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The Effects of the COVID-19 Pandemic Process on the Treatment and Follow-up of Diabetes Mellitus in Type 2 Diabetic Patients

Tip 2 Diyabetik Hastalarda COVID-19 Pandemi Sürecinin Diabetes Mellitus Tedavi ve İzlemine Etkileri

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ABSTRACT

Background: During the Coronavirus disease-2019 (COVID-19) pandemic, the frequency of doctor visits may decrease in patients with type 2 diabetes, physical activity may decrease due to restrictions, and eating habits may change. This study aimed to examine the impact of the COVID-19 on glycemic control, lipid profile, body mass index (BMI), blood pressure, and liver and kidney functions in patients with type 2 diabetes.

Materials and Methods: In this study, the biochemical values of type 2 diabetic patients admitted to the internal medicine and endocrinology outpatient clinics of our hospital between 01/04/2022 and 01/04/2023 were compared with their initial values before and during the pandemic. In addition, anti-diabetic drugs, BMI, blood pressure, and frequency of doctor visits were compared before and after the pandemic.

Results: The patients' glycated hemoglobin (HbA1c) levels demonstrated a significant increase from both their initial and current readings during the pandemic, surpassing the values before the pandemic ($p<0.05$). Additionally, the initial glucose levels of the patients during the pandemic also exhibited a notable rise in contrast to the pre-pandemic measurements ($p<0.05$). On the other hand, the current levels of total cholesterol, low-density lipoprotein cholesterol, and BMI for the patients saw a significant decrease in relation to their pre-pandemic values ($p<0.05$).

Conclusion: This study noted a decline in the frequency of doctor visits and a subsequent deterioration in glycemic control among patients with type 2 diabetes during the COVID-19 pandemic. In case of a natural disaster that may occur, deterioration in glycemic control can be prevented by increasing physical activities, paying attention to diet, and providing intensified diabetes treatment with tele-medicine when necessary.

Keywords: COVID-19 pandemic, glucose, HbA1c, type2 diabetes mellitus

ÖZ

Amaç: Koronavirüs hastalığı-2019 (COVID-19) pandemi sürecinde tip 2 diyabetli hastalarda hekim başvuru sıklığı azalabilmekte, kısıtlamalara bağlı fiziksel aktivitelerde azalma ve yemek yeme alışkanlıkları değişebilmektedir. Bu çalışmamızda COVID-19 pandemi sürecinin tip 2 diyabetli hastalarda glisemik kontrol, lipid profili, beden kitle indeksi (BKİ), kan basıncı, karaciğer ve böbrek fonksiyonları üzerine etkisini incelemeyi amaçladık.

Gereç ve Yöntemler: Bu çalışmada 01/04/2022 ile 01/04/2023 tarihleri arasında hastanemiz iç hastalıkları ve endokrinoloji polikliniğine başvurmuş tip 2 diyabetik hastaların rutin tetkikleri sırasında bakılmış olan biyokimyasal değerleri, pandemi öncesi ve pandemi sürecindeki ilk değerleri ile karşılaştırıldı. Ayrıca kullandığı anti-diyabetik ilaçlar, BKİ, kan basıncı, hekim başvuru sıklığı pandemi öncesi ve sonrası karşılaştırıldı.

Bulgular: Hastaların pandemi sürecindeki ilk glikozlanmış hemoglobin (HbA1c) değeri ve güncel HbA1c değeri, pandemi öncesi değerine göre anlamlı düzeyde artmıştır ($p<0,05$). Hastaların pandemi sürecindeki ilk glukoz değeri de pandemi öncesine göre anlamlı düzeyde artmıştır ($p<0,05$). Hastaların güncel toplam kolesterolü, düşük yoğunluklu lipoprotein (LDL) kolesterol ve BKİ değerleri, pandemi öncesine göre anlamlı düzeyde azalmıştır ($p<0,05$).

