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## Changes in clinic visits and diabetes and metabolic control in patients with type 2 diabetes during COVID-19 pandemic: A real world evidence

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### ABSTRACT

**Purpose:** The study aim was to evaluate the effects of public lockdown during the covid-19 pandemic on glucose and metabolic parameters as well as body weight control in type 2 diabetic patients.

**Methods:** This study was conducted in two outpatient Diabetes Clinics and analyzed data available in database of Diabetes Clinic. Data related to a year before covid-19 pandemic and a year during covid-19 pandemic was collected from the database and analyzed. Patients with type 2 diabetes included in the analysis if they had referred to Diabetes Clinics both before and during covid-19 pandemic. Demographic information and data about metabolic status were collected from the records of previous outpatient Clinic visits and compared

**Results:** Finally 9440 patients with mean age of  $61.08 \pm 11.62$  referred to Diabetes Clinics in both the year before and the year of the corona pandemic. Mean FBS and HbA1c in diabetes patients reduced significantly from  $155.37 \pm 62.93$  and  $7.97 \pm 1.74$  before pandemic, respectively to  $138.77 \pm 45.39$  and  $7.54 \pm 1.34$ , respectively during covid-19 outbreak. During covid-19 pandemic, all metabolic parameters including glycemic and lipid profile (except for triglyceride) and BMI (body mass index) reduced significantly statistically, but, these changes were not clinically significant. However, triglyceride level increased statistically significantly but again it was not significant clinically.

**Conclusion:** During COVID-19 lockdown, glycemic and metabolic control of diabetes patients have improved significantly except for triglycerides.

### 1. Introduction

Outbreak of severe acute respiratory syndrome caused by a novel coronavirus (known as COVID-19) pandemic becomes a global health emergency [1,2]. According to the latest evidences, people suffered from chronic diseases such as Diabetes Mellitus (DM) are more vulnerable than others to severe outcome of the COVID-19 [3–5]. DM as global health issue cause to increase mortality related to the COVID-19 [6]. Type 2 DM is the most prevalent type of diabetes [7] which without

glycemic control caused microvascular and macrovascular complications [8]. The importance of glycemic control in decreasing the incidence of complications has been recommended [9]. Additionally patients with poor glucose control affected with Covid-19 encountered with worse outcomes even increasing mortality and morbidity [9].

Until now different approaches have been proposed to reduce risk of COVID-19 spread including Physical distancing, face masks, and eye protection [10]. In this regard lockdown was imposed which restricted all outdoor activities, as well limited the face to face visit at diabetes

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clinics [11].

Additionally as lockdown affects the lifestyle of the diabetic patients including physical activity, diet, and stress it is expected to influence the glycemic control [11]. Moreover, metabolic syndrome indicators such as hypertension and dyslipidemia should be considered in patients with type 2 diabetes to prevent and likely managed properly and in the right time [12].

Now in such a Covid-19 lockdown that patients with type 2 diabetes have no face-to-face visit and may have consulted virtually, or do not have any routine care, there are concerns about glycemic control, life style changes, metabolic control and well-being. [13]. As well fear of infection caused the reduced clinic visits [14]. Since routine diabetes care in this unique condition differ by country, the effect of lockdown on glycemic control and diabetic care vary too. Accordingly there are different studies with different results from different countries on the Covid-19 restriction on diabetes management.

Some studies reported glycemic parameters worsening during covid-19 restriction [15,16] however the result of some studies suggested glucose control improvement [17–20].

Due to the heterogeneous findings related to local lockdown caused, the current study was carried out to investigate the effects of lockdown during the covid-19 pandemic on glucose, metabolic parameters and body weight control in type 2 diabetic patients.

## 2. Methods

This study was performed using registered data in Diabetes Registry databank which was collected in two outpatient Diabetes Clinics affiliated to Tehran University of Medical Sciences, Tehran, Iran and analyzed data available from the cohort of Diabetes Clinic.

