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Glycemic Control Improvement amongst Patients with Diabetes Mellitus during a COVID-19 Lockdown in Jordan

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Abstract

Aims: The purpose of this study is to evaluate the effects of lockdown measures by the Jordanian government to contain the spread of the novel corona virus (COVID-19) on glycemic control of patients with diabetes mellitus.

Methods: This cross-sectional study was conducted in Jordan University Hospital. A total of 264 patients with type 2 or type 1 diabetes mellitus were sampled. The authors evaluated the extent of glycemic control reached by patients with type 2 or type 1 diabetes mellitus by measuring change in glycosylated hemoglobin (A1C) values, in addition to the number of hypoglycemic episodes experienced by patients during lockdown. The authors conducted a questionnaire via telephone interviews to record information about drug adherence and availability, diet, physical activity, and telephone consultations. A paired sample *t*-test was used to compare values before and after lockdown.

Results: A significant reduction in HbA1C values was found during lockdown (p=0.038), with only 33.6% of patients experiencing one or more hypoglycemic episodes; both factors suggest controlled blood glucose levels. Medication adherence was found to be the main reason for improvement, with 74.8% of our population being strongly adherent to their medications.

Conclusions: In Jordanian patients with diabetes mellitus, glycemic control was significantly improved during COVID-19 lockdown and this was found to be associated with strong medication adherence.

Keywords: Adherence, COVID-19, diabetes, glycemic control, lockdown

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Introduction

The novel coronavirus disease (COVID-19) has affected over 113 million people in 219 countries and territories across the globe [1]. Based on the severity of the disease and its rapid spread day by day all over the world, the World Health Organization (WHO) declared COVID-19 a pandemic on March 11, 2020 [2]. COVID-19 is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), which primarily targets the human respiratory system [3]. This latest coronavirus strain is not similar to other coronaviruses that cause mild respiratory infections or the common cold in adults and children; SARS-CoV-2 can be mild, moderate or severe based on the strength of the immune system of the infected individual. Acute influenza, acute respiratory distress syndrome, sepsis and septic shock are among the severe health symptoms [4].

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Due to the widespread nature of the SARS-CoV-2 virus, measures have been taken to restrict the spread of the virus, one of which is the lockdown [5]. This lockdown affected routine care for chronic illnesses; for example, follow-up appointments were affected. Telemedicine services in middle to low income countries like Jordan are limited and scarce. Such scarcity leads to negative consequences for patients with chronic illnesses who need regular follow-ups to assess the control of their illnesses [6]. A fact that has been proven by some studies is that, during disasters, the management of patients with chronic illnesses may be affected by a lack of medications and medical care [7]. Another effect of the lockdown is the sudden and radical changes occurring in the habits and lifestyles of the population (physical activity, diet, sleeping habits etc.), with a drastic reduction in any form of socialization [5]. The situation in Jordan is an example of the state of countries during a pandemic; according to Jordan's Ministry of Health data, a total of 413,000 cases of coronavirus were confirmed across the country as of March 5, 2021. Jordan has enforced public health infection prevention and control measures in order to control the threat. On March 17, 2020, the government called for social distancing and seized all forms of inbound and outbound movement or international travel [8]. In addition, strict lockdown measures were taken by the government, including the closure of most clinics and reliance on emergency rooms to provide care for patients. We believe this may have had drastic and negative effects on the control of chronic diseases, including diabetes.

Diabetes mellitus is a group of metabolic diseases whose common feature is an elevated blood glucose (BG) level resulting from defects in insulin secretion, action or both [9]. Patients with diabetes must balance diet, physical activity, and hypoglycemic medications as well as monitor their blood glucose levels each day to attain and maintain good metabolic control. Because of the complexity of the therapy regimen, patients with diabetes benefit from intensive follow-up [10].

In order to sustain effective diabetes management, participants require a combination of structured and responsive individualized follow-up support, which is recommended for all participants. This includes those with optimal glycemic control who have access to good social support and report confidence in their knowledge and skills [11]. During follow-up, doctors explore the patient's understanding of the need for good glucose control, give lifestyle advice, arrange the necessary investigations, and ensure the patient is in concordance with their medication [12]. The importance of regular follow-up for patients with diabetes with health care providers is of great significance in averting and preventing the progression of complications associated with diabetes [13]. As many patients lost this close follow-up during lockdown, our study explores the impact of lockdown on diabetes control as reflected mainly by glycosylated hemoglobin (A1C) levels before and after the lockdown. In addition, the study investigates the factors that may have affected diabetes control, including sociodemographic factors, education level, and access to distance medical care or advice.