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ÖZ

Sonuç: Bu çalışmada COVID-19 pandemi sürecinde tip 2 diyabetli hastalarda hekim başvuru sıklığının azaldığını ve glisemik kontrolün bozulduğunu gözlemledik. İleride meydana gelebilecek doğal afet durumunda fiziksel aktiviteler artırılıp, beslenme tarzına dikkat edilip, tele-tıp ile gerektiğinde yoğunlaştırılmış diyabet tedavisi verilerek glisemik kontrolde bozulmanın önüne geçilebilir.

Anahtar Kelimeler: COVID-19 pandemisi, glukoz, HbA1c, tip 2 diabetes mellitus

Introduction

Coronavirus disease-2019 (COVID-19), which emerged in December 2019 in Wuhan, Hubei province of China, and was declared a pandemic on March 11, 2020, is an infectious disease caused by severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) (1). According to World Health Organization (WHO) data, as of January 29, 2023, it has caused more than 753 million cases and more than 6.8 million deaths worldwide (2). Bats are natural hosts of alpha and beta coronaviruses. The Hunan seafood market in Wuhan, China, is the starting point of the COVID-19 outbreak, and bats are considered possible SARS-CoV-2 reservoirs (3,4). According to WHO data, the number of patients with diabetes increased from 108 million in 1980 to 422 million in 2014. In 2014, 8.5% of adults over the age of 18 years had diabetes. In 2019, 1.5 million diabetes-related deaths occurred (5). According to the TURDEP-II study conducted in our country in 2010, the prevalence of diabetes was found to be 16.5%. It was 7.2% in the TURDEP-I study conducted 12 years before this study (6). Individuals with diabetes are more likely to develop acute and chronic infections than those without diabetes. Among the 72,314 reported cases of COVID-19 by the Chinese Center for Disease Control and Prevention, diabetic patients experienced a mortality rate of 7.3%, whereas non-diabetic patients had a lower mortality rate of 2.3%. Viral infections may cause dysregulation in glucose levels in diabetic patients or new-onset diabetes in those without a history of diabetes (7).

The curfew, change in eating habits, decrease in physical activity, and difficulties in accessing medications used for diabetes during the COVID-19 pandemic had a negative impact on blood glucose levels (8). The COVID-19 pandemic presented challenges in effectively managing patients with diabetes mellitus. Even if patients with diabetes were not infected with COVID-19, they were at risk of irregular glycemic control because of restrictive measures that jeopardized healthcare delivery (9). Doctors should be aware of the impact of social distancing and quarantine measures on glycemic control when treating patients with diabetes. Urging people to stay home during the pandemic reduced the amount of physical exercise compared with the normal daily routine. Although there is no reliable data on this, it can be expected that calorie balance may have increased in some patients with diabetes during the COVID-19 process. Both situations may lead to deterioration in glycemic control (10). During the COVID-19 pandemic, the frequency of routine doctor visits of patients with type 2 diabetes may change, physical activity may decrease due to restrictions, and eating habits may change. The purpose of this study was to investigate the impact of COVID-19 on various aspects including glycemic control, liver and kidney functions, lipid profile, body mass index (BMI), systolic and diastolic blood pressure (DBP), and diabetes treatment in patients diagnosed with type 2 diabetes.

Materials and Methods

This is a retrospective quasi-experimental study conducted among patients who applied to the internal diseases and endocrinology outpatient clinic between 01/04/2022 and 01/04/2023 at the University of Health Sciences Türkiye, İstanbul Sultan 2. Abdülhamid Han Training and Research Hospital with the approval number 132781 at the University of Health Sciences Türkiye, Hamidiye Clinical Research Ethics Committee meeting dated 12.05.2022. The power analysis of our study was calculated using the R-Studio program, and the number of patients required at 0.80 power and 0.95 confidence interval was 93, and 120 patients were included in the study, considering 0.2 missing data. Total cholesterol (mg/dL), triglycerides (mg/dL), serum glycated hemoglobin (HbA1c) (%), glucose (mg/dL), aspartate aminotransferase (AST) (U/L), high-density lipoprotein (HDL) cholesterol (mg/dL), low-density lipoprotein (LDL) cholesterol (mg/dL), urea (mg/dL), and creatinine (mg/dL) were measured during routine examinations. Alanine aminotransferase (ALT) (U/L) values were screened retrospectively, and the latest values before the COVID-19 pandemic in our country (before March 1, 2020) and the first values during the pandemic (after June 1, 2020) and the current values in outpatient clinic applications were compared. In addition, the frequency of doctor visits for annual routine control before the COVID period, the frequency of doctor visits for annual routine control during the COVID period, the antidiabetic drugs used before the COVID period, and

