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MASTER OF SCIENCE THESIS

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TEZ ONAYI FORMU

Kurum: Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü

Program: Halk Sağlığı Yüksek Lisans Programı

Tez Başlığı: Impact of Covid -19 Pandemic on Glycemic Regulation in Type 2 Diabetes Mellitus Patients and Evaluation of Diabetes Distress Scale

Tez Sahibi: Yasmin Adam Hassan

Sınav Tarihi : 27.07.2023

Bu çalışma jurimiz tarafından kapsam ve kalite yönünden Yüksek Lisans Tezi olarak kabul edilmiştir.

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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu'nun 27/07/2023tarih ve 2023/07/27sayılı kararı ile onaylanmıştır.

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Sağlık Bilimleri Enstitüsü Müdürü

DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

Date: 17.07.2023

Signature

Yasmin Hassan

ACKNOWLEDGEMENTS

First and foremost, I express my sincere gratitude to Allah for granting me the strength, will, and ability to accomplish this research project.

I would like to extend my heartfelt thanks and profound gratitude to numerous individuals for their guidance and support. I wish to express my deep appreciation to my supervisor, **Dr. Hale Arık Taşyıkan** for her dedicated efforts, invaluable direction, and supervision throughout this endeavor.

I am immensely grateful and fortunate to have received continuous encouragement, support, and guidance from Prof. Dr. Hasan Aydin and Dr. Ozlem Haliloglu during the data collection phase.

I am deeply thankful to all the patients who graciously agreed to participate in the study, without whom this research would not have been possible.

Furthermore, I would like to express my gratitude to my friends, Bushra Ismail and Muna Moallim Abdulle, and Dr. Samira Abo Al-Shiekh for their unwavering support and encouragement.

Finally, I extend my deepest gratitude to my beloved family members who have stood by me and provided unwavering support throughout the entire process of completing this research project. In particular, I would like to express my heartfelt appreciation to my father, Adam Hassan Bariise, my mother, Shamso Salad Awale, my husband, Suheyb Abdulkhadir Abdi, and my siblings, Zamzam, Samira, Sagal, Mohamed, Mustafa, Hussein, Yusuf, Muno, Rahma, and Hamdi.

With utmost appreciation and respect,

Yasmin Adam Hassan

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LIST OF ABBREVIATIONS

ARDS	Acute Respiratory Syndrome
BMI	Body Mass Index
CT	Computed Tomography
DDS	Diabetes Distress Scale
DM	Diabetes Mellitus
GDP	Gross Domestic Product
GI	Glycaemic Index
GPs	General Practitioners
H.R	Hazard Ratio
HPs	Healthcare Providers
IDF	International Diabetes Federation
LF	Lateral Flow
LMICs	Low Middle Income Countries
PCR	Polymerase Chain Reaction
PEP	Personal Protective Equipment
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
T1D	Type 1 Diabetes
T2D	Type 2 Diabetes
TEMD	Nationwide Survey of Glycemic and Other Metabolic Parameters of Patients with Diabetes Mellitus
TURDEP-II	Second Turkish Diabetes Epidemiological
WHO	World Health Organization

ABSTRACT

HASSAN.Y (2023). Impact of Covid -19 Pandemic on Glycemic Regulation in Type 2 Diabetes Mellitus Patients and Evaluation of Diabetes Distress Scale. Yeditepe University, Institute of Health Science, Department of Public Health, MSc thesis, İstanbul.

Diabetes and COVID-19 have significant impacts on healthcare, with worse outcomes for individuals affected by both conditions. The study design is an observational before and after study design used to assess the effect of Covid-19 pandemic on glycemic regulation in patients with type 2 diabetes mellitus in Turkey. Data were collected through medical records and structured questionnaire over telephone interviews. A total of 70 patients were interviewed, and data from 42 patients were analyzed.

The majority of participants were males (61.4%), married (80.6%), with a mean age of 58.2 years, 48.6% had completed high school education or higher. 24.3% were employed. The majority (79.1%) demonstrated a high level of compliance with medication-taking behavior. The majority of the participants (92.7%) reported low stress. The analysis revealed no statistically significant relationship between exercising and HbA1C levels, both before and after the COVID-19 pandemic ($p = 0.128$, $p = 0.869$, respectively). No significant association was found between contracting COVID-19 and HbA1C levels ($p = 0.846$). Additionally, no significant relationship was observed between COVID-19 infection and compliance with medication ($p = 0.543$). Moreover, no significant differences were found in HbA1C and fasting blood glucose levels between the pre-pandemic and pandemic periods ($p = 0.883$, $p = 0.513$, respectively). These findings highlight the need for ongoing support and interventions for individuals with diabetes during health crises.

Keywords: Diabetes, COVID-19, Type 2 diabetes mellitus, Glycemic regulation, Pandemic impact

ABSTRACT (TURKISH)

HASSAN, Y. (2023). Tip 2 Diabetes Mellitus Hastalarında Covid-19 Pandemisinin Glisemik Regülasyona Etkisi ve Diyabet Sıkıntı Ölçeğinin Değerlendirilmesi. Yeditepe Ü niversitesi Sağ lık Bilimleri Enstitü sü , Halk Sağ lığ ı ABD., Master Tezi. İ stanbul.

COVID-19 pandemisinin sağlık hizmetlerinin devamlılığı üzerinde önemli etkileri olmuştur. Özellikle kronik hastalığı olan bireylerin hastalık izlemi ve yönetiminde aksaklıklar yaşanmıştır. Bu araştırmada, pandeminin diyabetli bireylerde kan şekeri regülasyonu üzerine etkisini ve bu dönemde diyabete bağlı sıkıntı durumunu değerlendirmek amaçlanmıştır. Pandemi öncesi ve pandemi sırasındaki veriler, tıbbi kayıtlar ve telefon görüşmeleri yoluyla yapılandırılmış anket aracılığıyla toplanmıştır. Toplam 70 hasta ile görüşülmüş ve 42 hastanın verileri analizlere dahil edilmiştir. Katılımcıların çoğunluğu (%79.1) tedavi alma davranışına yüksek uyum göstermiş ve düşük düzeyde (%92.7) stres bildirmiştir. Analizlerde, COVID-19 pandemisinden önce ve sonra yapılan fiziksel aktivite düzeyi (sırasıyla $p = 0.128$, $p=0.869$) ve pandemi sırasında COVID-19 geçirmiş olma ile HbA1C seviyeleri arasında istatistiksel olarak anlamlı bir ilişki saptanmamıştır ($p = 0.846$). COVID-19 enfeksiyonu ile ilaca uyum arasında da anlamlı bir ilişki gözlenmemiştir ($p=0.543$). Ayrıca, HbA1C ve açlık kan şekeri düzeylerinde pandemi öncesi ve pandemi dönemi arasında anlamlı bir fark bulunmamıştır (sırasıyla $p = 0.883$ ve $p=0.513$). Araştırma sonucunda, araştırma örneğine seçilen hastaların düzenli sağlık hizmetine ulaşabildiği sonucuna ulaşılmış ve sağlık krizleri sırasında diyabetli bireyler için sürekli destek ve müdahalelerin önemi vurgulanmıştır.

Anahtar Kelimeler: Diyabet, COVID-19, glisemik kontrol, pandemi

1. INTRODUCTION AND PURPOSE

1.1 Background

High blood sugar levels are the hallmark symptom of diabetes, commonly known as diabetesmellitus (1). Diabetes places a heavy financial strain on healthcare systems around the world (2). From 30 million in 2000 to 135 million in 2010 (3), and an expected 300 million by 2025 (4), the prevalence of diabetes mellitus is on the rise. Type 2 diabetes, which occurs when the body develops insulin resistance or insufficient insulin production, is the most common form of the disease.

The 2019 (COVID-19) Coronavirus disease was first detected in December in Wuhan, China. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the causative agent of COVID-19 (6). The World Health Organization (WHO) declared COVID-19 a pandemic

(7) due to its fast spread despite containment attempts. In addition to a global mortality rate of 3-4%, COVID-19 can induce severe symptoms such as dry cough, runny nose, sore throat, dysphagia, and even diarrhea and vomiting in rare cases (8). The elderly, those with impaired immune systems, and those with chronic conditions like diabetes or HIV/AIDS are more vulnerable to the severe consequences and mortality caused by SARS-CoV-2 (9-11).

COVID-19 infection has been associated with poor glucose control (12). Patients with diabetes and COVID-19 experience worse outcomes, including higher mortality and morbidity rates (12). Unfortunately, diabetes impairs the host's immune response, and the presence of neuropathy and hyperglycemia further compromises cellular immunity due to insulin deficiency (13). Additionally, studies have indicated that diabetic patients without COVID-19 infection have been negatively affected by lockdown measures implemented during the pandemic (14). As a result of the lockdown imposed to prevent the spread of the pandemic, follow-up and glycemic control of diabetic patients have been interrupted (13). Inactivity, distress, poor diet compliance, and lack of follow-up are all factors that contribute to impaired blood sugar control as a result (13). There are four critical dimensions of distresscaptured by Diabetes distress Scale (DDS) (15).

Despite sufficient research, the effects on type 2 diabetic patients have not been adequately investigated. Therefore, the purpose of our study was to investigate the Impact of COVID -19 pandemic on glycemic regulation in type 2 diabetes mellitus patients and evaluation of Diabetes Distress Scale (DDS).

1.2 Study objectives

1.2.1 The general objectives

To examine the impact of Covid -19 pandemic on glycemic regulation in type 2 diabetes mellitus patients.

1.2.2 The specific objectives

1. To determine the changes in glycemic regulation in type 2 DM patients before and during the pandemic of covid-19 disease.
2. To determine the factors contributing to the glycemic regulation in type 2 DM patients during the pandemic of covid-19 disease.
3. To evaluate the diabetes distress scale on glycemic control in type 2 DM patients during the pandemic of covid-19 disease in terms of treatment compliance, lifestyle, and changes in physical activity.
4. To describe the descriptive factors such as socio-demographic characteristics (age, gender, marital status, education level, BMI, duration of diabetes, any diabetes complications) in patients with type 2 DM during the pandemic of covid-19 disease.

