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# Outcomes of COVID-19 restrictions on patients with type 2 diabetes in Turkiye

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## ABSTRACT

**Aims:** This study aimed to assess the impact of the national COVID-19 lockdown in Turkiye, initiated in March 2020, on glycemic and lipid parameters in patients with type 2 diabetes mellitus (T2DM).

**Methods:** We included T2DM patients who visited Akdeniz University Hospital between 11.03.2019 and 10.03.2021. Clinical and laboratory data (age, gender, blood glucose, serum creatinine, LDL, triglyceride, HDL, hemoglobin, HbA1c) were retrieved from the hospital database for analysis.

**Results:** A total of 1,715 T2DM patients were included, with 828 males (48.2%) and 887 females (51.8%). The number of patients seen before and during the pandemic was 930 and 785, respectively. The mean glucose levels before and during the pandemic were 153 mg/dl (149.25-157.47) and 165 mg/dl (160.14-170.62), respectively ($p<0.001$). HbA1c levels increased from 8.11% (7.99-8.23) to 8.30% (8.16-8.43) ($p=0.046$). Triglyceride levels rose from 189.17 mg/dl (181.13-197.21) to 215.12 mg/dl (202.80-227.45) ($p=0.001$). Significant deterioration in glucose ($p<0.000$), triglycerides ($p<0.001$), and HbA1c ($p=0.046$) levels was observed during the pandemic.

**Conclusion:** The COVID-19 lockdown negatively impacted the glycemic control and lipid profiles of patients with type 2 diabetes, indicating a potential worsening of metabolic parameters during this period.

**Keywords:** Diabetes mellitus, COVID-19, diabetes complications

## INTRODUCTION

Coronaviruses are significant pathogens capable of causing infections in both humans and animals. COVID-19, caused by severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2), was first identified in Wuhan, China, in late 2019 and rapidly spread across the globe. The World Health Organization (WHO) declared it a pandemic in March 2020.[1] The COVID-19 pandemic has become one of the foremost health challenges of the last century.

Similarly, diabetes mellitus (DM) has also been declared a pandemic by WHO. It is a chronic metabolic disorder characterized by hyperglycemia, necessitating ongoing medical care.[2] Type 2 DM, a common chronic illness, is increasingly prevalent worldwide. The incidence of diabetes has risen significantly in recent years. For instance, the global number of individuals with DM was estimated at 285 million in 2009, 366 million in 2011, 415 million in 2015, and 425 million in 2017. Projections indicate there will be 578 million cases by 2030 and 700 million by 2045.[3] In our country, data reveal that the number of diabetes patients has doubled over the past decade. Moreover, the prevalence of diabetes among adults exceeded 13.4% in 2010.[4] The coexistence of these two pandemics-the COVID-19 pandemic and the diabetes pandemic has led to a significant number of individuals affected by both conditions, resulting in poorer health outcomes for these patients.[5]

The presence of diabetes negatively impacts clinical outcomes in various disease states. It is frequently associated with metabolic disorders involving proteins, fats, and electrolytes, as well as acid-base imbalances. Diabetic patients face a heightened risk of vascular diseases affecting the brain, heart, or kidneys compared to non-diabetic individuals.

In Turkiye, schools and universities were closed on March 16, 2020, following the first official case reported on March 11, 2020. Throughout March, the government imposed a series of restrictions, closing public facilities such as cinemas, theaters, cafes, sports arenas, and entertainment venues. Domestic and international travel restrictions were enacted, and lockdown measures were put in place for individuals under 18 and over 65. These restrictions began to be gradually lifted starting June 1, 2020. Consequently, outpatient clinical services were disrupted, adversely affecting the follow-up care of diabetes patients. A study from China indicated a deterioration in

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glycemic control and elevated fasting blood sugar levels among individuals with diabetes during the COVID-19 pandemic.[6]

During the pandemic, the management of diabetic patients, along with many other health issues, faced significant disruptions. These included barriers to accessing healthcare services and inconsistencies in the supply of necessary medications. The experiences recorded during previous crises suggest a likelihood of increased rates of diabetes and associated complications both during and after the pandemic. Additionally, the lack of opportunities for physical exercise, challenges in adhering to dietary regimens, and psychological stress related to illness anxiety further complicate blood sugar regulation in diabetic patients during this period.

