Original Article

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Dietary habits, lifestyle changes, and glycemic control in patients with type 2 diabetes mellitus during coronavirus disease 2019 (COVID-19): A cross-sectional study in Egypt

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Abstract:

BACKGROUND: The coronavirus disease 2019 (COVID-19) lockdown had a significant effect on people's lifestyles and dietary habits resulting in a possible negative health impact, particularly for patients with type-2 diabetes mellitus (T2DM). The objective of the study was to assess the changes in dietary habits and lifestyle and how these relate to glycemic control in patients with type 2 diabetes (T2D), who attended Zagazig Diabetes Clinic, Sharkia Governorate, Egypt, during the COVID-19 pandemic.

MATERIALS AND METHODS: A total of 402 patients with T2D were included in this cross-sectional study. A semistructured questionnaire was used to collect information on socioeconomic status, dietary habits, lifestyle changes, and previous medical history. Weight and height were also measured, and hemoglobin A1C levels before and after lockdown were compared. Data analysis was performed using the SPSS. To determine statistical significance, Chi-square test was used for categorical variables whereas, paired t-test or McN-Nemar test, as appropriate, was used to compare change in HbA1c before and after lockdown. Ordinal logistic regression was used to determine factors associated with weight change, whereas binary logistic regression was used to determine factors related with glycemic control.

RESULTS: During the COVID-19 pandemic, 43.8% of the studied groups consumed more than their usual diet with an increase in fruits, vegetables, and immunity-boosting food; 57% depended on home-cooked food, 48.3% did not practice exercise. About 57% reported to have gained weight, 70.9% suffered from mental stress, and 66.7% reported inadequate sleep. Collectively, there was a statistically significant decrease in the percentage of good glycemic control in the studied groups (28.1% vs. 15.9%) before and after the COVID-19 lockdown, respectively ($P < 0.001$). Weight gain, physical inactivity, mental stress, and inadequate sleep were significantly associated with poor glycemic control.

CONCLUSION: COVID-19 pandemic has had a negative impact on the lifestyle and dietary habits of the studied groups. Therefore, it is very important to ensure better diabetes management in this critical period.

Keywords:

COVID-19, dietary habits, lifestyle, type 2 diabetes mellitus

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Introduction

On December 12, 2019, a new coronavirus (SARS-CoV2) was discovered in Wuhan, China, triggering a pandemic of acute respiratory syndrome in humans (coronavirus disease 2019). SARS-CoV-2 spread quickly from Wuhan, Hubei Province, China, to the rest of the world.[1] Owing to the massive international spread of cases, the World Health Organization's Emergency Committee declared it a global pandemic on January 30, 2020.[2]

The coronavirus disease 2019 (COVID-19) pandemic created life-altering issues for people worldwide, where "social detachment" and "self-isolation" became commonplace, and people were required to stay inside their homes for a lengthy period to combat the outbreak resulting in such side effects as boredom and stress. These side effects were often associated with overeating, particularly "comfort foods" mostly rich in calories to break the monotony.[3] Obesity is an important risk factor for increased morbidity and mortality in T2DM patients, and weight gain has been proven to diminish glycemic control and increase the risk of diabetes progression.[4]

The prevalence of type 2 diabetes (T2D) has increased worldwide,[5] almost doubling between 1980 and 2014 worldwide in adults (85%–95% T2D). These increases are more prominent in low- and middle-income countries and in men than in women.[6] Egypt is the eighth leading country in the prevalence of diabetes mellitus (DM). In 2022, it was estimated that more than ten million adults live with DM in Egypt, which represents a prevalence of almost 18.4%.[7]

Uncontrolled diabetes is one of the leading causes of death in COVID-19 patients, which possibly occurs as a result of the lack of physical activity, dietary changes, trouble obtaining drugs, insulin, or glucose test strips, or inability to seek medical advice. All these lifestyle factors could have had an impact on type 2 diabetes progression and management (T2DM).[8]

The COVID-19 pandemic could last long, with long-term implications for people's lifestyle choices such as nutrition, physical activity, and sleep habits.[9] Therefore, clinicians must evaluate the effect of COVID-19 on lifestyle-related behavior in those at risk, particularly those on treatment for T2DM.[3]

In addition, the gene expression levels of all cytokines are regulated by a diet that can impact inflammation and oxidative stress processes; therefore, it is essential to maintain a healthy nutritional status. Furthermore, because diet influences the gene expression levels of all cytokines, which can modulate inflammation and oxidative stress processes, the maintenance of healthy nutritional status is critical, particularly when the immune system is required to fight back.[10]