1.3 Study importance

Approximately 6.5 million adults have diabetes mellitus In Turkey and about half of DM patients have co-disease management, as a result of consequently glycemic control below expected levels (16).

DM is a significant public health concern in Turkey, where approximately 95% of all diabetes cases are type 2. Important public health objectives include achieving target glycemic control, providing tertiary protection for diabetes, enhancing quality of life, and preventing diabetes complications. Recent studies have shown a correlation between diabetes and the severity of COVID-19, resulting in higher death rates (10). In a population-based study conducted in England, one-third of patients with COVID-19-related fatalities had

diabetes (31.4% had type 2 diabetes and 1.5% had type 1 diabetes) (11). Despite these results, there is a dearth of research in Turkey investigating the effect of the COVID-19 pandemic on glycemic regulation in type 2 DM patients and evaluating the Diabetes Distress Scale (DDS). Therefore, it is necessary to conduct research in these areas to better comprehend the situation.

1.4 Common influence and added value

The purpose of this research is to investigate how COVID-19 infection affects glycemic regulation in T2DM patients. The study's secondary objective is to determine what aspects of home quarantine during the COVID-19 pandemic contribute to the patients' ability to maintain tight control of their blood sugar levels. With the problems of the epidemic in mind, the results of this study will provide significant insights and recommendations to enhance glycemic management in people with type 2 diabetes mellitus.

This research has the potential to improve the management of diabetes and raise public awareness and health literacy by focusing on glycemic control. As a result, patients may experience fewer serious diabetes-related problems and a higher quality of life.

It is hoped that this research may lead to improved methods for helping those who have type 2 diabetes mellitus keep their blood sugar levels in check when quarantined at home because of things like natural catastrophes or disease outbreaks. These methods can be helpful in guiding future healthcare planning and interventions for people with diabetes in high-risk settings.

2. GENERAL INFORMATION

2.1 Introduction

This chapter examines how the management of disease and access to care was affected by the covid-19 pandemic, and it examines the additional burden that Covid has placed on diabetic patients in Turkey.

2.2 Effects of covid-19 on essential chronic care

Hubei's provincial capital Wuhan saw its first cases of pneumonia with an unknown etiology in December 2019. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) was discovered to be the etiological culprit, and it exhibited genetic characteristics with SARS (17). At first, the epidemic was thought to have originated from a zoonotic transmission at a market for fresh seafood and live animals. However, it soon became obvious that transmission was also happening from person to person (18).

According to the World Health Organization, there were approximately 465 million confirmed cases of COVID-19 worldwide as of March 18, 2022, resulting in approximately 6 million fatalities (19). The peak of daily verified cases occurred during the third week of January 2022, when there were approximately 4 million confirmed cases and approximately 10,000 deaths per day.

An extensive reorganization of healthcare services was necessary to accommodate COVID-19 patients after the sudden and devastating impact of the virus on the global population. A previous study (20) found that healthcare workers from various fields were reassigned to treat people with COVID-19. A related study (21) found that in order to lessen the likelihood of infection, in-person clinic sessions and associated services were either postponed or given with reduced personnel. These changes probably worsened the quality of treatment for vulnerable patients with chronic diseases who, under normal circumstances, need constant monitoring and attention.

The WHO says that this has had a “profound impact” on the delivery of healthcare in at least 44% of the countries that were investigated (22) and this reduction would have had highly adverse effects on patients with chronic underlying health problems. It should be noted that the WHO classification of death within 28 days of being diagnosed with Covid does not mean that the death was actually from Covid but may well have been caused by a

deterioration in the underlying health condition or even from the delay in the provision of normal healthcare for the underlying condition. It has been reported that in America, 42% of patients with underlying chronic health conditions have not turned up for their regular checks and that this may have resulted in delays in timely detection and treatment (23) Another study found that "urgent or emergency care avoidance" was significantly greater in adults who had two or more underlying conditions than adults who had only one condition (24), and it has been reported that in the United States, 42% of patients with underlying chronic health conditions have not shown up for their regular checks, which may have resulted in delays in timely detection and treatment. Furthermore, it was claimed that the number of heart attacks and strokes among people with poorly treated chronic comorbid diseases increased, which would have led to a decrease in the provision of such care as a result of Covid (25). Patients with preexisting conditions like diabetes have undoubtedly been negatively impacted by Covid.

A lowered immune system increases susceptibility to infection in those with preexisting chronic conditions (26). Patients with diabetes were shown to be 2.4 times more likely to be infected than those without diabetes (27), while patients with a pulmonary condition were found to be four times more likely to catch Covid, according to another study (28). Patients with underlying chronic diseases are affected both directly and indirectly by Covid, and comorbidity is a contributing factor (29).

2.3 Diabetes Mellitus (DM) in Turkey

The World Health Organisation (WHO) recommends a "fasting" blood glucose concentration range of 70–100 mg/dl, with hypoglycaemia referring to a concentration of glucose in the blood below 70 mg/dl (3.9 mmol/L) and hyperglycaemia referring to a concentration of glucose in the blood above 100 mg/dl (5.6 mmol/L). According to the World Health Organisation, "diabetes is diagnosed if fasting blood glucose (concentration level) is 126 mg/dL (7 mmol/L) or higher on two separate tests."

Diabetes, when referring to humans, is a condition that alters the way in which food is converted into energy. Autoimmune illness that typically strikes young people is known as type 1 diabetes (T1D), while In Type 2 diabetes (T2D), the body does not make good use of insulin and so cannot maintain blood sugar at the 'normal' levels indicated by the WHO.

T2D accounts for 90–95% of all cases of diabetes and is more prevalent in adults, while T1D affects less than 10% of the population and is more prevalent in children. Type 2 diabetes is a chronic condition that mostly affects adults (but it is increasingly being identified in younger age groups such as children and teenagers). Losing weight, eating better, and increasing physical activity are just a few of the ways in which you might reduce your risk of developing type 2 diabetes or at least delay its onset (30).

The International Diabetes Foundation says that there were roughly 537 million adults aged 20-79 living with diabetes in the world in November 2021 (up from 285 million in 2009), and the figure is expected to rise to 643 million by 2030 and to 783 by 2045. In Turkey the comparable number of adults was approximately 9 million and the figure is expected to rise to 13.4 million (up roughly 50%) by 2045, and the total diabetes-related health expenditure in Turkey was roughly US$9.5 billion pa or approximately US$1,000 per person (31).

Scientists are not fully aware of the reasons for the significant increase in the prevalence of diabetes, but relevant factors include a rise in obesity, aging combined with better survival rates, improved management of the disease, a reduction in premature mortality, and an increase in the number of young people contracting Type 2 Diabetes, T2D (30).

According to the Turkish Statistical Institute, in Turkey (as in many countries in the world) over the last ten years, there has been an increase in the number of people living in cities rather in the countryside, and this has resulted in less exercise being taken and in less healthy eating habits. The US National Diabetes Statistics Report says that 10.4 % of the US population has diabetes, but the Second Turkish Diabetes Epidemiological, TURDEP-II, study (16), conducted in 15 provinces in Turkey estimated the figure in Turkey was 13.7% and raised concerns that Diabetes was becoming an epidemic in Turkey.

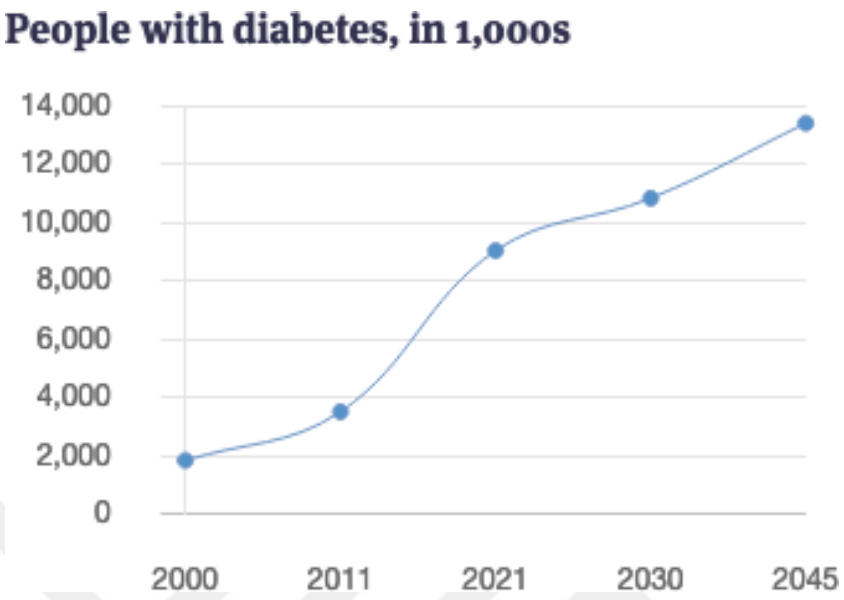

Figure 1: Diabetes Mellitus prevalence and expected incidence by 2045 in Turkey.

The way in which particular individuals respond to their environment varies from individual to individual, but epidemiologists are aware of most of the factors that have caused the increase in the "prevalence" of T2D in both the World and Turkey. The prevalence of a disease is defined as (number of cases in a population ÷ total number of people in the population) either at a given point in time (giving "point prevalence") or for a given period (giving "period prevalence"). Whether prevalence will rise, or fall is therefore arithmetically a relative matter and depends on whether the numerator is rising faster than the denominator (or vice versa). In absolute terms, there has been an increase in the number of diabetic cases worldwide mainly because of an increase in obesity caused by increased consumption of processed food and an increase in the consumption of "sweet" foods. "The dramatic increase in obesity is the main reason why there are so many more people living with T2D than there were 20 years ago" (32). However, there has been an increased prevalence of diabetic patients because there has been a better understanding of how to control diabetes, new and better drugs have been formulated, and there has been an increase in the awareness of the need to eat more healthy food and to take more exercise – with all of these leading to a 'better' glycaemic index (GI) being achieved by well-informed diabetic patients. Therefore, as the

life span of diabetic patients has increased faster than the lifespan of total populations has increased, arithmetically the prevalence of diabetes has increased. However, it is worth noting that the International Diabetes Federation (IDF) says that 1 in every 2 people with diabetes is unaware of the fact that they have diabetes because they have not been clinically diagnosed with the disease (31), and the US National Institute of Diabetes and Digestive and Kidney Diseases estimated that 34.2 million people in the USA had diabetes, of whom 26.9 million were diagnosed and 7.3 million were undiagnosed (33).