In this context, we aim to investigate the impact of the COVID-19 pandemic on the management and blood sugar levels of patients with diabetes mellitus.

## METHODS

### Ethics

Ethical approval was obtained from the Akdeniz University Faculty of Medicine Clinical Researches Ethics Committee (Date: 18.08.2021, Decision No: KAEK-559-560). Furthermore, the study was approved by the Ministry of Health of the Republic of Turkiye (2021-06-24T22_43_30) for the research. All procedures comply with the provisions of the Declaration of Helsinki.

### Study Design

Type 2 DM patients who applied to Akdeniz University Medical Faculty Hospital Internal Diseases Polyclinic between 11.03.2019-10.03.2021 were included in the study. Patients under 18 and patients who followed up for type 1 DM were not included in the study. The patient's clinical and laboratory data (age, gender, glucose, creatinine, LDL, triglyceride, HDL, hemoglobin, HbA1c) in the hospital database were collected.

### Statistical Analysis

Data were analyzed using SPSS version 20.0 software (IBM Corp., USA). Quantitative data were reported as means with standard deviations (SD) for parametric distributions and as medians with minimum and maximum values for non-parametric distributions. The Kolmogorov-Smirnov test was employed to assess the distribution of variables. A one-way ANOVA was conducted for parametric data, while the Welch ANOVA test was utilized to compare means between groups when homogeneity of variance assumptions were violated. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

### Patients Demographics

The study included a total of 1,715 patients diagnosed with diabetes mellitus (DM). Of these, 828 (48.2%) were male, and 887 (51.8%) were female. The participants' mean age was 58.49 years, ranging from 19 to 93 years.

Before the pandemic, 930 patients were admitted to the internal medicine outpatient clinic, compared to 785 patients during the pandemic. Among individuals with type 2 DM, the mean age prior to the pandemic was 59.01 years (range: 58.26-59.76), while during the pandemic, it was slightly lower at 57.90 years (range: 57.06-58.73).

A subgroup analysis was conducted based on age groups. Among 1,178 patients under 65 years old, the mean age was 53.13 years (range: 52.43-53.83) before the pandemic and 52.02 years (range: 51.29-52.74) during the pandemic. For the 537 patients aged 65 years and older, the mean age was 71.32 years (range: 70.69-71.94) prior to the pandemic and 71.49 years (range: 70.79-72.19) during the pandemic (Table 1).

**Table 1. Demographic characteristics of the patients**

| | | Groups | | |
|---|---|---|---|---|
| **Variables** | **Total patients** | **Group 1 (before pandemic)** | **Group 2 (through pandemic)** | **p-value** |
| **Number (%)** | 1715 | 930 | 785 | |
| **Mean age±SD** | | 59.01±0.75 | 57.90±0.83) | 0.052 |
| 65> | 1178 | 53.13±0.7 | 52.02±0.72 | 0.030 |
| <65 | 537 | 71.32±0.62 | 71.49±0.7 | 0.714 |
| **Gender (%)** | 1715 | | | |
| Male | 828 | 448 | 380 | |
| Female | 887 | 482 | 405 | |
| **Glucose (mg/dl, mean±SD)** | 158.69±3.28 | 153±4.47 | 165±5.62 | 0.000< |
| **Serum creatinine (mg/dl, mean±SD)** | 0.92(0.81-1.03) | 0.95±0.2 | 0.87±0.3 | 0.797 |
| **LDL (mg/dl, mean±SD)** | 123.31±1.7 | 122.56±2.24 | 124.33±2.62 | 0.314 |
| **HDL (mg/dl, mean±SD)** | 43.82±0.46 | 43.88±0.62 | 43.75±0.7 | 0.781 |
| **Triglyceride (mg/dl, mean±SD)** | 200.64±7.15 | 189.17±8.04 | 215.12±12.32 | 0.001 |
| **25-OH vitamin D3 (ng/ml, mean±SD)** | 18.93±0.33 | 18.94±0.36 | 19.27±0.6 | 0.350 |
| **HbA1c (%)** | 8.20±0.9 | 8.11±0.12 | 8.30±0.14 | 0.046 |
| **Vitamin B12 (pg/ml, mean±SD)** | 400.58±9.78 | 398.28±11.32 | 407.4±16.65 | 0.374 |
| **Hemoglobin (g/L, mean±SD)** | 13.33±0.8 | 13.33±0.11 | 13.34±0.13 | 0.918 |
| **Ferritin (ng/ml, mean±SD)** | 82.56±6.06 | 83.12±8.96 | 81.03±7.91 | 0.731 |
| **TSH (mU/L, mean±SD)** | 2.38±0.23 | 2.49±0.38 | 2.24±0.23 | 0.279 |
| **FT4 (ng/dl, mean±SD)** | 1.20±0.1 | 1.20±0.1 | 1.20±0.1 | 0.665 |

