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Impact of lockdown COVID-19 on metabolic control in type 2 diabetes mellitus and healthy people

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ABSTRACT

Aims: The impact of prolonged COVID-19 lockdown on metabolic control in type 2 diabetes patients and healthy individuals has not exactly been known. We aimed to evaluate the change in body weight and metabolic control in type 2 diabetic and non-diabetic healthy subjects during the prolonged lockdown period.

Methods: Diabetic (n = 85), and age-and sex-matched non-diabetic subjects (n = 55) were included in this prospective study. Body mass index and metabolic parameters were compared between before and 6th months of lockdown. Changes in values were evaluated using the difference before and after lockdown.

Results: Age (54.81 ± 10.53 vs. 52.61 ± 4.88 years), gender (female, 68.2% vs. 56.4%) and, BMI (33.44 ± 6.48 vs. 31.63 ± 3.57 kg/m^2) were similar between groups ($p > 0.05$). Before and after lockdown, BMI increased both in non-diabetic (0.54 ± 0.95 kg) and diabetic groups (1.91 ± 5.48 kg) ($p > 0.05$). Increase in HbA1c was more in diabetic than in non-diabetic groups (0.71 ± 1.35 vs. 0.02 ± 0.19%, $p = 0.002$). Glucose, LDL-C, and TG increased in diabetic (39.69 ± 74.69, 7.60 ± 34.33, and 58.21 ± 133.54 mg/dl, $p < 0.05$) whereas non significantly decreased in non-diabetic group (−0.51 ± 4.40, −3.52 ± 14.53, and −6.47 ± 41.77 mg/dl, respectively. After adjusting BMI, increase in blood glucose ($p = 0.021$), HbA1c ($p = 0.018$), and TG ($p = 0.041$) levels were more in diabetic than non-diabetic group. Duration of diabetes was an independent predictor of the change in HbA1c (OR: 1.2, 95% CI = 1.1–1.8, $p = 0.032$).

Conclusions: Body weight gain was observed in type 2 diabetic patients and healthy subjects. This is the first study to show that prolonged lockdown COVID-19 pandemic worsened glucose regulation and increased TG level in diabetes mellitus independent of weight gain.

1. Introduction

The coronavirus disease 2019 (COVID-19), due to SARS-CoV-2 viral infection, outbreak forced Turkey to begin lockdown on 20 March 2020. Schools, hospitals, universities, restaurants, and most public entertainment areas, including sports arenas, cafes, and swimming pools were closed in this period. Travel ban has been applied between cities. There had been a nearly complete lockdown for under 18, over 65 aged people, and people who had chronic diseases (diabetes, chronic obstructive lung disease, cancer, etc.). These restrictions have begun to be lifted after June 2020, and similar procedures have been seen in most of the world. This period caused limiting daily routine activities of people [1] such as alteration in eating patterns, increasing physical inactivity, increased weight gain [2] difficulty in accessibility to medications, and increasing psychological disorders [3]. These factors may be responsible for badly change in glucose control and metabolic parameters. However, these studies with self-reported data didn't point out any precise laboratory and clinical results [1–3].

It has been known that poor glucose control has been observed in subjects affected by COVID-19 infection. Diabetes patients have suffered from worse outcomes, including increased mortality and morbidity due to COVID-19 infection [4]. Nevertheless, conflicting data reported that lockdown during COVID-19 pandemic was associated with worsening glucose control in diabetic patients without COVID-19 infections [5]. Few studies have reported that lockdowns

Abbreviations: COVID-19, Coronavirus Disease 2019; BMI, body mass index; WC, waist circumference; FPG, fasting plasma glucose; HbA1c, haemoglobin A1c; LDL-C, low-density lipoprotein-cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein-cholesterol.

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have been associated with poor glucose control in type 1 diabetes patients [6]. The effect of lockdown on metabolic parameters and in patients with type 2 diabetes and non-diabetic healthy controls have not been examined yet. Therefore, this is the first study investigating the impact of lockdown on glucose and body weight control in diabetic patients and non-diabetic subjects. This study aimed to evaluate the effect of prolonged lockdown due to COVID-19 pandemic on metabolic and body weight control in adults with type 2 diabetes and non-diabetic subjects.