Serial data of all type 2 diabetes patients refer to these Diabetes Clinics for diabetes management are recorded in related database after each visit regularly since 4 years ago. Therefore, data related to a year before covid-19 pandemic (20 Feb. 2019–19 Feb. 2020) and a year during covid-19 pandemic (20 Feb. 2020–19 Feb. 2021) was collected from the database and analyzed.

All patients with type 2 diabetes included in the analysis if they had referred to Diabetes Clinics both before and during covid-19 pandemic and those referred only in one period (before or during covid-19 pandemic) were excluded (the patients were the same in the two periods).

After considering inclusion and exclusion criteria, finally 9440 patients remained for analysis.

Demographic information and data about metabolic status including glycemic control and lipid profile, as well as liver and kidney function were collected from the records of previous outpatient.

Clinic visits in order to compare the findings before and after pandemic.

The IRB approval was obtained from the ethics committee at Endocrinology and Metabolism Research Institute, Tehran University of Medical Sciences and all patients gave consent to use their data.

### 2.1. Data analysis

Data are presented as mean and standard deviation (SD) for numerical data and number and percentage for categorical data. Between groups comparison of numerical data was performed using paired-T-test or Wilcoxon signed-rank test as appropriate. Categorical data was compared using chi-squared (chi<sup>2</sup>) test. All analyses was conducted by SPSS software ver. 20.00 for Windows and *p* values less than 0.05 were considered significant.

## 3. Results

Information of diabetes clinic visits during one year of beginning of covid-19 pandemic and corresponding before pandemic was collected,

retrospectively and analyzed. During this two-year period, totally 31,918 diabetes visits was registered, of them 21,044 occurred before covid-19 pandemic and 10,874 during pandemic. The comparison of periods showed approximately 50 % reduction in diabetes visits during corona pandemic (Fig. 1).

Overall, a total of 9440 patients (52.8 %, 4990 F) with mean age of  $61.08 \pm 11.62$  y and mean duration of diabetes  $12.86 \pm 7.97$  y, referred to diabetes clinic in both the year before the pandemic and the year of the corona outbreak.

Mean FBS and HbA1c in diabetes patients reduced significantly from  $139.09 \pm 46.09$  and  $7.54 \pm 1.29$  before pandemic, respectively to  $136.24 \pm 42.43$  and  $7.44 \pm 1.25$ , respectively during covid-19 outbreak (Table 1). During covid-19 pandemic, all metabolic parameters including glycemic and lipid profile (except for triglyceride) and BMI (body mass index) reduced significantly statistically, but, these changes were not clinically significant (Table 1). However, triglyceride level increased statistically significantly but again it was not significant clinically (Table 1).

Before pandemic about 74.73 % of diabetes patients were overweight and obese that during covid-19 outbreak did not change significantly and remained 74.91%. Also, the rate of obesity (BMI  $\geq 30$ ) did not change significantly during the pandemic (31.05 % before vs. 30.37 % during pandemic).

In elderly adults aged  $\geq 65$  years, 62.5 % had optimal glycemic (treatment goal) control with HbA1c less than 8 % and 35.2 % HbA1c  $\leq 7$  before pandemic while 72.8 % and 39.7 % during corona pandemic ( $p < 0.001$ ). The differences were significant statistically but again these differences were not clinically significant.

Among all ages, 3359 of 5591 patients (60.1 %) had HbA1c less than 8 % before pandemic while 72.4 % (1526 of 2109 patients) during the pandemic, which among all of them, the age group with most patients with HbA1c  $< 8$  (54.3 %) was group 45–65 years before and during pandemic.

Among all ages, during pandemic only 40 % had HbA1c less than 7 % while before pandemic 33.6 % had, which among all of them, the age group with most patients with HbA1c  $< 7$  (54.1 % and 54.9 % before and during pandemic, respectively) was group 45–65 years before and during pandemic.

Before corona, the prevalence of cholesterol level  $> 200$  was 11.4 %, which decreased to 5.2 % during corona pandemic. In addition, frequency of LDL levels  $> 100$  decreased from 23.1 % before corona to 12.1 % during corona pandemic.

