50.9	
No	6	12		4	14		5	13	
	33.3	66.7		22.2	77.8*		27.8	72.2	
Home exercise									
Yes	27	27	0.101	31	23	**0.037**	33	21	0.088
	50.0	50.0		57.4	42.6		61.1	38.9	
No	12	27		13	26		16	23	
	30.8	69.2		33.3	66.7		41.0	59.0	
Blood Glucose Monitoring									
Less than once a week	N/A**	N/A	N/A	N/A	N/A	N/A	14	3	**0.015**
							82.4	17.6	
At least once a week	N/A	N/A		N/A	N/A		35	41	
							46.1	53.9	

* The row that gives statistical significance with chi-square test
** Not applicable

Table 4. The change according to the combination of diet and exercise

	HbA1c Change		P value
	Yes	No	
	N	N	
	%	%	
No dietary compliance – No exercise	17	3	
	85.0*	15.0	
Dietary compliance /partial – No exercise	18	18	
	50.0	50.0	
Dietary compliance /partial – Home exercise	14	23	**0.003**
	37.8	62.2	
Total	49	44	
	52.7	47.3	

*The row that gives statistical significance with chi-square test

DISCUSSION

This study was conducted to observe the impact of quarantine of COVID -19 pandemic on diabetic patients. In our study, it was observed that during this period, the patients maintained a diet, checked their blood sugar regularly and made sure to take their medications regularly.

People with diabetes are thought to be at higher risk for infection-related complications and death from coronavirus infection. However, there is limited evidence that these patients are at increased risk of becoming infected (4). This hypothesis about diabetic patients led to more cautious behavior in those with existing disease. On the other hand, the COVID -19 pandemic caused psychological stress in diabetic individuals as in normal individuals. Under all these influences, although the lockdown orders led to increased compliance in some patients, they also led to negative consequences in some due to impaired stress management.

In the evaluations of the patients included in our study, there was a significant decrease in fasting glucose values ($p = 0.026$) before and after the 3-month quarantine, and there was also a decrease in HbA1c levels, but it did not reach significant levels. A significant difference was also found between the body mass indexes of the patients before and after quarantine ($p = 0.008$). It was observed that although patients were concerned about their diet compliance and blood glucose levels, they did not spend enough time on exercise. In a study conducted with type 1 diabetics in Italy, there was no deterioration in the patients' glycemic control when the patients' regular blood glucose measurements were compared before and after the quarantine period. This effect was thought to be a result of the increased home exercise during the quarantine period (7). In another study conducted by Nachimutti et al, the factors of diet and exercise were shown to have a positive effect on diabetes during the quarantine period (9). In a study conducted in Spain, it was found physical inactivity was high before the quarantine period, and dietary habits also changed and contributed to weight gain during this period. Although there was more time to prepare foods suitable for the diet program, the stress of staying at home led to the consumption of high-calorie foods. This study also emphasized that unbalanced diet and insufficient physical activity are important public health problems (10).

In contrast, the authors of a study by Ghosal et al. found that there was a worsening of HbA1c levels at the end of the lockdown period, resulting in both an increase in complications of diabetes mellitus and a poor progress of coronavirus infection in these patients (11). Treatment of diabetic patients is through lifestyle changes (diet and exercise) and the use of pharmacological agents. The main goal of treatment is to minimize cardiovascular and other long-term risk factors. Medical nutrition therapy (MNT) should be tailored to the patient's diabetes type, lifestyle, and complications. Diet has been found to reduce HbA1c by 1-1.9 percent in patients with type-1 diabetes and by 0.3-2 percent in patients with type-2 diabetes, independent of pharmacological treatment (12). Regular exercise has a positive effect on diabetes by increasing insulin sensitivity, independent of weight loss (13). It is also important in diabetic patients because of its effect on weight loss. However, in a study by Egan et al. that investigates exercise compliance in diabetic patients; it was found that only about half of the patients were able to exercise regularly (14). In our study, also, a significant increase in HbA1c levels was found in patients who did not follow a diet and did not exercise.

In this study, a significant relationship was also found between frequency of blood glucose measurement and HbA1c level. Frequency of blood glucose measurement in patients increases awareness and compliance to treatment. Frequent blood glucose testing is recommended, especially in patients with type 1 diabetes and type 2 diabetes who use insulin. This way, more attention is paid to hypoglycemia and complications are avoided. In a study that investigated the relation between the frequency of blood glucose measurement and HbA1c levels in Turkey, a statistically significant lower HbA1c levels were found when patients who regularly measured their blood glucose every day were compared with those who measured their blood glucose monthly and those who did not measure at all (15). Miller et al. showed in a study of 20,555 patients with type-1 diabetes that HbA1c levels decrease proportionally and better glycemic control is achieved when the number of daily blood glucose measurements increases (16). The atherogenic lipid profile in type-2 diabetes begins before the diagnosis of diabetes mellitus. Even with good glycemic control, atherogenic dyslipidemia persists in diabetic patients and lipid-lowering therapy is required (17). When 68% of the patients who participated in our study came to the visit, they were already receiving lipid-lowering treatment. In our study, there was a significant increase in non-HDL cholesterol level in the patients who were taking statins and not adhering to diet and not exercising. Although LDL cholesterol is the primary target of therapy in dyslipidemia patients, non-HDL cholesterol should be considered as a secondary target in most diabetic patients with triglyceride levels of >200 mg/dl (18). Previous studies have emphasized that non-HDL cholesterol is an independent risk factor related to cardiovascular disease. In the study conducted by Bittner et al, non-HDL cholesterol was evaluated as a strong predictor of nonfatal myocardial infarction and angina pectoris (19). In diabetic patients, non-HDL cholesterol might be a better CVD precursor compared with LDL cholesterol or triglycerides. However, a number of same considerations would also apply to non-HDL cholesterol. Although it is more stable than total triglyceride because a large proportion of it is LDL cholesterol, non-HDL cholesterol also reflects VLDL and IDL cholesterol, which vary greatly in individuals from day to day, depending on dietary patterns and other metabolic variables (20).

LIMITATIONS

The limitations of our study are the fact that it is a single-center cross-sectional study, the small number of patients with type 1 DM at the time of enrollment, and the evaluation of the frequency of blood glucose monitoring, patient diet, and exercise status according to the patient's statement.

CONCLUSION

In summary, in this study, the progression of blood glucose levels was more regular in patients who adhered to the diet during quarantine and monitored blood glucose at home. Once again, the importance of diet, exercise, diabetes education, frequency of blood glucose monitoring and continuity of adherence to therapy in the management of diabetes is emphasized. In view of possible quarantines in the future, strategies should be planned in this regard. Larger studies with more patients are needed to see the long term results of quarantine.

Competing Interests: The authors declare that they have no competing interest.

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Ethical Approval: Ethics committee approval was obtained with protocol number 2020/161 at Karadeniz Technical University.

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