the drugs currently used were questioned. The BMI (kg/m^2) and arterial blood pressure (mm/Hg) values before the COVID period were compared with the current values during the last outpatient clinic visit. The inclusion criteria were as follows: adult patients over 18 years of age and under 75 years of age, patients with type 2 diabetes mellitus diagnosed at least one year before the start of the COVID-19 pandemic (before March 1, 2019), patients without any known history of malignancy, and people without psychiatric disability who can personally give consent for the examination of file records in the study. Patients under 18 years of age and over 75 years of age, patients with type 1 diabetes mellitus, patients with gestational diabetes mellitus, pregnancy status, and breastfeeding, patients with any known history of malignancy, and patients with psychiatric disability who could not give personal consent for the examination of file records in the study were excluded.

Statistical Analysis

Parametric tests were used without normality tests because of conformity with the central limit theorem (11). In the data analysis, the mean and standard deviation, median, minimum, and maximum values were given for the statistics of continuous data. Descriptive statistics are given as number (n) and percentage (%) for categorical variables. A paired t-test was used to evaluate the difference between two dependent measurements. Repeated ANOVA test statistic was used to compare the mean of more than two (3) measurements, and in case of a difference, pairwise comparisons were evaluated using Tukey statistics. The statistical significance level of the data was taken as $p<0.05$. IBM SPSS 21 and the MedCalc statistical package program was used for data evaluation.

Results

The study included 120 patients with type 2 diabetes admitted to the internal medicine and endocrinology outpatient clinic of İstanbul Sultan 2. Abdülhamid Han Training and Research Hospital between 01/04/2022 and 01/04/2023. Table 1 presents the descriptive characteristics of the patients. The minimum age of the patients was 35 years, and the maximum age was 74 years, with a mean age and standard deviation of 58.1±8.22 and a median value of 58 years. The minimum duration of diabetes was 4 years and the maximum was 35 years. The mean duration and standard deviation were 11.8±6.5 years, and the median was 10. 45.8% of the patients had a history of COVID. While the mean number of annual doctor visits was 2.6±1.1 times before the pandemic, it was 1.8±0.99 times during the pandemic period, which was lower. While 30% of the patients were using insulin before the pandemic, the number of patients using insulin increased during the pandemic, and 41.7% of the patients are currently using insulin.

Table 2 shows the change in the patients' biochemical values depending on the pandemic time. The change in the mean HbA1c value of the patients according to time was significant ($p<0.05$). The mean pre-pandemic HbA1c value (%) was 7.79±1.75, the first HbA1c value (%) during the pandemic was 8.51±2.13, and the current HbA1c value (%) was 8.17±2.01. The initial HbA1c value of the patients during the pandemic increased significantly compared with the pre-pandemic HbA1c value ($p<0.05$). The current HbA1c value also increased significantly compared with the pre-pandemic HbA1c value ($p<0.05$). The initial glucose value of the patients during the pandemic process increased

Table 1. Distribution of patients diagnosed with type 2 diabetes based on descriptive characteristics (n=120)