Materials and Methods

Study design and participants

This is a cross-sectional retrospective study conducted among patients who attended the Endocrinology and Diabetes Clinics at Jordan University Hospital (JUH), Amman, Jordan. JUH is a tertiary medical center that provides high quality medical services for all age groups. The study was approved by the institutional scientific committee and the approval review

board at JUH and was conducted in concordance with the latest declaration of Helsinki between July 20, 2020, and September 8, 2020.

The authors recruited patients from Endocrinology and Diabetes Clinics according to the following inclusion criteria: patients had to be diagnosed with type 1 diabetes mellitus or type 2 diabetes mellitus for at least one year prior to the beginning of data collection, aged 15 and above, and have visited the clinic twice—in the period prior to the lockdown, extending from December 2019 to March 18, 2020, and the period immediately after the lockdown, from May 2020 to July 2020. Patients with cognitive problems were excluded due to their inability to give appropriate consent; patients with pre-diabetes mellitus were also excluded.

The authors first screened patients through the health records of the hospital. After confirming eligibility, we collected patient demographic data, including age, educational level, occupation, type of insurance, type and duration of diabetes mellitus, address, and medical conditions, as well as prescribed medications. After this, we collected patients' lab values of significance (i.e., A1C, kidney function test (KFT) and urine analysis).

Data collection

After confirming eligibility for inclusion and acquiring informed verbal consent, a questionnaire was conducted via telephone. The questionnaire first assessed patients' adherence to medications (type, time, and doses) and lifestyle habits, including diet and exercise during the quarantine on a scale of four grades (1=very poor, 2=poor, 3=moderate and 4=strong). The second part evaluated the patients' monitoring of diabetes by asking about the frequency of blood glucose home measurements, high glucose levels (>200 mg/dl) and hypoglycemic attacks. It also inquired about any self-made changes to the medication (increasing or decreasing the dose, changing the frequency or type of drug), if patients acquired contact with their doctor due to a diabetes mellitus-related problem, and history of ER visits or hospital admission due to diabetes mellitus complications during the lockdown. This part also assessed the availability of medications and how it affected patients' adherence. The last part was related to the post-quarantine clinic visit and involved questions about changes in medications or doses made by their doctor, referral to the nephrology, ophthalmology, or neurology clinics due to changes in patients' laboratory values or new complaints.

Trained research assistants were responsible for obtaining consent from patients, explaining the purpose of the study, completing the questionnaire by telephone, and ensuring that patients understood the questions well and that all questions were answered.

Statistical analysis

We used SPSS version 26.0 (Chicago, USA) in our analysis. We used mean (± standard deviation) to describe continuous variables (e.g., age), and count (frequency) to describe other nominal variables (e.g., sex).

We performed a paired sample *t*-test to analyze the mean difference between A1C before and after the COVID-19 period and we presented data in mean (standard deviation).

All underlying assumptions were met. We adopted a *p*-value of 0.05 as a significant threshold.

Results

A total of 264 patients were included in this study, with a mean age of 59.16 (±14.25) years. Of these, 121 patients (45.8%) were men and 143 (54.2%) women. The characteristics of the sample are presented in Table 1. A significant feature was that most of the sample was aged 50 years and older, with 30.3% (*n*=80) falling into the age group between 51–60. Most of the patients had type 2 diabetes (*n*=241; 91.3%) and 37.9% (*n*=100) held a graduate degree. Only one fifth of

the sample was employed. The majority of participants (*n*=135; 51.1%) were insured via the Ministry of Health insurance. Regarding co-morbid medical conditions, the most frequent co-morbidity was hypertension, which was found in 66.7% (*n*=176) of the sample, followed by dyslipidemia (*n*=109; 41.3%), then ischemic heart disease (IHD) (*n*=67; 25.4%), chronic kidney disease (CKD) (*n*=38; 14.4%), cerebrovascular accident (CVA) (*n*=22; 8.3%), obesity (*n*=17; 6.4%) and the least frequent comorbidity was polycystic ovarian syndrome (PCOS), occurring in only one patient (0.4%).