SD: Standard deviation, LDL: Low density lipoprotein, HDL: High density lipoprotein, TSH: Thyroid stimulating hormone, FT4: Free thyroxine

### Lockdown May Lead to Poorer Blood Glucose Control Among Individuals with DM

The study revealed notable changes in key metabolic parameters among patients with diabetes mellitus before and during the pandemic. The mean glucose level increased significantly from 153 mg/dl (range: 149.25-157.47) before the pandemic to 165 mg/dl (range: 160.14-170.62) during the pandemic (p<0.001). Similarly, the average HbA1c level rose from 8.11% (range: 7.99-8.23) before the pandemic to 8.30% (range: 8.16-8.43) during the pandemic, a statistically significant difference (p=0.046).

In addition, the mean triglyceride level showed a marked increase, rising from 189.17 mg/dl (range: 181.13-197.21) before the pandemic to 215.12 mg/dl (range: 202.80-227.45) during the pandemic (p=0.001). These findings indicate a significant worsening in glucose (p<0.001), triglyceride (p<0.001), and HbA1c (p=0.046) levels during the pandemic, reflecting an overall decline in glycemic and lipid control among patients with diabetes.

### The Lockdown can Worsen Metabolic Syndrome in Both Men and Women

The analysis of gender differences revealed that women experienced a significant increase in triglyceride levels during the pandemic. Before the pandemic, the mean triglyceride level in women was 177.33 mg/dl (range: 168.04-186.62), which rose to 201.38 mg/dl (range: 187.77-214.99) during the pandemic (p=0.004). In contrast, no significant gender-based differences were observed for glucose levels (p=0.078) or HbA1c levels (p=0.706) (Table 2).

When comparing the biochemical parameters of male and female individuals before and during the pandemic, significant changes were observed. The average glucose level increased from 158.60 mg/dl (range: 152.82-164.38) before the pandemic to 174.33 mg/dl (range: 166.69-181.97) during the pandemic (p<0.001). Similarly, the average triglyceride level rose from 201.60 mg/dl (range: 188.27-214.94) before the pandemic to 229.80 mg/dl (range: 208.89-250.70) during the pandemic (p=0.026). Additionally, the average HbA1c increased from 8.23% (range: 8.06-8.41) before the pandemic to 8.57% (range: 8.35-8.78) during the pandemic, reflecting a statistically significant difference (p=0.018) (Table 3).

## DISCUSSION

This study examined the impact of the national lockdown in Turkiye on patients with type 2 diabetes mellitus (T2DM) during the global COVID-19 pandemic. Overall, the findings indicate that the lockdown had a detrimental effect on the health status of T2DM patients across both genders. Significant deteriorations in key biochemical parameters were observed, reflecting poorer glycemic control and worsening metabolic syndrome. These results underscore how lifestyle changes induced by the lockdown negatively influenced the disease trajectory and metabolic control in individuals with diabetes.[7]