Obesity is more prevalent in Turkey than in any other country in Europe (34), and only 10% of the participants in Sonmez et al.'s survey had what might be called a 'normal' Body Mass Index (BMI). Unsurprisingly, therefore, Turkey also has the highest prevalence of T2D in Europe. High BMIs were associated with the amount of insulin used, the number of statins used, the number of antihypertensive medicines consumed, the levels of education of the participants, and the prevalence of T2D was also associated with gender, age, the amount of physical activity taken, and the amount of tobacco consumed (34).

Patients with diabetes mellitus (DM) were surveyed for their glycemic and metabolic parameters as part of a large-scale national survey in Turkey (n=35). According to the TEMD, just 6.7% of female Turkish adults with T2D had a 'normal' body mass index, while 17% of Turkish people with T2D were very obese. Low education level was a major predictor of poor glycaemic control, according to the most current study (35), and only 1.5% of patients met all the criteria for not being fat, not smoking, exercising, and under triple metabolic control.

In the year, 2021, The International Diabetes Federation Europe mentioned that 97% of the Turkish population is covered by Social Security, and diabetic patients have to pay only for the newest medicines and the most recently developed technologies. Both T1D and T2D patients are treated in primary and secondary care settings where they receive adequate education about their disease and condition. There is an adequate provision of specialist diabetic clinicians, but there is a shortage of nurse specialists and multi-disciplinary teams, and there is room for improvement in the service in primary care settings which has suffered during the Covid crisis (35).

Data on diabetes is held by the National Diabetes Registry and can be accessed by the appropriate people with the permission of the patient through the Ministry of Health (35). However, there is still work to be done on many fronts concerning legal issues, security issues, and the liability of healthcare providers. However, a unique feature of the Turkish Diabetic scene is its 'Diabetes Parliament' which brings under one umbrella everybody who has an interest in Diabetes including an appointee of the Minister of Health and a representative of the President. The Parliament in con-Covid times meets twice a year, and the institution demonstrates the priority that is accorded to diabetes in Turkey (35).

The percentage of Gross Domestic Product (GDP) that Turkey has spent on health rose significantly in the first half of the last decade and then fell back sharply in the second half of the decade.

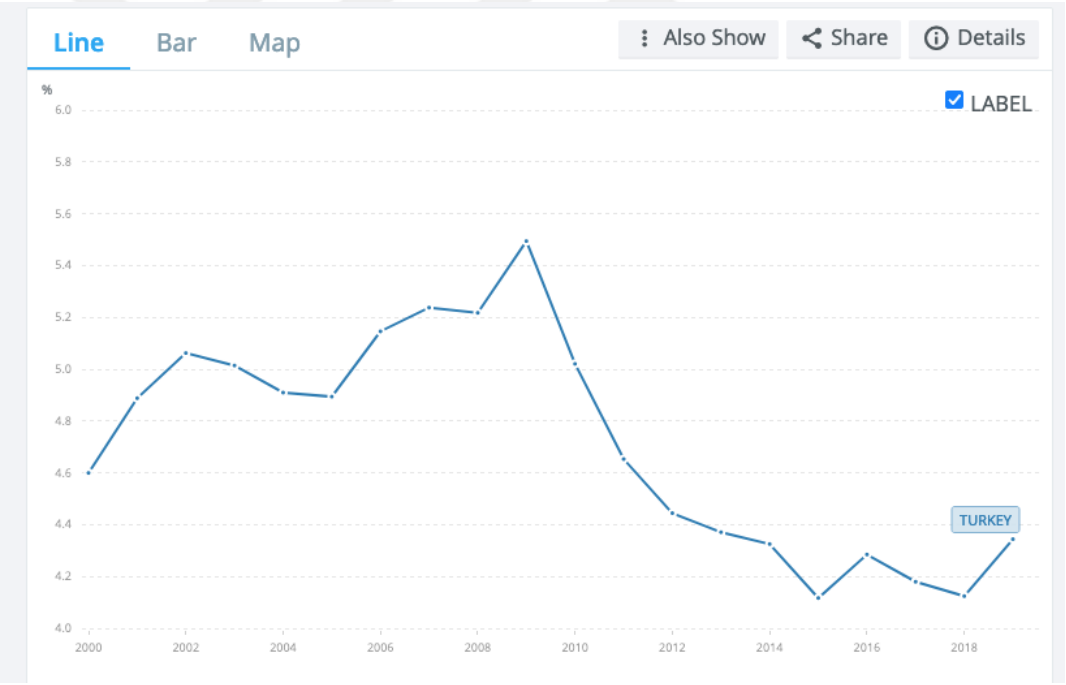

Figure 2: Current health expenditure GDP) in Turkey (WHO, 2022a).

2.4 COVID-19 and its effect on diabetes outcomes

Covid has been linked to a more severe progression in patients with T2D than in patients without T2D, according to one study (37), while another study (36) found that for 283 diabetic patients in six hospitals in Turkey, compliance with the hospitals' diet and exercise regimes resulted in no significant change in HbA1C levels, fasting plasma glucose levels, or weight. Patients with type 2 diabetes had a higher 30-day mortality rate than those without type 2 diabetes (13.6% vs 8.7%; hazard ratio 1.75; 95% CI, 1.58-1.93; P .001), according to research conducted by Sonmez et al. on a total of 18,426 patients hospitalised with Covid. Length of hospital stay and admission to intensive care units were also shown to be longer (37), as were fatality rates.

There has been a change in people's eating and exercise lifestyles, and this is important in GI control for diabetic patients (38), but Covid Lockdowns have not allowed people (and hence diabetic patients) to get together and exercise in gyms. However, the Psoma et al.'s (2020) Greek study found reductions in BMI values, reduced HbA1C values, and reduced total cholesterol values compared to pre-Lockdown examinations. Another study (14) also reported an improvement in GI values during Lockdown in India. Both studies noted an increase in physical activity and a corresponding weight loss.

Numerous studies have demonstrated that the prognosis for patients with both diabetes and COVID-19 is worse. Diabetes is associated with an unfavorable prognosis prediction for COVID-19 patients, according to one study (40). Another study (41) found that impaired glycemic control contributes to immune suppression and exacerbates COVID-19. Observations indicate that adequate healthcare services can reduce complications and enhance the quality of life for diabetic patients (40).

COVID-19 infected diabetic individuals have been shown to suffer severe or fatal consequences in multiple studies (18,39,40). Another study (41) reported a 2.34-fold greater risk for ARDS in a group of 201 patients with diabetes and COVID-19 co-infection. Chen et al. (42) did a meta-analysis included 1,936 participants and found a significant correlation between COVID-19 severity and diabetes. The non-survival rate of COVID-19 patients with comorbidities was also found to be greater in a separate study (43). According to data from the Chinese Centre for Disease Control and Prevention (41), the CFR for patients with

COVID-19 was 2.3%, whereas it was 7.3% for those with diabetes and 6.0% for those with hypertension. In a multivariate regression study, Zhou et al. (43) showed that diabetes was linked with an odds ratio of 2.85 for in-hospital mortality; however, they did not find comorbidity to be an independently significant factor associated with mortality. There were relationships between age, the SOFA score, and D-Dimer concentrations. Diabetic patients were less likely to experience fever (59.5% vs 83.2%), more likely to experience nausea and vomiting (16.7% vs 0%), and more likely to die (16.7% vs 0%). However, neither gender nor age made a noticeable impact. A greater probability of severe COVID-19 (44) was also seen in diabetic patients.

Another study (45) found that patients with immune 'dysregulation' had a higher risk of Covid breakthrough after vaccination than immunocompetent patients, and patients with rheumatic and musculoskeletal diseases lacked a humoral response even after two doses of an mRNA vaccine (46), and this is especially true for patients on lymphocyte depleting medication (such as my However, this may contradict the results of a different study (47), which found that Covid-19 antibodies were increased in individuals with Covid-19 infection who received immunosuppressive therapy.

Diabetic patients were found to have lower white blood cell count, red blood cell count, and Hb levels as well as inflammatory markers (interleukin-6, serum ferritin, erythrocyte sedimentation rate, C-reactive protein, fibrin degradation fragment, and neutrophil counts) than non-diabetic patients. Patients with diabetes displayed more severe pathological changes (46) when CT images were compared to those of people without diabetes.

There is much that is still to be discovered about Covid and the effect of comorbidity of diabetes and Covid, and there is equally a large amount still to be learned about the best management by the healthcare system of how to manage a continuum of care during Lockdowns and the emergence of harmful variants of the SARS-CoV-2 virus. It is therefore important that there should be a free interchange of information between all the interested parties.

2.5 How COVID-19 has affected access to care among diabetic patients in Turkey and other countries

Fisher et al. (2020) found that Diabetic patients have reported higher levels of both general and diabetes-related stress during the covid crisis than before the crisis, and this has had a negative effect on their access to health care, and disease management, and adherence to covid precautions (48). In the text that follows, the challenges faced by diabetic patients will be examined – and this will include the delay in seeking care, the inevitable lack of treatment of undiagnosed cases and events, the unavailability of out-patient facilities that resulted from the Lockdowns, shortages of medicines, medicines being unaffordable, and the delay in the seeking of help (49) (See the following diagram).