Table 1: Sociodemographic of the sample

		Number (%)
Gender	**Male**	121 (45.8)
	Female	143 (54.2)
Job	Employed	53 (20.1)
	Retired	96 (36.4)
	Unemployed	106 (40.2)
Insurance Type	MOH	135 (51.1)
	JUH	18 (6.8)
	Army forces	53 (20.1)
	Private	50 (18.9)
	Other	50 (18.9)
Level of education	Illiterate	27 (10.2)
	Elementary	59 (22.3)
	High school	76 (28.8)
	Graduate	100 (37.9)
Age	≥20	5 (1.9)
	21–30	11 (4.2)
	31–40	10 (3.8)
	41–50	28 (10.6)
	51–60	80 (30.3)
	61–70	75 (28.4)
	Over 70	55 (20.8)
Type of DM	Type 1	22 (8.3)
	Type 2	241 (91.3)
Hypertension		176 (66.7)
Hypothyroidism		37 (14)
IHD		67 (25.4)
CVA		22 (8.3)
CKD		38 (14.4)
Dyslipidemia		109 (41.3)
PCOS		1 (0.4)
Obesity		17 (6.4)

Abbreviations: MOH: Ministry of Health. JUH: Jordan University Hospital. IHD: Ischemic Heart Disease. CVA: Cerebrovascular Accident. CKD: Chronic Kidney Disease. PCOS: Polycystic Ovary Disease

Table 2 shows we found a statistically significant difference (decrease) between A1C before and after COVID quarantine (p= 0.038), with a mean difference of 0.038 (95% *CI* 0.01 to 0.31).

Table2: Difference in Hba1c before and after quarantine

	Mean Hba1c	**Mean Hba1c (mmol/mol)**	**Std. Deviation**	***p* value**	**Mean difference**	**95% CI**
Hba1c Before	8.0365	64	1.70608	0.038	0.16	0.01 to 0.31
Hba1c After	7.8779	63	1.57975			

Most patients described their overall adherence to their diabetes medications as strong (n=196; 74.8%), with 78.6% (n=206) strongly adhering to medication doses and 83.1% (n=196) adhering to medication times. Patients were less adherent to diet as 33.7% (n=88) said they did not adhere to a healthy diet and 28.4% (n=74) described their adherence as weak. Only 15.3% (n=40) of our patients described their exercise as strong or moderate. Table 3 illustrates these results.

Table 3: Overall adherence to medications, healthy diet and exercise during lockdown

	No adherence no. (%)	**Weak adherence no. (%)**	**Moderate adherence no. (%)**	**Strong adherence no. (%)**
Adherence to DM medication	2 (0.8)	12 (4.6)	52 (19.8)	196 (74.8)
Adherence to DM medications doses	1 (0.4)	16 (6.1)	39 (14.9)	206 (78.6)
Adherence to DM medications times	1 (0.4)	25 (9.5)	49 (18.7)	187 (71.4)
Adherence to Other medications	6 (2.5)	10 (4.2)	24 (10.2)	196 (83.1)
Adherence to Diet	88 (33.7)	74 (28.4)	65 (24.9)	34 (13.0)
Adherence to exercise	181 (69.3)	40 (15.3)	23 (8.8)	17 (6.5)

Patients were asked about the occurrence of incidence and complications related to diabetes during the lockdown. Table 4 shows that 88 patients (33.6%) experienced at least a single hypoglycemic episode, and around 60% (n=150) had hyperglycemia with home blood glucose readings above 200mg/dl. Most of the patients (n=240; 91.6%) reported that drugs were available during the quarantine. Some 27.2% patients (n=71) had self-adjusted their medications, 35 (13.4%) had consulted their doctors, and 49 (18.8%) had visited an emergency room; 13 of these patients (5.0%) required hospital admission. Only 1.5% (n=4) experienced diabetic ketoacidosis.