Key factors contributing to these adverse outcomes included reduced physical activity, disruptions to dietary routines, and limited access to healthcare services. The inability to visit hospitals or pharmacies, treatment discontinuation due to infection fears, lack of physician oversight for critical interventions, and heightened anxiety and stress-especially in a population already prone to depression-further exacerbated these challenges.[8] A study conducted in Spain on dietary habits among T2DM patients during the lockdown revealed efforts to improve nutrition, such as increased vegetable consumption and reduced intake of fast food. However, it also noted an increased consumption of carbohydrate-rich foods, likely driven by boredom and stress. This shift, combined

**Table 2. Biochemical parameters of female individuals before and during the pandemic**

| | | Groups | | |
|---|---|---|---|---|
| **Variables** | **Total patients** | **Group 1 (before pandemic)** | **Group 2 (through pandemic)** | **p-value** |
| **Number (%)** | 887 | 482 | 405 | |
| **Age, mean±SD** | | 59.80±1.1 | 58.20±1.01 | 0.046 |
| 65> | 590 | 310 | 280 | |
| 65< | 297 | 172 | 125 | |
| **Glucose (mg/dl, mean±SD)** | 887 | 148.74±5.9 | 157±6.1 | 0.078 |
| **Serum creatinine (mg/dl, mean±SD)** | 887 | 0.97±0.39 | 0.76±0.30 | 0.304 |
| **LDL (mg/dl, mean±SD)** | 887 | 125.99±3.8 | 128.10±3.4 | 0.376 |
| **HDL (mg/dl, mean±SD)** | 887 | 47.75±1.1 | 47.56±1.1 | 0.791 |
| **Triglyceride (mg/dl, mean±SD)** | 887 | 177.33±10.9 | 201.38±12.1 | 0.004 |
| **25-OH vitamin D3 (ng/ml, mean±SD)** | 887 | 18.11±0.5 | 19.07±0.85 | 0.078 |
| **HbA1c (%)** | 887 | 8.02±0.19 | 8.04±0.27 | 0.706 |
| **Vitamin B12 (pg/ml, mean±SD)** | 887 | 398.91±15.9 | 422.19±24.5 | 0.128 |
| **Hemoglobin (g/L, mean±SD)** | 887 | 12.51±0.13 | 12.67±0.11 | 0.107 |
| **Ferritin (ng/ml, mean±SD)** | 887 | 59.79±7.1 | 57.96±11.9 | 0.787 |
| **TSH (mU/L, mean±SD)** | 887 | 2.64±0.4 | 2.24±0.23 | 0.78 |
| **FT4 (ng/dl, mean±SD)** | 887 | 1.19±0.02 | 1.19±0.02 | 0.686 |

SD: Standard deviation, LDL: Low density lipoprotein, HDL: High density lipoprotein, TSH: Thyroid stimulating hormone, FT4: Free thyroxine

**Table 3. Biochemical parameters of male individuals before and during the pandemic**

| | | Groups | | |
|---|---|---|---|---|
| **Variables** | **Total patients** | **Group 1 (before pandemic)** | **Group 2 (through pandemic)** | **p-value** |
| **Number (%)** | 828 | 448 | 380 | |
| **Age, mean±SD** | | 58.16±1.07 | 57.57±1.19 | 0.470 |
| Number | | 448 | 380 | |
| 65> | 588 | 318 | 270 | |
| 65< | 240 | 130 | 110 | |
| **Glucose (mg/dl, mean±SD)** | 828 | 158.60±5.78 | 174.33±7.64 | 0.001 |
| **Serum creatinine (mg/dl, mean±SD)** | 828 | 0.94±0.29 | 0.98±0.3 | 0.101 |
| **LDL (mg/dl, mean±SD)** | 828 | 118.95±8.31 | 120.23±3.91 | 0.619 |
| **HDL (mg/dl, mean±SD)** | 828 | 39.68±0.74 | 39.46±0.8 | 0.685 |
| **Triglyceride (mg/dl, mean±SD)** | 828 | 201.60±13.33 | 229.80±2.91 | 0.026 |
| **25-OH vitamin D3 (ng/ml, mean±SD)** | 828 | 19.99±0.43 | 19.60±0.75 | 0.378 |
| **HbA1c (%)** | 828 | 8.23±0.17 | 8.57±0.22 | 0.018 |
| **Vitamin B12 (pg/ml, mean±SD)** | 828 | 396.50±15.79 | 390.89±21.39 | 0.678 |
| **Hemoglobin (g/L, mean±SD)** | 828 | 14.25±0.14 | 14.05±0.19 | 0.104 |
| **Ferritin (ng/ml, mean±SD)** | 828 | 116.53±16.80 | 111.51±10.80 | 0.622 |
| **TSH (mU/L, mean±SD)** | 828 | 2.32±0.67 | 2.24±0.44 | 0.843 |
| **FT4 (ng/dl, mean±SD)** | 828 | 1.21±0.01 | 1.21±0.02 | 0.887 |