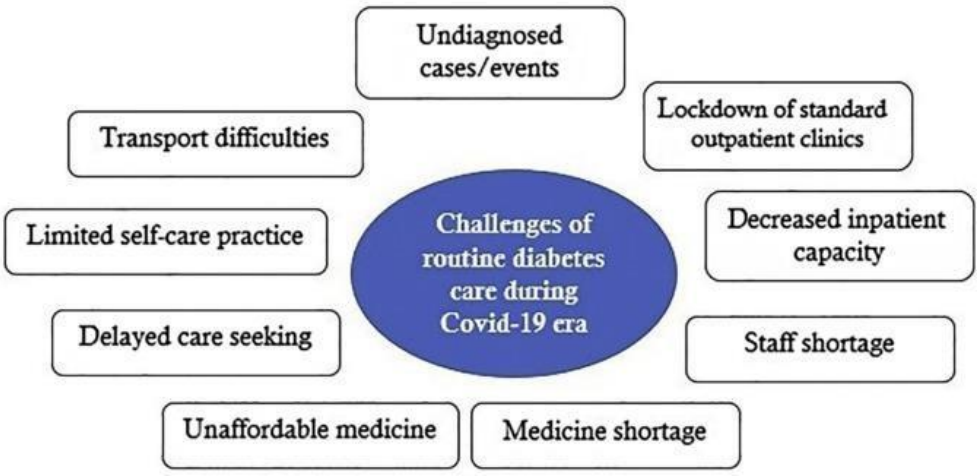

Figure 3: Figure 2.3: Challenges of routine diabetes care during Covid-19 era

2.6 Delays in seeking care

In America, 42% of patients with underlying chronic health conditions have not turned up for their regular checks, and this may have resulted in delays in timely detection and treatment (23), while Another study (50) found that during the Covid crisis, many patients were reluctant to seek help for fear of contracting Covid, and this has been especially true for diabetic patients because Covid is a highly transmissible respiratory disease and diabetes is a disease. They have reason to worry; research has shown that diabetic people have a worse prognosis from COVID-19 infection than those who do not have diabetes (51).

2.7 Lockdown of outpatient clinics

Schools and Universities in Turkey were closed in the wake of the first officially notified case of Covid in the country on 11 March 2020, and that was followed by other restrictions such as the closure of cafes, cinemas, theatres, etc, and restrictions were also placed on both domestic and international travel arrangements, and Lockdowns were enforced – but restrictions were gradually eased after 1 June 2020. Alterations were made to healthcare services, and diabetic patients were affected along with other patients.

In a study investigated 101 T2D patients with regard to their weight, diet, GI levels, exercise patterns, etc, and reported increases in weight, girth, and fasting GI values and GI values after meals, but did not report any statistically significant differences (34).

Diabetic patients should have regular contact with their healthcare providers – not just with their General Practitioners (GPs) and endocrinologists but also with their dieticians, chiropodists, etc. It is vital that T2D patients optimise their GI controls (52), but all the above healthcare providers have been mobilized to help out with Covid patients during the intense periods of the Covid crisis, and this has resulted in a reduction in the care provided to other non-Covid patients including T2D patients, and GI control has thus suffered.

It has pointed out that this can create serious problems for T2D patients and for other patients who need regular long-term care and raised concern about the future effect of current unmet needs (50), while another study (53) has pointed out that a shortage of disinfectant products could affect the sterilization of insulin injections and GI monitors, and thus cause infections.

2.8 Decreased inpatient capacity.

The high influx of Covid patients to hospitals because they have needed urgent attention has over-stretched the available capacity of hospitals (54), and the problems are compounded where, before admission, patients have to provide evidence of not being infected with the virus. Issues arise such as whether the patient has to do a Lateral Flow (LF) Test at the door of the hospital and if not, how does the hospital know when the LF test was taken, and if the test proves positive does the hospital, then turn the patient away until a polymerase chain reaction (PCR) test shows negative. The ability of hospitals to treat any

non-Covid patients (unless the patient is an ‘emergency’ case) has been severely limited during the Covid crisis.

2.9 Staff shortages

It is often overlooked that not only has the public been affected by the Covid crisis, but healthcare professionals have themselves been affected by the virus, and not only have healthcare staff been affected by the virus thus causing a reduced availability of staff, but the substantially increased workload of healthcare providers coupled with the absence of colleagues who have been in enforced self-isolation has resulted in overloaded work shifts. This has caused mental health problems to those who have been overworked and have had the mental distress of caring for more patients (than normal) who are dying despite the best efforts of healthcare providers to save the lives of their critically ill patients (50), (2). The problems outlined above have applied not just to T2D patients, but to all patients with severe chronic debilitating diseases.

2.10 Shortages of Medicines

The world was ill-equipped to deal with a major epidemic, and there have been major supply problems with regard to personal protective equipment (PEP), but perhaps even more importantly, despite the setting up of the COVAX program (the “global equitable access to Covid-19 vaccines”), the WHO (June 2021) says that there has been a major shortage of Covid vaccines in the poor countries of the world. In its June 2021 statement, the WHO said that the COVAX program had already delivered 90 million doses to 131 countries but given that there are almost 8 billion people in the world who need say two doses, 90 million doses represents roughly 0.006 of the doses needed (49). Rich countries such as the UK are in March 2022 already giving their over-75s their fourth (booster) vaccination while in almost all the African countries and in Pakistan, Syria, and New Guinea, less than 20% of the population has had at least one of the doses of a Covid vaccine. In Turkey, 63% of the adult population has been fully vaccinated, and 43% have had an additional dose (49).

Shortages of staff have hit pharmaceutical companies, not just regarding the manufacture of Covid vaccines, but concerning all medicines and ancillary equipment such as syringes, needles, swabs, disinfectants, dressing for ulcers, etc – and diabetic patients have been affected by supply shortages as having all patients with chronic debilitating

diseases (55), and this has been compounded by budget cuts in some countries (56). Low-income countries have been more affected than rich countries, and 80% of all diabetic patients live in low- and middle-income countries (57). In addition, there is widespread anxiety that the current war between Russia and Ukraine and the ensuing very steep rise in the price of oil gas, and food could result in a worldwide recession (58). This could result in budget cuts worldwide which would affect the financial ability to service all healthcare services including that for diabetic patients. Supply chains for insulin, which has a 'cold-chain supply' requirement (because it loses potency when it is subject to heat or when it is frozen) have also been affected, and this has affected both T1D patients and an increasing number of T2D patients who need insulin. In any case, the insulin needed for patients with type 2 diabetes is expected to increase by more than 20% between 2018 and 2030 (59).

2.11 Unaffordable medicines

As mentioned above, 80% of the world's diabetic patients live in Low Middle Income Countries (LMICs) (57), and with a low income then, if there is no free "national health provision", diabetics find it hard or almost impossible to afford the insurance premiums to buy the cover needed to pay for their costs. During the Covid crisis, many diabetics have lost their jobs and thus their access to medicine has been diminished (55), (56), (60), and if there is a worldwide recession, then the prospects for anyone with a chronic debilitating disease (including diabetes) are potentially very damaging. How will such people survive?

2.12 Undiagnosed cases/events

Delay in presenting new or existing instances of T1D can lead to a potentially lethal scenario due to diabetic ketone acidosis (56), and delayed identification of diabetes and, thus, delayed treatment of the disease, worsens the result (61, 62).

2.13 Difficulties with transportation

Access to care has been difficult during the Covid crisis because of Lockdowns or because the people who provide transport have themselves been affected by sickness and self-isolation regulations (62). However, 'mobility' has compounded the problem because as it was noted in another study (63), a very large proportion of diabetic patients develop musculoskeletal problems in their feet and have limited mobility, and mobility is also

constrained when the patient is fitted with an offloading device such as a cast-walker or a total contact cast.

2.14 Constraints on self-care

To stay healthy, diabetic patients must exercise good control over their GIs, but during a Lockdown there is no or limited access to gyms (62), and even in public parks the public was asked to observe strict social distancing. This means that diabetic patients were limited to performing exercise routines at home and this was not easy either because of the limited mobility of the patient without proper physiotherapy supervision or because the domestic situation did not lend itself to such exercises (53). Moreover, another study pointed out that restrictions on movement reduce access to sunlight, and this reduces exposure to Vitamin D formation (64), and a survey showed an almost 60% reduction in physical exercise in Brazil (61).

Good GI control involves healthy eating and it was found that the Covid crisis had limited the availability of healthy foods (65), while another study by Klatman et al. (2020) reported an increase in food prices at a time when diabetics did not have the power to increase their income (56). And another study reported an increase in carbohydrate consumption resulting in poor GI control (66).

2.15 Mental health problems

Human beings are by nature gregarious animals, and the nature of a Lockdown is that it is meant to force people to stay at home, or at very least to restrict congregating with other people, and enforced separation from other members of society has caused mental stress in the form of anxiety and depression. It should not be forgotten that very considerable mental stress has been imposed on healthcare providers (HPs) themselves, that many HPs have been off sick, and that this has imposed an additional burden on those who are still turning up for work (53). In the UK, the official figure for doctors who were off sick in April 2020 was given by the Health Secretary as 5.7%, but a poll conducted by the Royal College of Physicians as reported by the Guardian newspaper suggested that a more realistic figure would be 14.6% – and it was certainly the case that at that time, on the TV News, queues of ambulances were to be seen parked outside hospitals because there was either not enough staff to cope with the crisis, or there was not enough equipment to deal with the crisis. The

US Centres for Disease Control and Prevention (CDC) notes on its Type 2 Diabetes (T2D) website that "people with diabetes are 2 to 3 times more likely to have depression than people without diabetes," and a separate study (60) noted that self-care declines both during and after times of crisis. It was mentioned that stress has an influence on GI, with the authors going on to explain that this effect is due to a combination of physiological and psychological causes. Stress hyperglycaemia is linked to higher rates of death and morbidity in the critically ill, according to the authors (67).

3. MATERIALS AND METHODS

In this section, we provide a comprehensive summary of the research approach taken over the course of this investigation. The study's limitations and ethical considerations are also included in this category, along with the study's design, time frame, demographic, sample size, and methods of selection.

3.1 Study Design

The study design is an observational before and after study design used to assess the effect of Covid-19 pandemic on glycemic regulation in patients with type 2 diabetes mellitus in Turkey. By combining an observational and before-after study design, this study aims to provide a comprehensive understanding of the impact of the COVID-19 pandemic on glycemic regulation in patients with type 2 diabetes mellitus. This design allows for the collection of valuable information on the relationship between the pandemic and glycemic control, before COVID-19 pandemic in period June 2019 to Feb 2020 and during COVID-19 pandemic in period March 2020 till December of 2021, without imposing any interventions or manipulations on the participants.