Furthermore, sleep has a tremendous impact on the immune system because it allows the body to repair and relax, which is especially important during critical diseases. During the Spanish flu pandemic, clinicians regarded sleep as vital for their patients' recovery.[11,12]

Uncontrolled diabetes has emerged as one of the leading causes of death in patients with COVID-19. The dietary and lifestyle habits of this vulnerable group may be impacted by the restrictive measures taken in Egypt to prevent the spread of the virus. Early detection and handling of these changes could help improve diabetic control with minimal complications. This research was conducted to assess the changes in dietary habits and lifestyle as well as their relationship to glycemic control in patients with T2D who attended the Zagazig Diabetes Clinic, Sharkia Governorate, Egypt, during COVID-19 pandemic.

Materials and Methods

This cross-sectional study was carried out from March 1, 2021, to the end of August 2021 among patients with T2DM. Both male and female patients aged 18 or older, who visited the Zagazig Diabetes Clinic in Sharqia Governorate for routine follow-up and had been diagnosed for at least six months were eligible for the study. This clinic is one of the sectors of the general authority for health insurance in the Sharkia Governorate. It provides comprehensive services for diabetic patients with health insurance, including free examination and investigations, the disbursement of treatment "insulin-tablets," and periodic follow-up, in addition to DM counseling seminars for patients.

Patients with type 1 diabetes, gestational diabetes, severe psychiatric disorders or mental retardation, or end-stage organ failure were excluded from the study. Ethical approval was obtained from the Zagazig University Institutional Review Board vide letter No. ZU-IRB #6766 dated 21/02/2021 and written informed consent was taken from all participants.

Epi Info™[13] was used for sample size calculation if the weight gain compared to before lockdown was 19%.[11] From records, the attendance rate of type 2 diabetic patients at Zagazig Diabetes Clinic was 110 cases/month. Therefore, the total population size in 1 year was 1320 cases. The total sample was 402 at a 5% confidence limit and a design effect of 2.

The study participants were chosen using systematic random sample technique. We selected the day randomly, based on the interviewers' availability and the day the diabetes clinic was run; then, the first patient was selected randomly. After that, we selected every third patient who arrived at the clinic and could be approached in the waiting area. Patients who met the study's eligibility requirements and agreed to participate were interviewed using a self-administered questionnaire. Their weight, height, and glycated hemoglubin (HbA1C) were measured. The researchers provided them with clear information about the rationale and study objectives and assured them of complete confidentiality of all data and opinions provided.

Data were collected using a semistructured questionnaire based on previous studies.[3,8] It consisted of the following main parts: (a) sociodemographic level assessment[14] and (b) eating habits and lifestyle with questions on diet and lifestyle issues before the COVID-19 pandemic in the form of past medical history (duration of DM, type of treatment, complications, and history of SARS-CoV-2 infection), diet (changes in quality and quantity, meal times, frequency of snacks and food orders from restaurants, and the consumption of fruits, sugar, and ready-to-cook meals), exercise (type and frequency), and other lifestyle habits (smoking, appetite, mental stress, and the ways to cope with irritation, and sleep).

By reviewing the participants' records, baseline data on weight and height before the COVID-19 pandemic were obtained and compared to those measured by the researchers. The subject's weight and height were estimated when standing straight barefooted on scales. Weight in kilograms was divided by the square of height in meters, and the percentile body mass index (BMI) was calculated. BMI ranges from 18.5 to 24.9 kg/m^2 were used to define normal body weight.[15]

The baseline level of HbA1C before the COVID-19 pandemic was obtained from patients' records, and the level at the study time was measured at the diabetic clinic laboratory. HbA1c below 6.4% was considered good glycemic control.[16]

Linguistic experts translated the questionnaire into Arabic and then back into English. Internal consistency measurement was used to assess the reliability of the eating habits and lifestyle questionnaire. It had a good level of consistency (Cronbach's alpha = 0.85).[17]

A pilot study was conducted on 40 patients (10% of the study participants) to identify any data collection challenges, assess the questionnaire's validity and reliability after translation, and determine the amount of time required to collect the data. Because no changes were made, the pilot sample was included in the main sample.