Serum cholesterol in 69.8 % of people with cholesterol level  $> 200$  before corona decreased below 200 during corona pandemic, which was a significant difference ( $P < 0.001$ ). Also, in 66.9 % of those with LDL level  $> 100$  before corona, it decreased below 100 during corona pandemic as well ( $p < 0.001$ ).

Before corona pandemic the prevalence of LDL level  $\leq 100$  in age groups of  $< 45$ , 45–65 and  $> 65$  was 6.9 %, 54.1 % and 39.0 %, respectively.

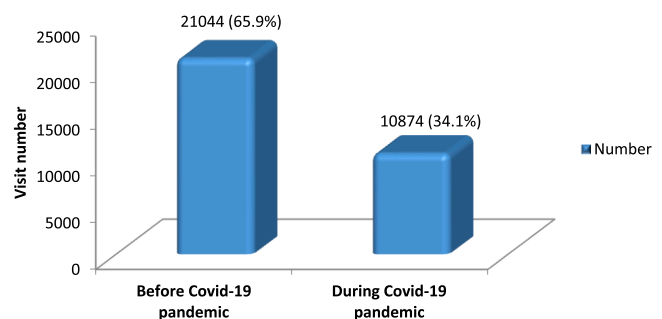


Fig. 1. Number and percentage of Diabetes Clinic visits before and during covid-19 pandemic.

**Table 1**

Demographic characteristics of diabetes patients referred to diabetes clinic in both the year before and the year during covid-19 pandemic.

Parameter	Number of patients	Before Covid-19 pandemic	During Covid-19 pandemic	P-value
FBS, (mean $\pm$ SD) mg/dL	1626	139.09 $\pm$ 46.09	136.24 $\pm$ 42.43	0.02*
BS2hpp, (mean $\pm$ SD) mg/dL	1036	197.58 $\pm$ 74.06	190.21 $\pm$ 69.71	0.002*
HbA1c, (mean $\pm$ SD), (%)	1644	7.54 $\pm$ 1.29	7.44 $\pm$ 1.25	0.003*
Total cholesterol, (mean $\pm$ SD)	814	143.39 $\pm$ 34.49	140.45 $\pm$ 33.10	0.01*
Triglyceride, (mean $\pm$ SD) mg/dL	1001	146.05 $\pm$ 71.72	150.82 $\pm$ 80.28	0.02*
HDL, (mean $\pm$ SD) mg/dL	651	43.65 $\pm$ 11.24	42.88 $\pm$ 10.73	0.03*
LDL, (mean $\pm$ SD) mg/dL	965	75.68 $\pm$ 25.83	73.16 $\pm$ 26.17	0.004*
BMI, kg/m <sup>2</sup> (mean $\pm$ SD)	800	28.36 $\pm$ 4.53	28.21 $\pm$ 4.58	0.001*

respectively. During corona pandemic frequency of LDL  $\leq$  100 reached to 4.9 %, 54.4 % and 40.7 %, respectively.

#### 4. Discussion

In general, although the number of outpatient visits reduced significantly during COVID-19 lockdown, metabolic parameters including FBS, BS2hpp and HbA1c as glycemic control indices in patients with type 2 diabetes improved significantly compared before pandemic. In addition other metabolic parameters including total cholesterol, HDL and LDL as well as BMI reduced significantly statistically but however these changes were not clinically significant. Triglyceride was the only indicator that did not improve during the lockdown.

Other studies also showed reduced number of outpatient visits in diabetes and cardiovascular diseases during covid-19 lockdown similar to our study as well [21,22].

Although lockdown in Covid-19 pandemic reduces the infection spread, it increased specific worries and reduced physical activity among patients [23,24] and caused challenges in the treatment of chronic diseases that require constant care and follow-up like type 2 diabetes and cardiovascular diseases. There are many studies about the effect of covid-19 pandemic lockdown on diabetes control in different countries but the results are controversial [21,25–29]. Some studies about glycemic control during lockdown in type 2 patients showed increased HbA1c and mean glucose [25–29]. The main reason to the mentioned deteriorations in glycemic control may be changing pattern of lifestyle (reduced compliance to diet and exercise, excessive sedentary behavior) [25,30,31], psychological stress related to pandemic [23] and lack of adherence to diabetes treatment regimen.