2. Patients and methods

Patients with previously confirmed type 2 diabetes (n = 85) and age-and gender-matched non-diabetic healthy subjects (n = 55) were included in this observational case-controlled study. All individuals were regularly followed-up at Endocrinology and Metabolism Department, Istanbul Research and Education Hospital, Turkey, from March 2019 to October 2020. Patients with type 2 diabetes mellitus, subjects not affected by COVİD-19 infection, who have complete records in our patient data file system and accessible data during follow-up, and who didn't have any diabetic treatment modification were included study. Patients with type 1 diabetes mellitus, subjects who were nonadherent to therapy, subjects who had treatment modification in the last six months, patients who had been COVID-19 positive or who had COVID 19 infection, incomplete records, who didn't have accessible data, and having co-morbidities such as liver disease, renal failure, active infections, cancers were excluded. After exclusion criteria, 85 of 167 type 2 diabetes patients were included in the study. The control subjects were selected from population-based routine screening programs. Control subjects without any chronic illness (diabetes, renal failure, cancer, or any cardiac disease) and who were completely euthyroid were selected. Data from before lockdown and 6th months of lockdown period were compared in diabetic patients and non-diabetic controls. Change in value (Δ) was evaluated the difference as 6th-month value minus before value.

The measurements of all parameters (physical and biochemical) were performed in the same outpatient clinic. Gender, age, duration of diabetes, medications, adherence to therapy, weight, body mass index (BMI), and waist circumference (WC) were recorded. WC was measured between the lower costal margin and iliac crest. BMI was calculated by formula as body weight (kg)/height (m^2). Biochemical parameters including fasting plasma glucose (FPG), serum haemoglobin A1c (HbA1c), triglyceride (TG), high-density lipoprotein- cholesterol (HDL-C), low-density lipoprotein-cholesterol (LDL-C) were measured before lockdown and during lockdown at 6th month. Serum HbA1c was measured by spectrophotometry.

This prospective study was approved by the Local Ethics Committee (12/06/2020-243), and informed consent was obtained from all participants.

2.1. Statistically analysis

Statistical analysis was performed using SPSS 18.0 software (SPSS, Inc). Descriptive analyses were expressed as mean $\pm$ standard deviation (SD), percentages (%), odds ratio (OR), and confident interval (CI). Kolmogorov–Smirnov or Shapiro–Wilk W was examined for normality. Logarithmic analysis was used for variables without normally distributed. The student's *t*-test was examined for normally distributed continuous variables. Mann–Whitney *U* test was examined for nonparametric variables. The paired samples *t*-test was examined for parametric variables, and the Wilcoxon test was examined for nonparametric variables before and 6th month lockdown period. The correlation between metabolic parameters was tested using Spearman's correlation coefficients (r). A multiple backward logistic regression analysis was performed to identify independent predictors of change in HbA1c in the model, dependent variable: change in HbA1c; independent variables: change in BMI, age, gender, duration of diabetes, change in glucose, and change in lipids. Multivariate analysis was performed to adjust the change in BMI. $p < 0.05$ was accepted as statistically significant.

3. Results

Age, gender, and body mass index were similar between diabetic group and non-diabetic group ($p > 0.05$). According to medications, 51.7% of patients with diabetes were on both oral antidiabetic and insulin therapy. 37.6% were on only oral antidiabetic therapy, and 10.5% were on insulin therapy. All diabetic patients were adherent to treatment. At baseline, serum glucose, HbA1c, LDL-C, TG, and HDL-C levels were significantly higher in diabetic group compared with non-diabetic group (each, $p < 0.05$, Table 1). During lockdown at 6th month, body weight was significantly increased in the non-diabetic group (86.10 $\pm$ 10.48 vs. 85.56 $\pm$ 10.53 kg) and diabetic group (89.75 $\pm$ 18.68 vs. 87.83 $\pm$ 18.27 kg) (each, $p < 0.05$). Fasting glucose (224.08 $\pm$ 89.01 vs. 184.38 $\pm$ 62.92 mg/dl), HbA1c (9.26 $\pm$ 1.70 vs. 8.54 $\pm$ 1.56%) and, TG level (288.18 $\pm$ 186.78 vs. 229.97 $\pm$ 162.56 mg/dl) were significantly increased in diabetic group at 6th month ($p < 0.05$). Comparisons of the clinical parameters in non-diabetic subjects and diabetic patients during lockdown are shown in Table 2.