Table 4: Diabetes-related incidents during quarantine

	Yes No. (%)	**No No. (%)**
Hypoglycemic episodes	88 (33.6)	174 (66.4)
Blood sugar reading more than 200	150 (60.2)	99 (39.8)
Drug Self-Modification	71 (27.2)	190 (72.8)
Doctor consultation	35 (13.4)	227 (86.6)
Emergency Visits	49 (18.8)	212 (81.2)
Hospital Admissions	13 (5.0)	249 (95.0)
Drug availability during quarantine	240 (91.6)	22 (8.4)
Effect of drug availability on adherence	43 (16.6)	216 (83.4)
Diabetic Ketoacidosis	4 (1.5)	258 (98.5)

Table 5 demonstrates the relationship between different sociodemographic variables and mean A1C, which was more likely to have statistically significant improvement in male patients (p= 0.030), high school graduates (p= 0.02), patients with Ministry of Health insurance (p= 0.035), and patients who had CKD and hypothyroidism (p=0.026 and p=0.046, respectively). Other factors had no significant effect.

Table 5: The relationship between sociodemographic variables and mean HbA1c before and after quarantine

Sociodemographic item	**Mean HbA1C before quarantine**	**Mean HbA1c after quarantine**	***p* value (paired sample *t*-test)**
Overall	8.03	7.87	0.038
DM Type			
Type 1	8.75	8.41	0.314
Type 2	7.97	7.83	0.065
Gender			
Male	7.91	7.63	0.030
Female	8.14	8.08	0.516
Job			
Employed	8.08	7.87	0.277
Retired	7.62	7.50	0.335
Unemployed	8.31	8.20	0.350
Insurance Type			
MOH	7.89	7.70	0.035
JUH	7.87	7.93	0.813
Army	8.44	8.48	0.809
Private	9.36	8.44	0.286
Others	7.84	7.61	0.213
Level of Education			
Illiterate	7.92	8.09	0.341
Elementary	8.45	8.49	0.820

Sociodemographic item	Mean HbA1C before quarantine	Mean HbA1c after quarantine	*p* value (paired sample *t*-test)
High school	8.19	7.83	0.020
Graduate	7.67	7.50	0.147
Age			
≥20	9.40	9.04	0.478
21–30	8.23	8.09	0.792
31–40	8.08	7.84	0.565
41–50	8.35	7.92	0.124
51–60	8.32	8.13	0.246
61–70	7.60	7.62	0.806
70 and older	7.89	7.69	0.205
Comorbidities			
Hypertension	7.95	7.87	0.340
Hypothyroidism	7.73	7.42	0.046
IHD	8.10	8.07	0.852
CVA	8.23	7.98	0.455
CKD	7.67	8.08	0.026
Dyslipidemia	8.00	7.87	0.221
PCOS	5.90	5.30	-
Obesity	8.45	8.07	0.233

Abbreviations: MOH: Ministry of Health. JUH: Jordan University Hospital. IHD: Ischemic Heart Disease. CVA: Cerebrovascular Accident. CKD: Chronic Kidney Disease. PCOS: Polycystic Ovary Disease

Discussion

Improved glycemic control was achieved by patients with diabetes mellitus during COVID-19 lockdown. This improvement was reflected by a reduction in A1C values after the lockdown in comparison to those before it, in addition to only a minority of patients experiencing one or more episodes of hypoglycemia during the quarantine. Such results are in line with recent studies [14–15]. However, our findings disagree with previous studies showing an increase in A1C [16–17]. Another study suggests the negative feedback of COVID-19 social distancing on A1C of socially active type 2 diabetes mellitus patients [18]. No significant change in A1C was found in multiple previous studies [19–20].

Our findings can be explained mainly by the fact that 74.8% of our population described their adherence to their diabetes medications as 'strong', in addition to a large percentage being adherent to both doses and times. Other studies have demonstrated such adherence in patients with diabetes [21] and patients with other non-communicable diseases [22].

In our population, 91.6% had their diabetes medications available during the quarantine, suggesting that the availability of diabetes medications is a major contributor to patients' adherence. This is supported by the fact that the non-availability of insulin injections in type 1 diabetes mellitus patients caused a significant increase in A1C [23].

Adherence to medication seemed to be affected by the sex of patients. Males showed higher compliance rates compared to females. Such results were also found in a study in Saudi Arabia [24]. However, such difference was not found in another study [15].

Only a minority of participants described

their adherence to a healthy diet as moderate (24.9%) or strong (13%). This agrees with international multiple studies in which unfavorable eating habits, increased carbohydrate intake, and snacking were reported [17, 25]. There are, however, studies which disagree with our findings [14–15].