Descriptive characteristics	**Mean ± SD**	**Median (min-max)**
Age	58.1±8.22	58 (35-74)
Gender	**Number (n)**	**Percentage (%)**
Female	77	64.2
Male	43	35.8
Hypertension	77	64.2
Cardiovascular disease	21	17.5
COVID	55	45.8
Current cigarette use	30	25
Smoking before the pandemic	35	29.2
Insulin use before the pandemic	36	30
Current use of insulin	50	41.7
Anti-diabetic drug use before the pandemic		
Single oral antidiabetic	34	28.3
Dual oral antidiabetic	23	19.2
Triple oral antidiabetic	27	22.5
Insulin	36	30
Current use of anti-diabetic drugs		
Single oral antidiabetic	21	17.5
Dual oral antidiabetic	18	15
Triple oral antidiabetic	31	25.8
Insulin	50	41.7
	Mean ± SD	**Median (min-max)**
DM duration	11.8±6.5	10 (4-35)
Annual number of pre-COVID doctor referrals	2.6±1.1	2 (1-4)
Annual number of doctor referrals during the COVID period	1.8±0.99	2 (1-4)

SD: Standard deviation, COVID: Coronavirus, DM: Diabetes mellitus

significantly compared with the pre-pandemic glucose value (p<0.05). The current glucose value decreased significantly compared with the first glucose value during the pandemic (p<0.05). Current total cholesterol and LDL cholesterol values of the patients decreased significantly compared with pre-pandemic total cholesterol and LDL cholesterol values (p<0.05). Current AST and ALT values of the patients decreased significantly compared with pre-pandemic AST and ALT values (p<0.05). The current AST and ALT values of the patients decreased significantly compared with those at the beginning of the pandemic (p<0.05). The current urea value of the patients increased significantly compared with the pre-pandemic urea value (p<0.05). There was no significant difference between the patients' HDL cholesterol, triglyceride, and creatinine values during the pandemic and pre-pandemic (p>0.05).

Table 3 illustrates the changes in the patients' systolic blood pressure (SBP), BMI, and DBP values according to the time of the pandemic. The patients' mean BMI before the pandemic was 30.92±5.74 (kg/m^2), whereas the current value was 30.4±5.64 (kg/m^2). The patients' current mean BMI values showed a significant decrease from the pre-pandemic BMI value (p<0.05). Likewise, the patients' current mean DBP values exhibited a significant decrease from the pre-pandemic DBP value (p<0.05). No significant difference was found between the pre-pandemic and current SBP values (p>0.05).

Discussion

The course of the global COVID-19 has revealed that COVID-19 and diabetes share a mutual link. Diabetes increases the risk of having a serious COVID-19 infection, and COVID-19 infection is also associated with the development of diabetes and deterioration of diabetes control (12). The COVID-19 pandemic has caused healthcare access and medication difficulties for patients with chronic conditions. Patients avoided face-to-face care because of fear of exposure to COVID-19. In the study conducted by Yoon et al. (13) in the early pandemic period, there were decreases in the rates of primary care visits, emergency room visits, and hospitalizations. Similar to this study, it was determined that the frequency of doctor visits decreased during the pandemic. During the COVID-19 pandemic, the number of applications to primary healthcare services and

Table 2. Change in biochemistry values depending on the pandemic period (n=120)

	Before the pandemic	Pandemic period first value	Current	Repeated ANOVA test	Post-hoc Tukey test
	Mean ± SD	Mean ± SD	Mean ± SD	p-value	p-value 1 vs. 2,1 vs. 3,2 vs 3
HbA1c (%)	7.79±1.75	8.51±2.13	8.17±2.01	**<0.001**	**<0.001/0.04/**0.07
Glucose (mg/dL)	159.01±69.48	187.31±81.94	167.84±74.84	**<0.001**	**<0.001/**0.49**/0.03**
Total cholesterol (mg/dL)	206.49±45.64	202.08±48.45	196.81±44.63	**0.04**	0.6**/0.03/**0.51
HDL (mg/dL)	47.71±11.95	47.24±14.16	47.42±13.32	0.8	-
LDL (mg/dL)	122.74±38.71	116.25±37.53	112.34±37.36	**0.004**	0.11**/0.003/**0.65
Triglycerid (mg/dL)	179.98±90.62	201.94±150.42	205.49±140.41	0.08	-
Urea (mg/dL)	30.31±14.56	31.86±14.36	32.97±15.01	**0.02**	0.32**/0.02/**0.58
Creatinine (mg/dL)	0.85±0.21	0.87±0.24	0.84±0.34	0.06	-
AST (U/L)	20.88±11.98	20.66±10.13	17.95±10.16	**<0.001**	0.99**/<0.001/0.004**
ALT (U/L)	26.06±14.59	24.82±15.42	20.46±14.56	**<0.001**	0.99**/<0.001/0.001**