SD: Standard deviation, LDL: Low density lipoprotein, HDL: High density lipoprotein, TSH: Thyroid stimulating hormone, FT4: Free thyroxine

with reduced physical activity, contributed to elevated blood glucose, HbA1c, and triglyceride levels.[9]

A simulation model using multivariate regression analysis compared the effects of previous natural disasters with those of the COVID-19 lockdown on patients with diabetes. The analysis identified a linear relationship between the duration of isolation and the worsening of diabetes-related complications.[10] For example, during the Gulf War, which involved a 60-day lockdown, patients with type 1 and type 2 diabetes experienced worsened glycemic control and weight gain, although these changes were not statistically significant.[11] 1999 Marmara earthquake removed from discussion

In the present study, a significant increase in HbA1c levels was observed in both male and female patients following the lockdown, aligning with findings from previous research.[12-15] These results emphasize the profound impact of pandemic-induced restrictions on the metabolic health of T2DM patients, highlighting the need for proactive strategies to mitigate such effects during future public health emergencies.

Our findings revealed that the worsening of HbA1c levels was more pronounced in men compared to women. This disparity may be attributed to the lower number of female patients presenting to outpatient clinics during the pandemic compared to pre-pandemic levels (**Table 2**). Despite this gender-based difference, our results align with previous studies showing an overall exacerbation of HbA1c levels in patients, regardless of gender. This deterioration is likely associated with prolonged periods of lockdown, weight gain, and impaired glycemic control.[14-17]

A similar trend was observed in patients with type 1 diabetes mellitus (T1DM) in India, where glycemic control worsened following the lockdown.[17] Conversely, studies from Europe reported an improvement in glycemic control among T1DM patients during the lockdown period.[18,19] The authors of these studies hypothesized that the increased availability of time for self-management during lockdowns may have allowed patients to better regulate their condition.

The adverse effects of various disasters on chronic disease management and quality of life are well-documented. Our findings emphasize the critical importance of closely monitoring vulnerable populations, such as individuals with diabetes, during public health crises and other disruptive events to mitigate the potential worsening of disease outcomes.[20]

### Limitations

Although this article compared two different time points, it was challenging to establish a precise causal relationship between the data and the constraint. Furthermore, our study did not include a detailed assessment of factors that may affect patients' glycemic values, such as lifestyle changes, dietary compliance, stress factor, and access to medications during restriction. Third, anthropometric assessments such as body-mass index could not be evaluated.

## CONCLUSION

The mandatory quarantines imposed during the COVID-19 pandemic have caused significant changes in lifestyle, dietary habits, and social isolation, leading to a rapid and substantial deterioration in cardiometabolic health among our patients. In other words, the SARS-CoV-2 outbreak has triggered a swift rise in metabolic syndrome cases and worsened diabetes in individuals already living with the condition. Prolonged and persistent stress, coupled with social isolation, has had harmful effects on cardiometabolic health. The impact of COVID-19 restrictions, isolation, and loneliness on health and mortality highlights the worsening of diabetes management, treatment, and complications. Our results demonstrated that lockdown has been lead to worsening metabolic syndrome

both in males and females. Future research will shed light on the long-term cardiometabolic consequences and burdens resulting from the COVID-19 pandemic.

## ETHICAL DECLARATIONS

### Ethics Committee Approval

The study was carried out with the permission of the the Akdeniz University Faculty of Medicine Clinical Researches Ethics Committee (Date: 18.08.2021, Decision No: KAEK-559-560).

### Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

The authors declared that this study has received no financial support.

### Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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