Changes in parameters between the non-diabetics and diabetic patients were compared in Table3. Increase in body weight did not differ between non-diabetic and diabetic groups (0.54 $\pm$ 0.95 vs. 1.91 $\pm$ 5.48 kg, $p > 0.05$). Increase in waist circumference was more in diabetic patients compared with non-diabetics (1.20 $\pm$ 2.38 vs. 0.03 $\pm$ 0.46 cm, $p < 0.05$). Fasting glucose was increased in the diabetic group while decreased in the non-diabetic group (39.69 $\pm$ 74.69 vs. $-$0.51 $\pm$ 4.40 mg/dl, $p = 0.001$). Increased in HbA1c was more in diabetic group compared with non-diabetic (0.71 $\pm$ 1.35 vs. 0.02 $\pm$ 0.19%, $p = 0.002$). After adjusting body weight gain, increases in fasting glucose ($p = 0.021$) and HbA1c ($p = 0.018$) were more in the diabetic group than in the non-diabetic group. Serum LDL-C (7.60 $\pm$ 34.33 mg/dl) and TG (58.21 $\pm$ 133.54 mg/dl) were increased in diabetic group while LDL-C ($-$3.52 $\pm$ 14.53 mg/dl) and TG ($-$6.47 $\pm$ 41.77 mg/dl) were decreased in non-diabetic group ($p = 0.032$ and $p = 0.027$, respectively). HDL-C was increased in the diabetic group while decreased in the non-diabetic group (1.09 $\pm$ 7.51 vs. $-$1.89 $\pm$ 3.17 mg/dl, $p = 0.044$). After adjusting body weight gain, increase in TG was more increased in the diabetic group than in the non-diabetic group ($p = 0.041$), while the change in LDL-C and HDL-C did not differ between groups ($p > 0.05$).

In univariate analyses, change in HbA1c was positively correlated with the change in glucose ($r = 0.521$, $p < 0.001$) and change in TG ($r = 0.312$, $p = 0.004$). Logistic regression analysis showed that duration of diabetes was an independent predictor of the change in HbA1c (OR: 1.2, 95% CI = 1.1–1.8, $p = 0.032$).

4. Discussion

Prolonged COVID-19 pandemic lockdown increased body weight in both type 2 diabetic and non-diabetic groups, but weight gain did not differ between groups. After the 6th month lockdown, body weight gain was observed even without metabolic disorders in non-diabetic subjects. Glucose metabolism was impaired, and TG level increased independent of weight gain in diabetic patients. The duration of diabetes was an independent risk factor for worsening in HbA1c.

Table 1
Comparisons of the clinical parameters in non-diabetic controls and diabetic patients at baseline.

	Non-diabetic controls (n = 55)	Diabetics (n = 85)	P
Female	56.4% (n = 31)	68.2% (n = 58)	0.154
Male	43.6% (n = 24)	31.8% (n = 27)	
Age (years)	52.61 ± 4.88	54.81 ± 10.53	0.153
Duration of diabetes (year)	–	11.71 ± 6.91	–
Body weight (kg)	85.56 ± 10.53	87.83 ± 18.27	0.405
BMI (kg/m^2)	31.63 ± 3.57	33.44 ± 6.48	0.061
WC (cm)	103.76 ± 7.07	107.45 ± 11.94	0.052
FPG (mg/dl)	94.90 ± 11.41	183.91 ± 66.91	**<0.001**
HbA1c (%)	5.46 ± 0.32	8.52 ± 1.55	**<0.001**
HbA1c (mmol/mol)	36.18 ± 3.52	69.67 ± 17.04	**<0.001**
LDL-C ((mg/dl)	138.55 ± 36.50	122.16 ± 32.08	**0.009**
LDL-C (mmol/L)	7.69 ± 2.02	6.78 ± 1.78	**0.009**
TG (mg/dl)	143.56 ± 88.44	229.97 ± 162.56	**<0.001**
TG (mmol/L)	7.96 ± 4.79	12.76 ± 9.02	**<0.001**
HDL-C (mg/dl)	54.34 ± 12.66	43.78 ± 9.11	**<0.001**
HDL-C (mmol/L)	3.07 ± 0.70	2.43 ± 0.51	**<0.001**

Data are shown as mean ± SD (standard deviation) or percentage (%).
p < 0.05 was expressed as statistically significant. Significant values were shown in bold.
Abbreviations: BMI, body weight index; WC, waist circumference; FPG, fasting plasma glucose; HbA1c, hemoglobin A1c; LDL-C, low-density lipoprotein-cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein-cholesterol.