HDL: High-density lipoprotein, LDL: Low-density lipoprotein, HbA1c: Glycated hemoglobin, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, SD: Standard deviation, ANOVA: Analysis of variance

Table 3. Changes in BMI, SBP, and DBP depending on pandemic time (n=120)

	Before the pandemic	Current	Paired t-test
	Mean ± SD	Mean ± SD	p-value
BMI (kg/m^2)	30.92±5.74	30.4±5.64	**0.03**
SBP (mm/Hg)	123.8±13.2	122.3±10.6	0.23
DBP (mm/Hg)	78.9±8.4	76.1±7.3	**0.003**

BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation

consultations decreased. In addition, low-income countries experienced problems accessing drugs and difficulty reaching hospitals during lockdown (14). In our study, we noticed a deterioration in diabetes control among patients with type 2 diabetes among the pandemic. This may be attributed to the decreased frequency of doctor visits for routine control purposes due to patients' compliance with stay-at-home calls during the pandemic, curfews, and fear of being infected with COVID-19.

Fonseca et al. (15) examined the impact of Hurricane Katrina on diabetes in the United States in 2005. A total of 1795 patients participated in the study, with HbA1c values measured 6 months before and 6-16 months after the hurricane. The HbA1c level assessed post-hurricane exhibited a significant increase compared with the pre-hurricane measurement ($p<0.01$) (15). In a study by Inui et al. (16), the effect of the Kobe earthquake in Japan in 1995 on glycemic control in diabetic patients was examined. HbA1c levels in the two years before the earthquake were compared with HbA1c levels 1 year after the earthquake. HbA1c levels increased 3-4 months after the Kobe earthquake and then returned to their previous levels (16). These studies show that natural disasters such as earthquakes and hurricanes have a negative effect on glycemic control in patients with diabetes.

Sasidharan et al. (17) investigated the occurrence of young-onset type 2 diabetes mellitus in individuals aged 21 years and younger before the pandemic, during the initial year of the pandemic, and in the subsequent year of the pandemic. According to their findings, there was an approximately threefold increase in the annual incidence of type 2 diabetes cases during the first year of the pandemic compared with the period before the pandemic. During the second year of the pandemic, the occurrence of type 2 diabetes increased by 61% in contrast to the initial year of the pandemic, and this upward trend persisted (17). In the meta-analysis led by Ojo et al. (18), which encompassed eleven studies, a comprehensive assessment of 16,895 patients with type 2 diabetes was conducted. The study compared HbA1c values before and after the COVID-19 pandemic. Following the pandemic, the average HbA1c level was found to be 0.34% higher than that prior to the pandemic, and this increase was statistically significant ($p<0.01$) (18). Our research outcomes aligned with the findings of this study, indicating a deterioration in diabetes management among patients with type 2 diabetes due to the pandemic. In an investigation carried out by Tanji et al. (19) in Japan, they assessed the impact of the COVID-19 pandemic on glycemic control in individuals with type 2 diabetes. The study encompassed 1009 patients with type 2 diabetes, and HbA1c values were compared before and after the COVID-19 outbreak. Following the COVID-19 outbreak, there was a notable increase in HbA1c values, particularly among women, patients aged 65 years, individuals with a BMI of 25 kg/m^2), and those not using insulin ($p<0.05$) (19). The research conducted by Sawada et al. (20) and associates at Tokyo University Hospital delved into the impact of the COVID-19 pandemic on diabetes control. The study encompassed 408 patients with diabetes, comprising 13 individuals with type 1 diabetes and 395 with type 2 diabetes. It was observed that the mean HbA1c value experienced a significant increase during the COVID-19 pandemic period as opposed to the pre-pandemic period ($p=0.010$) (20).