3.2 Study setting and period.

The study was carried out in the Department of Endocrinology, Yeditepe University Kozyatagi hospital, in Istanbul, Turkey. The study was conducted in the period June 2022 to November 2022.

3.3 Inclusion and exclusion criteria

3.3.1 Inclusion criteria

Type 2 DM patients diagnosed with COVID-19 who have fasting blood glucose levels and HbA1C levels recorded before the beginning of pandemic in period June 2019 to Feb 2020 and during the pandemic. in period March 2020 till December of 2021

3.3.2 Exclusion criteria

Type 1 DM, patients who were diagnosed with dementia and other cognitive/cognitive disorders, those who did not have contact information, and also those who did not agree to participate in the study.

3.4 Study population and sample

The population of the study consists of Type 2 DM patients who were diagnosed with COVID-19 based on laboratory and/or radiological findings and admitted to the Department of Endocrinology Outpatient Clinics at Yeditepe University Medical Faculty Hospital.

Patients were chosen based on the following criteria: patients who applied in the Department of Endocrinology, diagnosed by type 2 diabetes, being Turkish citizen living in Istanbul and allowed to participate the study.

Among 79 patients, 9 of them were excluded because the demographic characteristics of 4 of them were not found, and the files of 5 of them were not found. Therefore, 70 patients were interviewed, however 40 of them agreed to respond. The response rate was calculated as 57.1%

3.5 Data Collection Method

Data were collected via medical records and a structured questionnaire that was interviewed over the telephone. The data questionnaire consists of sections related to demographic characteristics, chronic diseases, smoking, exercises and others (Appendix 1a). Self-reported Medication-taking Scale (Appendix1b). Diabetes distress scale (Appendix 1c). Information from hospital files: (medical electronic) was also obtained (Appendix1d).

3.6 Data Analysis

Data was analyzed using SPSS version 25 (Statistical Package for the Social Sciences). At first, we were able to manage the data, clean the data, and recode it. In the case of quantitative data, descriptive statistics were performed in the form of mean SD; if the data is not normally distributed, the median will be used instead. Categorical variables were expressed as frequencies and percentages.

The total number of points on the 17 items was then divided by 17. Subsequently, we divided the stress scale into three groups: low stress (2), moderate stress (2-2.999), and high stress (>=3). The levels of HbA1c were split into two groups: normal (6.5) and high (>=6.5). The four components of the compliance score are as follows. Each question on the scale can be answered "yes" or "no," with a maximum score of 4 representing the least adhered to option. One is assigned to items with "yes" responses and zero to those with "no" responses. Scores can range from 0 to 4, with higher numbers indicating less compliance. The

correlation between HbA1c and infection with covid factors and physical activity was analysed using the chi-square test. It was also used to research how having a Covid infection affected patients' adherence to treatment. In addition, the Wilcoxon Signed Ranks test was utilized to analyze the differences in HbA1c and FBS before and after Covid. The level of statistical significance used was p 0.05, and the level of confidence was 95%.

3.7 Ethical approval

An ethical approval with a reference number of E.11156775-806.01.03-1420 was obtained in 07.02.2022 from T.C. YEDİTEPE UNIVERSITY and Non-Interventional Clinical Research Ethics Committee approval (Appendix4).

4. RESULTS

Table 1: Sociodemographic characteristics of the study participants- 1

Variable	**N**	**%**
Gender		
Male	43	61.4
Female	27	38.6
Marital status		
Single	13	19.4
Married	54	80.6
Education		
<=elementary school	9	20.9
>=high school	34	79.1
Social security		
General health insurance	46	65.7
Private health insurance	24	34.3
Working status		

Working	17	38.6
Not working	27	61.4
How is the income situation of yourself or your family		
Income is less than the expense	3	7.1
Income is equal to expenses	37	88.1
Income is more than expenses	2	4.8
Place of Residence		
Provincial-District	69	98.6
Sub-District/Village	1	1.4

Seventy participants were recruited in the study, the majority (61.4%) are males, and 80.6% are married. In addition, 79.1% have a high school or above, and 65.7% have general health insurance. Only 38.6% are working, and 88.1% perceived their income as equal to their expenses. Almost all are living in a district. The results are demonstrated in Table 1.

Table 2: Sociodemographic characteristics of the study participants- 2

Variable	Mean± SD	Min-Max
Age	58.2±13.7	35-87
Total monthly income of the family	17591.6±24425.8	3000-90000
Number of household's members	2.8±1.2	1-6

Table 2 shows the sociodemographic characteristics of the study participants (quantitative variables). Mean age is 58.2 years, the mean income 17591, and finally the mean of number of households is 2.8.

Table 3: Diabetes related questions

Variable	N	%
Knowledge about blood glucose monitoring meter		
Yes	40	97.6
No	1	2.4
Diabetes duration (years)		
Mean ± SD (Min-Max)	14.8±8.3 (3-40)	
measure own blood sugar		
Yes	31	75.6
No	10	32.4
How many times per day?		
Mean ± SD (Min-Max)	1.6± 0.7 (1-4)	
Knowledge about HbA1c level		
Yes	30	73.2
No	11	26.8
The last value recorded		
Mean ± SD (Min-Max)	10.7±13.3 (5.4-63)	
Type of medication		

Oral	33	47.1
Insulin	6	8.6
Oral+ Insulin	29	41.4
diet	2	2.9

Table (3) shows the descriptive analysis of the diabetes related questions for the study participants. 97.6% of the participants have blood Glucose Monitoring Meter. The mean years of diabetes duration is 14.8 years, and 75.6% can measure their own blood glucose in the mean 1.6 times per day, and 73.2% know their HbA1c level, and the mean of their last value is 10.7. The type of medication the patients take is 47.1% oral, 8.6% Insulin, 41.4/% oral and insulin, and 2.9 relying on diet only.

Table 4: Diabetes Related conditions

Variable	N	%
Loss of vision in the eyes		
yes	10	16.1
no	52	83.9
Numbness in hands and feet		
yes	7	11.3
no	55	88.7
Renal disease		
yes	5	8.1
No	57	91.9
Non-healing wounds (especially on the feet)		
yes	5	8.1

no	57	91.9
Other chronic diseases		
yes	45	66.2
No	23	33.8
High blood pressure		
yes	32	80.0
no	2	20.0
High cholesterol level		
yes	9	60.0
no	6	40.0

Comorbidities exist among the study participants; loss of vision 16.1%, Numbness in hands and feet 11.3%, renal disease 8.1%, Non-healing wounds (especially on the feet) 8.1%, other chronic diseases 66.2%, high blood pressure 80%, and high cholesterol level 60% as showed in table 4.

Table 5: Lifestyles and Covid 19 related questions

Variable	N	%
Smoking status		
Never smoker	32	46.3
Past smoker	17	24.7
Current smoker	20	29.0
Number of cigarettes per day		

Mean± SD (Min-Max)	1.1 ±0.4 (1-3)	
Drinking alcohol		
no	41	59.4
rarely	11	15.9
sometimes	16	23.2
Everyday	1	1.5
Have you ever had a Covid-19 disease		
yes	21	51.2
no	20	48.8
Number of infections by covid-19		
1.00	15	75.0
2.00	5	25.0
Vaccination for Covid -19		
yes	38	92.7
no	3	7.3
vaccine type		
Pfizer-BioNTech	36	94.7
CoronaVac(sinovac)	2	5.3
how many doses did you have vaccinated?		
Mean± SD (Min-Max)	3.6± 1.1 (2-6)	
Do you exercise regularly (at least half an hour, 3 days a week) before the pandemic?		

yes	3	7.3
no	15	36.6
Less than defined	23	56.1
Do you exercise regularly (at least half an hour, 3 days a week) after the pandemic		
yes	3	7.3
no	18	43.9
Less than defined	20	48.8
Weight		
Mean± SD (Min-Max)	86.8±18.2	
Height		
Mean± SD (Min-Max)	170.5±9	

Regarding smoking, 46.3% of the participants have never used smoking, 24.7% was past smokers, and 28% are currently smokers with mean number of cigarettes 1.1 per day. The majority of the participants do not drink alcohol 59.4%, 51% previously had COVID 19, one time or two times in the percentages 75%, and 25% respectively. 94.7% had vaccinated with either Pfizer-BioNTech type (51.4%) or CoronaVac (Sinovac) type 5.3%) and the mean number of vaccination time is 3.6. Regarding exercising, 7.3 of the participants do exercises regularly before and after the pandemic, and 56.1% of them do irregular exercise before pandemic and 48.8% after the pandemic. Their mean of wight is 86.8 Kg and height 17.5cm

Table 6: Self-reported Medication-taking Scale

Variable	N	%
Do you ever forget to take your medicine?		
Yes	17	41.5
No	24	58.5
Are you having trouble remembering to take your medicine?		
Yes	9	22.0
No	32	78.0
When you feel better do you sometimes stop taking your medicine?		
Yes	5	12.2
No	36	87.8
Sometimes if you feel worse when you take the medicine, do you stop taking it?		
Yes	3	7.3
No	38	92.7

Self-reported medication taking scale was illustrated in table (6). 58.5% did not ever forget to take medication, and 22% have trouble to remember take the medication, and 12.2% stop taking medication when feeling better, and 7.3% stop it when they feel worse as shown in table 6

Table 7: Patient responses to medication taking behavior scale (n=41)

Patient answered "Yes" to:		%	n
0 item	High	58.5	24
1 item	Med	14.6	6
2 items		17.1	7

3 items	Low	4.9	2
4 items		4.9	2

As shown in the table 7, 58.5% of patients responded “yes” to the meditative behavior scale with 0 items, indicating that they have a high level of compliance. 6 participants responded “yes” to 14.6% of the items and 7 participants responded “yes” to 17.1% of the items, placing them in the medium category. In addition, 2 participants responded "yes" to 4.9% of the items, and another 2 participants responded “yes” to 4.9% of the questions, placing them in the low compliance category.

Table 8: Turkish version of Diabetes Distress Scale

Stress	Frequency	%
Low stress	38	92.7
Moderate stress	3	7.3
Total	41	100.0

As shown in Table 8, only 3 patients (7.3%) have moderate stress, and 92.7% have low stress considering that 41.4% of patients did not fill the distress scale.