Table 2
Comparisons of the clinical parameters in non-diabetic and diabetic subjects during lockdown period.

	Non-diabetic subjects (n = 55)			Diabetic patients (n = 85)		
	Before Lockdown	6th month	P	Before Lockdown	6th month	p
Body weight (kg)	85.56 ± 10.53	86.10 ± 10.48	**0.001**	87.83 ± 18.27	89.75 ± 18.68	**0.002**
BMI (kg/m^2)	31.63 ± 3.57	31.83 ± 3.54	**0.001**	33.54 ± 6.48	34.15 ± 6.59	**0.002**
WC (cm)	103.76 ± 7.07	103.80 ± 7.14	0.568	107.45 ± 11.94	109.47 ± 12.87	**<0.001**
FPG (mg/dl)	94.90 ± 11.41	94.40 ± 9.30	0.396	184.38 ± 62.92	224.08 ± 89.01	**<0.001**
HbA1c (%)	5.46 ± 0.32	5.48 ± 0.33	0.387	8.54 ± 1.56	9.26 ± 1.70	**<0.001**
HbA1c (mmol/mol)	36.18 ± 3.52	36.48 ± 3.66	0.387	69.88 ± 17.14	77.71 ± 18.66	**<0.001**
LDL-C (mg/dl)	137.88 ± 36.5	134.35 ± 28.71	0.089	122.07 ± 33.06	129.68 ± 30.52	0.077
LDL-C (mmol/L)	7.65 ± 2.02	7.45 ± 1.59	0.089	6.77 ± 1.83	7.19 ± 1.69	0.077
TG (mg/dl)	143.56 ± 86.44	137.09 ± 54.68	0.256	229.97 ± 162.56	288.18 ± 186.78	**0.030**
TG (mmol/L)	7.96 ± 4.79	7.60 ± 3.03	0.256	12.76 ± 9.02	15.99 ± 15.91	**0.030**
HDL-C (mg/dl)	55.34 ± 12.66	53.45 ± 12.31	**0.001**	43.84 ± 9.19	44.94 ± 9.83	0.220
HDL-C (mmol/L)	3.07 ± 0.71	2.96 ± 0.68	**0.001**	2.43 ± 0.51	2.49 ± 0.54	0.220

Data are shown as mean ± SD (standard deviation).
p < 0.05 was expressed as statistically significant. Significant values were shown in bold.
Abbreviations: BMI, body weight index; WC, waist circumference; FPG, fasting plasma glucose; HbA1c, hemoglobin A1c; LDL-C, low-density lipoprotein-cholesterol; TG, triglyceride; HDL-C, high-density lipoprotein-cholesterol.

Table 3
Alterations in the clinical parameters in non-diabetic subjects and diabetic patients during the lockdown period.

	Non-diabetic (n = 55)	Diabetic patients (n = 85)	P	BMI-adjusted p-value
Δ Body weight (kg)	0.54 ± 0.95	1.91 ± 5.48	0.069	–
Δ BMI (kg/m2)	0.20 ± 0.36	0.71 ± 2.11	0.075	–
Δ WC (cm)	0.03 ± 0.46	1.20 ± 2.38	**0.035**	–
Δ FPG (mg/dl)	−0.51 ± 4.40	39.69 ± 74.69	**0.001**	**0.021**
Δ HbA1c (%)	0.02 ± 0.19	0.71 ± 1.35	**0.002**	**0.018**
Δ HbA1c (mmol/mol)	0.29 ± 2.11	7.83 ± 14.79	**0.002**	
Δ LDL-C (mg/dl)	−3.52 ± 14.53	7.60 ± 34.33	**0.032**	0.054
Δ LDL-C (mmol/L)	−0.19 ± 0.81	0.42 ± 1.91	**0.032**	
Δ TG (mg/dl)	−6.47 ± 41.77	58.21 ± 133.54	**0.027**	**0.041**
Δ TG (mmol/L)	−0.35 ± 2.31	3.23 ± 12.96	**0.027**	
Δ HDL-C (mg/dl)	−1.89 ± 3.17	1.09 ± 7.51	**0.044**	0.067
Δ HDL-C (mmol/L)	−0.10 ± 0.17	0.06 ± 0.41	**0.044**	

The difference (Δ) was shown as changes in values before and 6th-month lockdown (6th-month value minus before value).
Data are shown as mean ± SD (standard deviation).
p < 0.05 was expressed as statistically significant. The significant values were shown in bold.