In a meta-analysis led by Bouchi et al. (21) and his team in Japan, the study delved into the impact of the COVID-19 pandemic on glycemic control. A total of 2348 patients were included in this retrospective analysis, representing 15 different centers. Among these patients, 423 were diagnosed with type 1 diabetes, 1839 with type 2 diabetes, and 86 had other forms of diabetes. The study compared parameters such as HbA1c, lipids, AST, ALT, BMI, and blood pressure (both systolic and diastolic) before the pandemic, in the first year, and in the second year. Despite an initial increase in HbA1c levels during the first year of the pandemic followed by a decrease in the second year, no significant difference was observed ($p>0.05$). This suggests that glycemic control in the patients in this study did not worsen during the pandemic. It is worth noting that the participants in this study were chosen from specialized diabetes care facilities and maintained regular visits to their clinics or hospitals both before and throughout the pandemic. The pandemic led to an intensification of diabetes treatments, effectively averting any deterioration in glycemic control (21). In our study, patients disrupted their routine controls during the pandemic; thus, diabetes treatments could not be intensified, leading to deterioration of glycemic regulation. This meta-analysis found no significant difference in triglyceride and HDL cholesterol levels before and during the pandemic. There was a significant decrease in both LDL and total cholesterol values during the pandemic ($p<0.01$). In our study, similar to this, we found no significant difference in triglyceride and HDL cholesterol values during the pandemic, whereas total cholesterol and LDL cholesterol values decreased significantly ($p<0.05$). In this study, the mean BMI was 25.2 (kg/m^2) before the pandemic and 25.1 (kg/m^2) during the pandemic and decreased significantly ($p<0.01$). Both in this study and our study, the significant decrease in BMI during the pandemic may have caused a decrease in total and LDL cholesterol levels. In this study, no notable disparity was detected in SBP. However, a significant reduction in DBP

was observed in the second year of the pandemic compared with the pre-pandemic period ($p<0.01$). This aligns with findings similar to those of this study whereby SBP showed no significant variance, whereas DBP exhibited a significant decrease during the pandemic period in contrast to the pre-pandemic period ($p<0.05$).

In a study by Khare and Jindal (22) in India, 143 patients' pre-pandemic fasting and postprandial blood glucose values at the second hour after breakfast were compared with those in the third week of quarantine. Before the pandemic, the mean fasting blood glucose level was 115.9 mg/dL and increased to 119.4 mg/dL in the third week of quarantine. However, this increase was not significant ($p>0.05$). The patients' mean 2nd-hour post-prandemic post-prandial blood glucose value was 124.9 mg/dL before the pandemic and increased to 159 mg/dL in the third week of quarantine. This increase was significant ($p=0.02$). This study showed that general glycemic control deteriorated during the 3-week quarantine period (22). In our study, the difference between the mean fasting glucose values last checked before the pandemic and those checked during the pandemic was significant ($p<0.05$). In our research, we scrutinized data collected at a minimum of three months following the onset of the pandemic. This timeframe is crucial for observing the pandemic's impact more clearly. Nonetheless, our findings corroborate that glycemic control was compromised during the pandemic, aligning with the results of this study.