Table 9: Information from hospital files

Parameter	Before pandemic Mean±SD	n	During pandemic Mean±SD	n
Hemoglobin A1c (%)	7.3±1.4	56	7.7±1.85	68
Fasting blood sugar	154.7±56.8	55	165.6±62.6	66

Triglyceride	202±135	53	227.7±297.3	66
LDL	113.7±35.9	53	107.0±30.4	64
HDL	43.7±13.4	53	45±11.4	66
Total cholesterol	191.1± 42.8	53	190.8±44.9	66

Table (9) demonstrates six laboratory tests for the participants before and after the pandemic. The mean of four parameters were increased as follows; the Mean of Hemoglobin A1c before the pandemic is 7.3 and after the pandemic 7.7. The mean fasting blood sugar is 154.7 before the pandemic and after the pandemic 165.6. In addition, the mean of the Triglyceride increased from 202 to 227.7. Also, HDL increased from 43.7 before the pandemic to 45 after the pandemic. On the other hand, LDL decreased from 113.7 before the pandemic to 107 after the pandemic. Finally, the mean total cholesterol decreased from 191.1 before the pandemic to 190.8 after the pandemic.

Table 10: Relationship between exercising and HbA1C pre-Covid 19

Variable	Categories	HbA1c			Chi	p-value
		Normal N=5	High N=25	Total		
Do you exercise regularly (at least half an hour, 3 days a week) before the pandemic?	yes	1(100)	0(0)	1(100)	4.1	0.128
	no	1(9.1)	10(90.9)	11(100)		
	Less than defined	3(16.7)	15(83.3)	18(100)		

Table 11: Relationship between exercising and HbA1C post-Covid19

Variable	Categories	HbA1c			Chi	p-value
		Normal N=4	High N=29	Total		
Do you exercise regularly (at least half an hour, 3 days a week) after the pandemic?	yes	0(0)	1(100)	1(100)	0.281	0.869
	no	2(13.3)	13(86.7)	15(100)		
	Less than defined	2(11.8)	15(88.2)	17(100)		

Table (10) and Table (11) show there is no statistically significant relationship between exercising and HbA1C neither pre Covid nor post Covid as (Chi= 4.1, p-value= 0.128), (Chi= 0.281, p-value= 0.869) for the two relationships respectively.

Table 12: Relationship between HA1c during Covid and infection with Covid19

variable	Categories	HbA1c			Chi	p-value
		Normal N=4	High N=29	Total		
Have you ever had a Covid-19 disease	yes	2 (11.1)	16 (88.9)	18 (100)	0.038	0.846
	no	2 (13.3)	13 (86.7)	15 (100)		

Table (12) shows there is no statistically significant relationship between getting infected with Covid and HbA1C (Chi= 0.038, p-value= 0.846)

Table 13: Relationship between treatment compliance and infection with Covid

Variable	Categories	Compliance				Chi	p-value
		high compliance N=24	intermediate compliance N=13	Low compliance N=4	total		
Have you ever had a Covid-19 disease	yes	11(52.4)	7(33.3)	3(14.3)	21(100)	1.220	0.543
	no	13(65)	6(30)	1(5)	20(100)		

Table 14 shows there is no statistically significant relationship between having Covid and compliance with medication (Chi= 1.220, p-value= 0.543).

Table 14: Differences between HbA1c pre and during covid

Ranks						
		N	Mean Rank	Sum of Ranks	Z	Sig
HBA1c (%)- during pandemic - HbA1c (%)- pre pandemic	Negative Ranks	25[a]	29.02	725.50	-0.147	0.883
	Positive Ranks	29[b]	26.19	759.50		
	Ties	1[c]				
	Total	55				

a. Hemoglobin A1c (%)- during pandemic < Hemoglobin A1c (%)- pre pandemic

b. Hemoglobin A1c (%)- during pandemic > Hemoglobin A1c (%)- pre pandemic

c. Hemoglobin A1c (%)- during pandemic = Hemoglobin A1c (%)- pre pandemic

Table 15 shows the result of Wilcoxon Signed Ranks, there is 25 participants have HbA1c during the pandemic less than HbA1c before the pandemic with mean rank 29. Also, there is 29 participants have HbA1c during the pandemic more than HbA1c before the pandemic with mean rank 26.19, and only one patient has the same result pre and during the covid. The differences is not statistically significant as sig= 0.883.

Table 15: Differences between Fasting Blood Sugar pre and during COVID 19

Ranks						
		N	Mean Rank	Sum of Ranks	Z	Sig
FBS post pandemic - FBS pre pandemic	Negative Ranks	26[a]	25.63	666.50		
	Positive Ranks	28[b]	29.23	818.50	-0.654	0.513
	Ties	0[c]				
	Total	54				

a. FBS post pandemic < FBS pre pandemic

b. FBS post pandemic > FBS pre pandemic

c. FBS post pandemic = FBS pre pandemic

As shown in table 16, there is 26 participants have FBS during the pandemic less than FBS before the pandemic with mean rank 25.63. Also, there is 28 participants have FBS during the pandemic more than FBS before the pandemic with mean rank 29.23, and no one

patient has the same result pre and during the covid. The differences is not statistically significant as sig= 0.513

5. DISCUSSION AND CONCLUSION

The global spread of the COVID-19 pandemic has had a major effect on medical facilities everywhere. COVID-19 has been proven to have indirect impacts on the management of chronic illnesses, such as T2DM, in addition to its direct effects, which include respiratory and cardiovascular issues. During the pandemic, difficulties in glycemic control of T2DM patients have arisen due to the disruption of healthcare services, changes in lifestyle, and fear of infection.

Patients with type 2 diabetes mellitus are more likely to contract COVID-19 and have a poorer outcome following infection, according to several studies(17,43,68). Poor glycemic control has been linked to an increased risk of death and a lengthier stay in the hospital for type 2 diabetes patients (17,43,68,69).

Our research aimed to determine whether or not the COVID-19 pandemic had an effect on T2DM patients' ability to maintain healthy blood sugar levels and to evaluate the accuracy of the DDS in this patient population. To further understand the impact of the pandemic, we compared glycemic control measures from before and during the epidemic in T2DM patients. Clinical and policy implications for the management of type 2 diabetes patients during the current and future pandemics of COVID-19 are substantial.

5.1 Summary of the participants' demographics, lifestyles and comorbidities

This study included 70 participants, most of whom were male (61.4%) and married (77.1%). Nearly half of the participants had a high school education or higher (48.6%) and most had general health insurance (65.7%). Only a quarter of the participants were currently employed (24.3%) and slightly more than half perceived their income as equal to their expenses (52.9%). The mean duration of diabetes was 14.8 years, and nearly half of the participants could measure their blood glucose themselves (44.3%) with a mean of 1.6 times per day. About 43% of the participants knew their HbA1c level, with a mean of 10.7. The most commonly used medication was oral medication (47.1%), followed by a combination of oral and insulin (41.4%). The participants had comorbidities such as high blood pressure (45.7%), chronic diseases other than diabetes (64.3%), and loss of vision (14.3%). Nearly

30% of the participants had previously contracted COVID-19, and 54.3% had been vaccinated. The majority did not drink alcohol (58.6%) or smoke (45.7%). Only a small percentage (4.3%) exercised regularly before and after the pandemic, and a higher percentage (32.9%) did irregular exercise before the pandemic, but the percentage dropped to 28.6% after the pandemic.

5.2 Glycemic Control parameters and impact of Covid

According to the results, patients with type 2 diabetes mellitus did not show statistically significant variations in HbA1c or fasting blood sugar levels during the COVID-19 pandemic. The small sample size may explain this. Confirmation of our conclusions requires additional research with bigger sample sizes.

This study's findings are in line with those of others that reported no major shifts in glycemic control among populations during the pandemic (70–73). Studies have shown both an improvement in glycemic control due to lockdown measures and increased activity (14) and a worsening of HbA1c levels during the pandemic (74-76). Variations in research populations, cultural and socioeconomic contexts, healthcare systems, pandemic-related variables, and sample sizes may all play a role in explaining these inconsistencies. More study is required to fully comprehend the interconnected nature of the pandemic and glycemic management in patients with type 2 diabetes mellitus.

In individuals with type 2 diabetes mellitus, the current investigation found no statistically significant correlation between exercise and HbA1c levels either before or after the COVID-19 pandemic. It is important to highlight, however, that there is a dearth of data on how COVID-19 affects exercise and glycemic management in this population. Although prior research has shown that only a small fraction of patients exercised regularly throughout the pandemic, this research did not compare patients' exercise routines before and after the outbreak (76). Therefore, more study is needed to determine how COVID-19 influences exercise behaviour and how that impacts glycemic management in people with type 2 diabetes mellitus.

5.3 Self-reported Medication-taking Scale and compliance

The results of the study indicate that the majority of patients have a high level of compliance with taking their medication, with 58.5% of participants reporting no issues with

forgetting to take their medication. However, there were still a significant number of patients (12.9%) who reported having trouble remembering to take their medication, and a small percentage who reported stopping their medication either when they feel better or worse (7.1% and 4.3% respectively). The findings suggest that there may be room for improvement in medication adherence among some patients. Patients who could benefit from further assistance in maintaining their prescription regimens could be singled out by classifying study participants into high, medium, and poor compliance groups based on their responses to the medication-taking behaviour scale. When compared to the prior data (40.6% of patients presented with poor treatment compliance; 77), the new result is encouraging. Another study found that among Saudi patients (n=78), compliance was considerably higher before the lockdown (18.493.05) than after (17.403.25). Another study found similar results, showing low adherence to antidiabetic treatment plans in the UAE population (79). Another study in Turkey found statistical significance between the groups with regards to the average total score on the patient adherence measure used in the management of type 2 diabetes (80).