Data analysis was performed using the SPSS (Statistical Package for the Social Sciences, version 25).[18] When appropriate, quantitative data were presented as mean and standard deviations or median and interquartile range (IQR), and categorical variables were labeled with their absolute frequencies. The Chi-square test was used for categorical variables to compare the studied groups. For quantitative data, paired t-test was used to compare HbA1c before and after lockdown in no change, increased, and decreased weight groups, while the Mc-Nemar test was used to compare HbA1c before and after lockdown between no change, increased, and decreased weight groups. Ordinal logistic regression was used to determine factors associated with weight change, whereas binary logistic regression was used to determine factors related with glycemic control. $P < 0.05$ was considered statistically significant, and $P < 0.001$ was considered highly statistically significant.

Results

The average age of the studied group was 47.99 years and 55.2% were males. About three-quarters (74.9%) were married, 56.2% were highly educated, 69.2% were working, 61.7% resided in rural areas, and about half of the studied group belonged to a moderate socioeconomic level [Table 1].

The average BMI of the studied group was 30.4 ± 4.27 ranging from 21.6 to 44.08. About one-third (37.1%) were overweight, and 45% were mildly obese. The disease duration had a median of 4 years with an IQR of 2–7 years [Table 1].

About 45% suffered from a chronic disease, and hypertension was the most common (34.6%), followed by hepatic diseases (6.7%). The majority (71.9%) of the studied group took oral diabetic medication. History of confirmed COVID-19 infection was reported in 25.6% of them [Table 1].

As shown in Table 2, 43.8% of the studied group consumed more food, 60.2% had the same meal times, 45.8% had more fruits and vegetables in their diet, and 52.2% consumed the same amount of sugar as before the lockdown. About 53% increased their intake of fruits, 54.2% increased immunity-boosting food intake, 54.2% consumed snacks 2–3 times daily, 57% had home-cooked food, 54.2% did not order food from outside, 45.5% skipped meals as before lockdown, and 59% took supplements. Concerning exercise, about a quarter of the studied group (28.1%) practiced aerobic exercise, 42.3% worked out ≥5 days/week, 26.6% worked out for ≥half an hour, and 47% spent the same time on exercise. During COVID-19 pandemic the interest in learning

Table 1: Characteristics of patients with Type-2 diabetes attending Zagazig Diabetes Clinic, Sharkia Governorate, Egypt 2021 (*n*=402)

Characteristics	*N* (%)
Age (years)	
Mean±SD	47.99±10.8
Median	45
Sex	
Male	222 (55.2)
Female	180 (44.8)
Marital status	
Married	301 (74.9)
Single	30 (7.5)
Widow	63 (15.7)
Divorced	8 (2.0)
Education	
Below secondary	12 (3.0)
Secondary	134 (33.3)
University	226 (56.2)
Postgraduate	30 (7.5)
Occupation	
Not working	124 (30.8)
Working	278 (69.2)
Residence	
Rural	248 (61.7)
Urban	154 (38.3)
Socioeconomic class	
Low	57 (14.2)
Moderate	236 (58.7)
High	109 (27.1)
BMI (kg/m^2)	
Mean±SD	30.4±4.27
Range	21.6-44.08
Median	30.8
BMI classification	
Normal weight (20-24.9)	36 (9.0)
Overweight (25-29.9)	149 (37.1)
Mild obesity (30-34.9)	181 (45.0)
Moderate obesity (35-40)	24 (6.0)
Severe obesity (≥40)	12 (3.0)
Disease duration (years), median (IQR)	4 (2-7)
Comorbidities	
No	222 (55.2)
Yes	180 (44.8)
Hypertension	139 (34.6)
Heart diseases	21 (5.2)
Hepatic	27 (6.7)
High cholesterol level	15 (3.7)
Kidney disease	6 (1.5)
Thyroid	12 (3.0)
Bone diseases	12 (3.0)
Diabetic medicine	
Oral	289 (71.9)
Oral and insulin	113 (28.1)
Regular therapy intake	
No	31 (7.7)
Yes	371 (92.3)
History of confirmed COVID-19 infection	
No	229 (74.4)
Yes	103 (25.6)

Contd...

Table 1: Contd...

Data presented as *n* (%) or median (IQR) or mean±SD. SD=Standard deviation, IQR=Interquartile range, BMI=Body mass index

healthy ideas and the blood glucose self-monitoring were increased among 49% and 36.1% of the studied group, as well as more than half of them (57.2%) gained weight during the pandemic [Table 2].