Wu et al. (23) conducted a study investigating the impact of COVID-19 on renal function. The study included 758 stage 5 chronic kidney patients not receiving dialysis. This study found no significant difference between blood creatinine levels before and during the pandemic (23). Our study found no significant difference in the creatinine levels measured before and during the pandemic ($p>0.05$). In López-González et al. (24) in Spain, the effect of the COVID-19 pandemic process on non-alcoholic fatty liver disease and insulin resistance was examined. In this study, 6236 patients participated, and AST, ALT, BMI, and waist-hip circumference were analyzed in 2018, 2019, and 2020, the pandemic years. Patients exhibited a significant increase in AST and ALT values during the pandemic in contrast to the years preceding it ($p<0.001$). Furthermore, there was a significant rise in BMI, waist circumference, and hip circumference in these patients during the pandemic compared with the years before it ($p<0.001$) (24). In this study, the increase in AST and ALT values during the pandemic may be related to non-alcoholic fatty liver disease with increased BMI and waist-hip circumference. In our research, it was observed that the mean AST and ALT values registered a significant decrease during the pandemic compared with the pre-pandemic measurements ($p<0.05$). Additionally, there was a reduction in BMI values in the pandemic period as opposed to the pre-pandemic period. In both our study and the referenced one, AST and ALT values demonstrated a correlation with BMI.

Several meta-analyses have shown that obesity increases the severity of COVID-19 infection but does not increase mortality (25,26,27). A decrease in physical activity was observed during the COVID-19 pandemic. Based on step count estimates, in more than 30 million people in Europe, there was a decrease in physical activity between 7% and 38% during the pandemic (28). Our study found that the current average BMI values during the pandemic were lower than the pre-pandemic values. Our study examined current BMI values between 01/04/2022 and 01/04/2023. This period is two years after the pandemic began and is when the curfew and some restrictions were lifted. The BMI may have increased because of the decrease in physical activities at the beginning of the pandemic process, and with the lifting of the bans and restrictions, patients may have paid more attention to their physical activities and diet, and their BMI may have decreased.

Study Limitations

This study has some limitations. This is a retrospective study comparing pre-pandemic biochemical values such as HbA1c, lipid panel, and liver and kidney functions with their current values at the beginning of the pandemic. Because these biochemical values are not routinely checked in healthy people before and during the pandemic, no healthy control group exists. This study is a quasi-experimental research in which the control group is the patient himself/herself. Our study compared current systolic and DBP and BMI values with pre-pandemic values. Because these values could not be measured before the pandemic because it was a retrospective study, they were given based on the patient's declaration in the patient questioning.

The strength of our study is to examine the effect of the COVID-19 pandemic process on glycemic control in type 2 diabetic patients by comparing the three-month average HbA1c values, which are effective in showing glycemic regulation, with the pre-pandemic, pandemic onset, and current values. The absence of patients with newly diagnosed type 2 diabetes in our study was a factor in the significant increase in the mean HbA1c values during the pandemic compared with the pre-pandemic period.

Conclusion

As a result of this study, the mean HbA1c and glucose values increased significantly in patients with type 2

diabetes during the COVID-19 pandemic compared with the pre-pandemic period ($p<0.05$). During the COVID-19 pandemic, diabetes regulation deteriorated due to reasons such as the decrease in the number of annual doctor visits for diabetes control, a decrease in physical activity due to restrictions, and changes in diet. Our study found that the glycemic control of patients with type 2 diabetes was impaired during the pandemic. In future natural disasters, deterioration in glycemic control can be prevented by increasing physical activity, paying attention to diet, and using telemedicine.

Ethics

Ethics Committee Approval: This is a retrospective quasi-experimental study conducted among patients who applied to the internal diseases and endocrinology outpatient clinic between 01/04/2022 and 01/04/2023 at the University of Health Sciences Türkiye, İstanbul Sultan 2. Abdülhamid Han Training and Research Hospital with the approval number 132781 at the University of Health Sciences Türkiye, Hamidiye Clinical Research Ethics Committee meeting dated 12.05.2022.

Informed Consent: Retrospectively study

Authorship Contributions

Surgical and Medical Practices: E.K., İ.E., A.Y., Concept: E.K., İ.E., A.Y., Design: E.K., İ.E., A.Y., Data Collection or Processing: E.K., Analysis or Interpretation: E.K., İ.E., A.Y., Literature Search: E.K., İ.E., A.Y., Writing: E.K.

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