Trials assessing the impact of COVID-19 on medication adherence in patients with type 2 diabetes have yielded conflicting results. This may be due, in part, to when the trials were conducted. In the early phases of the pandemic, when there was a great deal of uncertainty and concern and healthcare systems were overloaded by the rapid surge of cases, many research were undertaken studying the impact of COVID-19 on health outcomes. During this time, many patients may have experienced disruptions to their healthcare, including difficulty accessing medication and healthcare services, which could have negatively impacted their medication adherence. As the pandemic has progressed and healthcare systems have adapted, it is possible that some of these disruptions have been mitigated, which could explain why some studies conducted in later stages of the pandemic have reported fewer negative effects on medication adherence. However, it is also possible that other factors, such as changes in patient behavior and attitudes towards their health, have contributed to the discrepancies in findings across studies. Further research is needed to better understand the factors contributing to differences in findings related to COVID-19 and medication adherence, and to identify strategies for improving medication adherence in patients with type 2 diabetes during and after the pandemic.

5.4 Evaluation of Diabetes Distress Scale

Out of the patients who completed the distress scale, only 3 (4.3%) reported moderate stress, while the majority of patients (54.3%) reported low stress levels. However, it should be noted that a significant proportion of patients (41.4%) did not fill out the distress scale, which may have affected the overall results. These findings suggest that, among those who completed the scale, the majority of patients had relatively low levels of stress. However, the high percentage of patients who did not complete the scale may indicate that there are patients who are experiencing higher levels of distress but did not report it. Consistent with our finding, the finding of a previous research showed that patients have little or no diabetes distress (1.55± .63) (81,82). However, inconsistent finding derived from other research that showed the prevalence of severe diabetes distress was 13.4% in a study (83) and 13.3% in another study (84). Also, among diabetic patients in the South Africa, 44% of the sample reported having moderate to high levels of distress (85).

The finding agrees with other studies that found minimal levels of diabetes distress among patients. The prevalence of severe diabetes distress, however, has been reported to be much greater in other investigations. Differences in study populations, sample techniques, and cultural norms may all contribute to this variance. Despite the contradictory results, it's clear that diabetes distress is a major problem that has a negative impact on patients' health and quality of life. It is the responsibility of healthcare personnel to **recognize** the signs of discomfort in individuals with diabetes and offer them the necessary assistance.

5.5 Conclusion

In summary, the study found that the COVID-19 pandemic has no negative impact on glycemic control in type 2 diabetes mellitus patients as indicated by the lack of statistically significant difference in HbA1c levels before and during the pandemic.

While the majority of patients reported a high level of compliance with taking their medication, a significant number still had trouble remembering to take their medication or stopped taking it when they felt better or worse. Therefore, some patients may have room for improvement in medication adherence. Finally, among the patients who completed the distress scale, the majority reported **low-stress** levels, but a significant proportion did not fill out the scale, which may have affected the overall results.

However, these findings highlight the need for continuity of interventions and support for individuals with diabetes during pandemics and other health crises. Further research is needed to better understand the complex relationships between the pandemic and glycemic control in type 2 diabetes mellitus patients.

5.6 Recommendations

Based on the findings of the research, some recommendations could be considered.

5.6.1 Recommendations for policy makers

- Implement interventions to improve medication adherence among patients with type 2 diabetes. This could include providing educational resources, reminders, or support from healthcare providers.
- Develop policies to promote telehealth and other remote care options for patients with type 2 diabetes. This can help to ensure that patients continue to receive necessary care and support even during times when in-person visits may be more difficult or risky.
- Encourage healthcare providers to monitor and support glycemic control in patients with type 2 diabetes during times of stress or uncertainty, such as during the COVID-19 pandemic.
- Encourage healthcare providers to routinely screen for stress and distress among patients with type 2 diabetes, especially during times of high stress such as the COVID-19 pandemic. This could include offering resources and support for managing stress and distress.

5.6.2 Recommendations for health care providers

- Encourage and educate patients on the importance of medication adherence, especially for those who reported having trouble remembering to take their medication or stopping their medication without medical advice.
- Monitor and support patients' glycemic control, especially during times of stress and crisis such as the COVID-19 pandemic. Consider alternative methods of care delivery, such as telemedicine, to ensure that patients continue to receive necessary care.
- Assess and address patients' stress levels, as stress can negatively impact glycemic control and overall health outcomes. Encourage patients to seek mental health support and provide resources for stress management.
- Continue to promote and encourage healthy lifestyle behaviors, such as physical activity and healthy eating habits, as they can improve glycemic control and overall health outcomes.

- Consider implementing routine distress screening for patients with type 2 diabetes to identify those who may need additional support and intervention.

5.6.3 Recommendations for future research

- Conduct further research to better understand the impact of stress and other environmental factors on glycemic control in patients with type 2 diabetes, and to develop effective interventions for improving glycemic control in these patients.
- Explore factors that affect medication adherence: Future research should also explore the factors that affect medication adherence among patients with type 2 diabetes mellitus, especially those who reported having trouble remembering to take their medication. Identifying these factors can help develop targeted interventions to improve medication adherence.
- Investigate the impact of stress on glycemic control: Since stress can affect glycemic control in patients with diabetes, future research should explore the relationship between stress and glycemic control during the pandemic. This would provide insight into the effects of stress on glycemic control during a crisis.
- Investigate reasons for non-response: Further research should investigate the reasons for non-response to the distress scale. This would help identify the reasons for non-response and develop strategies to increase response rates in future studies.

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7. APPENDIXES

Appendix1: Structure questionnaire

Impact of covid -19 pandemic on glycemic regulation in type 2 diabetes mellitus patients and evaluation of Diabetes Distress Scale DDS

Questionnaire No:

Date:……../……./……..

A– sociodemographic characteristics and diabetes-related questions (Turkey Demographic and Health Survey -2018)

1. gender ○ male ○ female
2. Age:……..   ○ age- 18-27   ○ age- 28-37   ○ age - 38-47   ○age- 48-65
3. Marital status: ○ single ○ married   ○ Widowed ○ Divorced ○Separated.
4. Education status: ○ Illiterate ○ Literate ○ Primary school   ○ Elementary school ○ High school ○ University and higher
5. Social security:

○ retired ○ private health insurance ○ Insurance under temporary protection ○ General health insurance(ssi) ○ No health insurance ○ I do not know
6. Job-status: ○ Working ○ Not working ○ Other please specify.....
7. how is the income situation of yourself or your family? ○Income is less than expense ○ Income is equal to expenses ○ Income is more than expense
8. What is the total monthly income of your family?..... TL 8-a How many individuals are living at home ?.....
9. Place of Residence: ○ Provincial-District ○ Sub-District/Village
10. Diabetes duration (years)? ……
11. Do you have a blood Glucose Monitoring Meter? ○ Yes, ○ No
12. Can you measure your own blood sugar? ○ No ○ Yes, 12-a ○ If yes how many times per day?..... Times
13. Do you know your HbA1c level?? ○ No ○ Yes, 13-a If Yes…. What is the last value?..... 13-b which date is it? ……..
14. Type of medication: ○ Oral ○ Insulin ○ Oral+Insulin ○ diet
15. Do you have any other diabetes-related conditions?

(such as loss of vision in the eyes, numbness in hands and feet, kidney disease, foot wounds)

Loss of vision in the eyes ○ Yes ○ No

Numbness in hands and feet ○ Yes ○ No

Renal disease ○ Yes ○ No

Non-healing wounds (especially on the feet) ○ Yes ○ No

16. Do you have any other chronic diseases?

○ No (if no, You can skip to question 17) ○ Yes (if yes

high blood pressure

high cholesterol level

Other (please specify)……

17. Are you smoking?

○ I have never used

○ I was using it, I quit.

○I am using … ..years .....number/day

18. are you drink alcohol?

○No ○ Rarely ○Sometimes ○ Everyday

19. Have you ever had a Covid-19 disease

○ No

○ yes (if yes ..…

19a. How many times have you had Covid-19 disease? …./times

20. Have you been vaccinated for Covid -19 disease? ○ No ○ Yes (if yes.… 20a. which vaccine? ○ Pfizer-BioNTech ○ CoronaVac(sinovac) ○ Turkovac 20b. How many doses?..... dose
21. Do you exercise regularly (at least half an hour, 3 days a week) before the pandemic? ○ yes i do it this way ○ I do , but not in this way ○ No
22. Do you exercise regularly (at least half an hour 3 days a week) during the pandemic? ○ yes i do it this way ○ I do , but not in this way ○ No
15. Body Mass Index (BMI (kg/m2) 15a Height:…….. 15b. Weight:……

B- Morisky (Self-reported Medication-taking Scale)

The scale consists of four closed-ended questions with two options.

The idea behind these questions is that disconnection may be due to forgetfulness, inattention, stopping the medication when you feel better, or experiencing an adverse event. The questions are answered as 'yes/no'. If all questions are answered "no", drug compliance is considered high, if "yes" is answered for

one or two questions, drug compliance is considered moderate, if three or four questions are answered "yes", drug compliance is considered low.

It is an easy to fill scale.

1. Do you ever forget to take your medicine? ○ No ○ Yes
2. Are you having trouble remembering to take your medicine? ○ No ○ Yes
3. When You feel better do you sometimes stop taking your medicine? ○ No ○ Yes
4. Sometimes if you feel worse when you take the medicine, do you stop taking it? ○ No ○ Yes

C- Turkish version of Diabetes Distress Scale.\

Assessment of distress The DDS is a 17-item psychological measurement tool that uses a Likert scale with each item scored from 1 (no distress) to 6 (serious distress) to reflect distress experienced over the last month. The total score is calculated by dividing the sum of the answers by 17. A score of ≥3 is defined as T2DM-related distress. There are four subscales and subscale scores are also calculated by dividing the sum of subscale answers by the total question count of the subscale. Subscales are as follows: the emotional burden subscale with 5 questions, the physician-related distress subscale with 4 questions, the regimen-related distress subscale with 5 questions, and the interpersonal distress subscale with 3 questions.

Sorunlar	Not a Problem	A Slight Problem	A Moderate Problem	Somewhat Serious Problem	A Serious Problem	A Very Serious Problem
1. Feeling that diabetes is taking up too much of my mental and physical energy every day						
2. feeling that my doctor doesn't know enough about diabetes and diabetes care						
3. Feeling angry, scared, and/or depressed when I think about living with diabetes.						
4. Feeling that my doctor doesn't give me clear enough directions on how to manage my diabetes.						
5. Feeling that I am not testing my blood sugars frequently enough.						