This study pointed out that prolonged COVID-19 lockdown caused to increase in body weight in both type 2 diabetic and non-diabetic groups, but the amount of weight gain did not differ between groups. These results were consistent with survey research of 1200 participants on self-quarantine. Twenty-two percent of the study sample stated that they gained 5–10 pounds. Risk factors for weight gain during self-quarantine in that study were insufficient sleep, post-dinner snacking, lack of dietary limitation, eating in reaction to stress, and diminished physical activity [7]. Another survey study has found a mean of 1.5 kg increase after one month of the lockdown period, self-reported anxiety and depression found a risk factor for weight gain [8]. Also, another recent study reported weight gain after lockdown beginning among obese people which was attributed to snacking habit [9]. Therefore, we might come closer to a common opinion about weight gain after the lockdown period. It is not surprising to find a similar weight gain pattern in both diabetes and non-diabetes groups in our study.

After lockdown, glucose metabolism was impaired and, TG level increased with weight gain in diabetic patients compared to non-diabetics. The impairment in glucose metabolism, including glucose and HbA1c continues even when the effect of weight gain is adjusted. Also, the increase in serum TG level in diabetic patients continued, while the increase in LDL-C level disappeared. Raise in HbA1c was a similar result to earlier studies that Verma et al. found in type 1 diabetes patients. A similar result from France, including a comparison between gestational diabetes patients from 2019 to 2020 showed lower diabetes control in pandemic lockdown [10]. As easily suspected, several factors can have been responsible for increasing blood glucose and lipid levels. A during pandemic nutrition and exercise survey study from Spain showed that snack and sugary food consumption and physical inactivity increased and exacerbated by home confinement in type 2 diabetes patients [11]. Limited social interactions and decreased social eating replaced by emotional eating would also have caused this [12]. Increased socioeconomic difficulties alter healthy nutrition and create an obesogenic environment of cheap, easily prepared, or accessible energy foods with less healthy ingredients. Increased sitting time in a day could have led to a decrease in calorie expenditure in all population [13]. According to a multinational electronic survey study about home confinement; daily sitting time increased from 5 to 8 h per day as well as eating quality has deteriorated [14]. Although there was an increase in weight in the non-diabetic group, there was no significant change in glucose metabolism and lipid level during lockdown. This may be due to the increased consciousness of nondiabetic individuals about health, such as healthy nutrition, despite physical inactivity during the pandemic period, whereas cognitive impairment of diabetic individuals could make them difficult to concentrate on the period. The cognitive function also was shown to have deteriorated with physical inactivity in patients with type 2 diabetes patients [15].

The duration of diabetes was independently associated with an increase in HbA1c (OR: 1.2, 95% CI = 1.1–1.8, $p = 0.032$). This showed that the deterioration in glucose control and TG level in the diabetic group was independent of weight gain. Multi variation analysis showed that duration of the diabetes was an independent predictor factor of increasing HbA1c. Worsening of glucose metabolism in diabetic patients may be attributed to the increasing diabetes duration [16]. The weight gain, increased blood glucose and HbA1C, blood lipid in diabetes patients in this study should also be a triggering factor for particularly cardiovascular diseases. As a result, when we consider about COVID19 pandemic, the measures could be seen right, but we should not disregard diabetes and cardiovascular diseases pandemic, which have been great burden on world health.

The effect of COVID-19 lockdown on metabolic parameters in non-diabetic subjects was evaluated. This is the strength of our study. However, this is a small-sized study. Diet habits, physical activity, and psychological concerns were not investigated during study. These are the limitations of our research.

5. Conclusion

This is the first study to show that prolonged lockdown COVİD-19 pandemic worsened glucose regulation and increased TG level in patients with diabetes mellitus. These effects were independent of weight gain, although on average, weight increased in both non-diabetic and diabetic patients. Metabolic parameters maintained stable despite weight gain in non-diabetic subjects after prolonged lockdown. More extensive studies including confounding factors such as social and economic conditions, physical activity, diet quality, cognitive status, psychological issues, and treatment adherence are needed to identify the long-term effects of lockdown COVID-19 on metabolic control.

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Conflicts of interest

None.

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