While in line with our findings, there are some studies [19,20] which glycemic values significantly improved during COVID-19 pandemic compared before. It seems that self-care and digital diabetes management would be particularly effective in diabetes management in the pandemic era. Since the patient in our study have not receive any tele-health services and digital treatments, it is likely the improvement in glycemic control were related to the patient self-management [13]. In this regard type 2 diabetic patients during pandemic had access to the educational materials, mobile phone apps, websites, text messaging and instagram page as Diabetgram. Probably feasibility to access a variety of educational materials cause the life style positive changes.

Another important point emphasized in similar study [19] was the opportunity to work from home which lead to improved eating behavior (like regular eating time and home-made food) and daily time for routine physical activity. Actually the majority of patients in the current study were 45–65 years and in this age group they are mostly have a

labor. Accordingly it could be noted that Covid-19 restriction prepared a flexible work schedule for patients to have healthier lifestyle. In view of similar study [11] the improved glucose control in diabetic patients may see because of more time for self-care and increased sleep duration which highlighting the importance of stable rhythm of life, including more regular mealtimes, diet and physical activity and less stressful life [11].

In this regard our study decreasing lipid profile and BMI could suggest the healthy lifestyle during Covid-19 among type 2 diabetic patients compared before. However some studies showed lack of enough outdoor physical activity, weight gain and poor glycemic control followed by lockdown due to Covid-19 [27] while others did not find any weight gain [25] similar to ours. It should be noted that part of the results of our study in line with this research, showed an increase in TG level independent of weight gain in the patients. It is noteworthy that decreasing in the TG level in diabetics was not clinically significant.

It should be mentioned that remote diabetes services as tele-healthcare system indicated helpful consequences with continuous patient support [32] though it is not widely accessible for our diabetic patients. However remote support of patients suffering from diabetes still challenging and.

The main limitation of this study is that there is no information about glycemic and metabolic control of those patients whom did not refer to the Clinic during covid-19 pandemic which may change these results.

#### 5. Conclusion

According to the results, during COVID-19 lockdown glycemic and metabolic control of diabetes patients has improved significantly except for triglyceride. Such metabolic improvement may be due to improved self-management and free-living of type 2 diabetes with flexible life style at home. However, all of these changes were significant only statistically but not clinically. It should be noted that these results belong only to those patients referred to Diabetes Clinic regularly before and during covid-19 pandemic which may indicate their better access to care, paying more attention to priority of diabetes care and control, having more knowledge about covid-19 complication and outcome and better self-management.

In this regard the effectiveness of self-management during the pandemic would be important. However, telehealth, virtual visit, and teleconsulting with health care providers in diabetes clinic were not available during corona outbreak. So, it is essential to implement a variety of online services for diabetes management and prevention of complications such as routine diabetes care, foot screening, eye screening, blood tests and urgent diabetes care. It seems that virtual communication with peers in virtual social network, potentially feasible in pandemic aiming to optimize self-care of diabetes should be considered.

#### CRedit authorship contribution statement

**FB:** concept of study, data collection and analysis, interpretation of results, writing first draft of manuscript, approving final manuscript. **MQ:** Data analysis and approving final manuscript. **MA:** writing first draft of manuscript, approving final manuscript. **MP:** data collection, approving final manuscript. **BL, ENE:** concept and design of study, approving final manuscript.

#### Consent for publication

Not applicable.

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## Declarations

The present study was approved by the Ethics Committee of Endocrinology and Metabolism Research Institute, Tehran University of Medical Sciences (TUMS) (code: IR.TUMS.EMRI.REC.1399.052). Moreover the authors seriously considered ethical issues.

## Conflict of Interest

The authors have no conflict of interest to report.

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