Exercise did not seem to be a factor in increased glycemic control in our study. Of our population, 69.3% had a sedentary lifestyle during lockdown. This agrees with other articles demonstrating less exercise in patients with diabetes mellitus during lockdown in comparison to before it [25–26].

Men and women do not seem to be affected equally in the matter of exercise, with men showing higher rates of exercise in lockdown. Evidently, women reported less frequency and duration of exercise compared to men in the Croatian population [27]. However, quarantine and other types of lockdown have been found to affect physical activity and exercise duration and intensity for men more than women, because women had a more sedentary lifestyle before lockdown [28].

Previous studies conducted on glycemic control during lockdown showed that telemedicine is an essential factor in this achievement [25, 29]. However, this impact cannot be recognized in our study as only 13.4% utilized telemedicine services.

The main limitation of our study is that the data were collected via a telephone-based questionnaire, and some patients who met the inclusion criteria did not respond to phone calls. We recommend that future studies use online questionnaires. Moreover, this study did not include data such as spot urine glucose, which could have added to the assessment of glycemic control.

In conclusion, despite relatively poor adherence to a healthy diet and exercise, both major components of the self-management of diabetes, Jordanian patients with diabetes mellitus achieved improved glycemic control during COVID-19 lockdown. The availability of medication and adherence to it played a major role in maintaining good glycemic control during this period.

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تحسّن السيطرة على نسبة سكّر الدمّ لدى مرضى السكّري خلال إجراء الإغلاق لمواجهة فايروس كورونا في الأردن

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الملخص

الأهداف: هدف الدراسة هو تقييم أثر تدابير الإغلاق التي فرضتها الحكومة الأردنيّة لاحتواء انتشار فايروس كورونا المستجدّ (كوفيد-19) على السيطرة على سكّر الدمّ لدى مرضى السكّري

منهجية الدراسة: أجريت الدراسة المقطعيّة في مستشفى الجامعة الأردنية. تمّ شمول 264 مريض سكّري من النوعين الأول أو الثاني في هذه الدراسة. قمنا بتقييم مدى السيطرة على نسبة السكّر في الدمّ لدى المرضى المشمولين في الدراسة من خلال قياس التغيير في قيم الهيموغلوبين الغليكوزيلاتي(A1c) ، بالإضافة إلى عدد نوبات هبوط السكّر التي عانى منها المرضى أثناء الإغلاق. أجرينا مقابلاتٍ هاتفيّة مع المرضى لتسجيل معلومات تتعلق بالتزام المرضى بأدوية علاج السكّري ومدى توفر هذه العلاجات لديهم، بالإضافة للنظام الغذائيّ المتبع أثناء الإغلاق، ومدى ممارسة النشاطات البدنية ومدى توفّر استشارات هاتفيّة مع مقدمي الرعاية الصحيّة الأوليّة لهم. تم استخدام اختبار paired t-test)) لمقارنة قيم النتائج قبل وبعد الإغلاق.

النتائج: شملت الدراسة مئتين وأربعة وستين مريضًا. كان هناك انخفاض ملحوظ في قيم الهيموغلوبين الغليكوزيلاتي (HbA1c) أثناء الإغلاق(p=0.038) ، قُدّرت نسبة من عانوا من نوبة أو أكثر من نوبات هبوط السّكر ب33.6% من المجموع الكليّ للمرضى، مما يشير إلى وجود سيطرة أفضل على مستويات السكّر في الدمّ. وُوجد أن العامل الرئيسي في تحسين السيطرة على مستويات السكر في الدم هو الالتزام بالأدوية حيث أنّ 74.8% من المرضى المشتركين بالدراسة كانوا ملتزمين بأدويتهم التزامًا صارمًا.

الاستنتاجات: فيما يتعلق بالعيّنة المدروسة من مرضى السكّري، لوحظ تحسّن في السيطرة على سكّر الدمّ بشكل ملحوظ أثناء الإغلاق المفروض بسبب فيروس كورونا (كوفيد-19)، والذي وُجد أنه مرتبط بالتزام المرضى الصارم بأدويتهم.

الكلمات الدالة: التزام؛ كوفيد-19؛ مرض السكّري؛ السيطرة على نسبة السكّر في الدم؛ الإغلاق.