6. Feeling that I am often failing with my diabetes regimen						
7. Feeling that friends or family are not supportive enough of my self-care efforts (e.g., planning activities that conflict with my schedule, encouraging me to eat the "wrong" foods)						
8. Feeling that diabetes control my life.						
9. Feeling that my doctor doesn't take my concerns seriously enough.						
10. Not feeling confident in my day-to-day ability to manage diabetes						
11. Feeling that I will end up with serious long-term complications, no matter what I do						

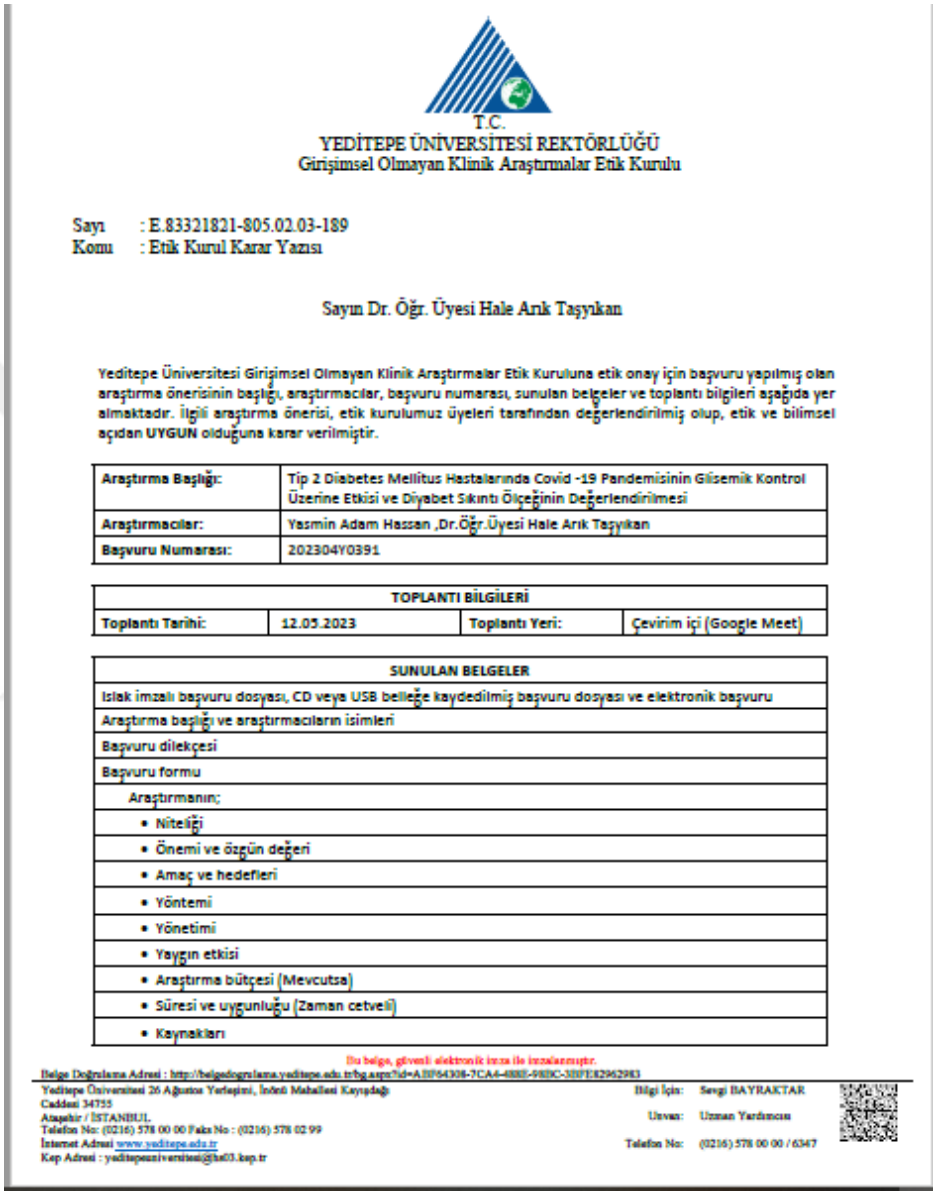
12. Feeling that I am not sticking closely enough to a good meal plan.						
13. Feeling that friends or family don't appreciate how difficult living with diabetes can be.						
14. Feeling overwhelmed by the demands of living with diabetes.						
15. Feeling that I don’t have a doctor who I can see regularly about my diabetes.						
16. Not feeling motivated to keep up my diabetes self-management.						
17. Feeling that friends or family don't give me the emotional support that I would like						

D- Information from hospital files: (medical electronic)

	before pandemia	during pandemia
Before pandemia and during pandemia Hemoglobin A1c (%)		
Fasting blood sugar before and during the pandemia		
Vitamin D		
Vitamin B12		
5. triglyceride		
6.LDL		
7. HDL		
8. Total-cholesterol		
9. TSH		
10. T3		
11. T4		

Contact information to make a survey:	phone number 1	phone number 2	E-posta adresi

Appendix2: Non-Interventional Clinical Research Ethics Committee approval



T.C.
YEDİTEPE ÜNİVERSİTESİ REKTÖRLÜĞÜ
Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu

Sayı : E.83321821-805.02.03-189
Konu : Etik Kurul Karar Yazısı

Sayın Dr. Öğr. Üyesi Hale Arık Taşyıkan

Yeditepe Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kuruluna etik onay için başvuru yapılmış olan araştırma önerisinin başlığı, araştırmacılar, başvuru numarası, sunulan belgeler ve toplantı bilgileri aşağıda yer almaktadır. İlgili araştırma önerisi, etik kurulumuz üyeleri tarafından değerlendirilmiş olup, etik ve bilimsel açıdan **UYGUN** olduğuna karar verilmiştir.

Araştırma Başlığı:	Tip 2 Diabetes Mellitus Hastalarında Covid -19 Pandemisinin Glisemik Kontrol Üzerine Etkisi ve Diyabet Sıkıntı Ölçeğinin Değerlendirilmesi
Araştırmacılar:	Yasmin Adam Hassan ,Dr.Öğr.Üyesi Hale Arık Taşyıkan
Başvuru Numarası:	202304Y0391

TOPLANTI BİLGİLERİ			
Toplantı Tarihi:	12.05.2023	**Toplantı Yeri:**	Çevirim içi (Google Meet)

SUNULAN BELGELER
Islak imzalı başvuru dosyası, CD veya USB belleğe kaydedilmiş başvuru dosyası ve elektronik başvuru
Araştırma başlığı ve araştırmacıların isimleri
Başvuru dilekçesi
Başvuru formu
Araştırmanın;
• Niteliği
• Önemi ve özgün değeri
• Amaç ve hedefleri
• Yöntemi
• Yönetimi
• Yaygın etkisi
• Araştırma bütçesi (Mevcutsa)
• Süresi ve uygunluğu (Zaman cetveli)
• Kaynakları

Bu belge, güvenli elektronik imza ile imzalanmıştır.
Belge Doğrulama Adresi : http://belgedogrulama.yeditepe.edu.tr/bg.aspx?id=AB864308-7CA4-4888-98DC-3E0E82962983

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755
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Kep Adresi : yeditepeuniversitesi@hs03.kep.tr

Bilgi İçin: Sevgi BAYRAKTAR
Unvan: Uzman Yardımcısı
Telefon No: (0216) 578 00 00 / 6347

Bilgilendirilmiş Gönüllü Olur Formu (yapılan araştırmaya özel olarak hazırlanmış)
Taahhütname-1 Araştırmanın yapılacağı kurumdan izin alma sorumluluğunun araştırmacılara ait olduğuna dair taahhüt
Taahhütname-2 Dünya Tıp Birliği Helsinki Bildirgesinin son versiyonunun ve Sağlık Bakanlığı'nın ilgili tüm kılavuzlarının okunmasına dair taahhüt
Taahhütname-3 Daha önce yapılmış etik kurul başvuruları mevcut olup olmadığına dair taahhüt
Taahhütname-4 Araştırma sırasında araştırma bütçesinde yer almayan ve gönüllünün kendisine veya Sosyal Güvenlik Kurumuna ek yük getirecek hiçbir işlem uygulanmayacağına dair taahhüt
Taahhütname-5 COVID-19 hastalarında tedavi yaklaşımları ve bilimsel araştırmalar genelgesi okunmasına dair taahhüt
Taahhütname-6 Millî Eğitim Bakanlığı Araştırma Uygulama İzinleri konulu yazının okunmasına dair taahhüt
Araştırmacıların her birisine ait özgeçmiş formu
Ek belgeler (Varsa kullanılan ölçek)

Prof. Dr. Didem ÖZDEMİR ÖZENEN
Başkan

Doç. Dr. Gökhan ERTAŞ
Başkan Yardımcısı

Doç. Dr. Elif SUNGURTEKİN EKÇİ
Raportör

Prof. Dr. Feryal SUBAŞI
Üye

Doç. Dr. Binnur OKAN BAKIR
Üye

Dr. Öğr. Üyesi Emine Nur ÖZDAMAR
Üye

Dr. Öğr. Üyesi Sevim ŞEN OLGAY
Üye

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Telefon No: (0216) 578 00 00 / 6347

CURRICULUM VITAE

Personal Informations

Name	YASMIN ADAM	**Surname**	HASSAN

Education

Degree	**Department**	**The name of the Institution Graduated From**	**Graduation year**
Doctorate			
Master			
University	MEDICINE	**AL-RAZI UNIVERSITY**	20014
High school	HIGH SCHOOL	**AL-HUDA PRIMARY AND SECONDARY SCHOOL**	2008

[#] All the grades must be listed if there is more than one (KPDS, ÜDS, TOEFL; EELTS vs),

Languages	**Grades ([#]))**
ENGLISH	VERY GOOD
TURKISH	GOOD

Work Experience (Sort from present to past)

Position	**Institute**	**Duration (Year - Year)**
ASSISTANT DOCTOR	DAYNILE HOSPITAL	2016-
ASSITANT TEACHER	MUGADISHU UNIVERSITY	2016-

Computer Skills

Program	**Level**
MICROSOFT	VERY GOOD
SPSS	GOOD

***Excellent, good, average or**