Tobacco chewing was not applicable in 74.1% of the studied group. Increased appetite, mental stress, irritation, feeling low, and decreased sleep duration were reported in 45.3%, 70.9%, 62.4%, 55.2%, and 66.7% of the studied group, respectively. The majority of them (66.2%) were able to cope with stress by spending time with family, 59.9% by watching TV, and 22% by reading books [Table 2].

Weight change was statistically significantly related to sex, education, occupation, socioeconomic class, diabetic medication, and COVID-19 infection [Table 3]. Age was not statistically significantly associated with change in weight.

Concerning lifestyle determinants, a statistically significant relation was found between weight change and the quantity and quality of diet, meal timing, sugar, fruit consumption, skipping meals, exercising, learning healthy tips, appetite, and the duration of sleep. No statistically significant association was observed between weight change and frequency of having snacks and eating foods that would increase immunity. The percentage of participants who gained weight was significantly more prevalent among those who reduced their fruit consumption as well as among the household workers. On the other hand, weight loss among the studied group was significantly associated with home-cooked fresh food consumption [Table 3].

Figures 1 and 2 show that patients who had gained weight had a higher statistically significant proportion of poor glycemic control. Interestingly, there was an improvement in HbA1C control in the weight loss group (20.5% versus 27.6%), while both the groups with no change and increased weight groups had a reduced percentage of well-controlled patients (24.4% versus 8.9% and 33% versus 10.9%) before and after COVID-19 lockdown, respectively. Furthermore, the percentage of good glycemic control was statistically significantly less in the studied groups (28.1% versus 15.9%) before and after COVID-19 lockdown, respectively ($P \leq 0.001$).

Table 2: Changes in the lifestyle and dietary behaviors among the study participants during COVID-19 pandemic (*n*=402)

Lifestyle behaviors	*N* (%)
Quantity of diet	
Same as before	108 (26.9)
Eating <25%-50%	79 (19.7)
Eating between 50 and 80%	39 (9.7)
More	176 (43.8)
Meal times	
The same	242 (60.2)
Delayed	136 (33.8)
Early	24 (6.0)
Quality of diet	
Same as before	133 (33.1)
More CHO	63 (15.6)
More fruits and vegetables	184 (45.8)
More protein	12 (3.0)
More CHO and fat	10 (2.3)
Sugar consumption	
Same as before	210 (52.2)
No consumption	105 (26.1)
Increase >25%-50%	87 (21.6)
Fruit consumption	
Same as before	136 (33.8)
Increased by 25%-50%	213 (53.0)
Decreased by >50%	23 (5.7)
Started eating fruits for the first time	30 (7.5)
Immunity-boosting food[!]	
Same as before	155 (38.6)
Increased by 25%-50%	218 (54.2)
Decreased by >50%	29 (7.2)
Snack frequency	
No snack	157 (38.6)
2-3 times daily	176 (54.2)
≥4 times daily	69 (7.2)
Ready-to-cook meals usage	
Home-cooked fresh food	229 (57.0)
Frozen and ready-to-cook processed food	173 (43.0)
Ordering food from outside	
None	218 (54.2)
Once a week	101 (25.1)
>Once a week	83 (20.6)
Skipping meal	
Same as before	183 (45.5)
Increased by 25%-50%	140 (34.8)
Decreased by >50%	79 (19.7)
Supplements	
Yes	237 (59.0)
No	165 (41.0)
Exercise	
No exercise	194 (48.3)
Aerobic	113 (28.1)
Household works and others	95 (23.6)
Exercise duration	
Decreased by 25%-50%	95 (23.6)

Contd...

Table 2: Contd...

Lifestyle factors	*N* (%)
Same as before	189 (47.0)
Increased by 25%-50%	66 (16.4)
Increased by >50%	52 (12.9)
Learning healthy tips	
No interest	39 (9.7)
Same as before	152 (37.8)
Increased	197 (49.0)
Start 1st time	14 (3.5)
Weight change	
No change	45 (11.2)
Decreased weight	127 (31.6)
Increased weight	230 (57.2)
Have sugar equipment	
No	137 (34.1)
Yes	265 (65.9)
Self-monitoring blood glucose	
Same as before	251 (62.4)
Decreased	6 (1.5)
Increased	145 (36.1)
Tobacco chewing	
Not applicable	298 (74.1)
Increased by 25%-50%	61 (15.2)
Decreased by >50%	43 (10.7)
Appetite	
No change	95 (23.6)
Increased by 25%-50%	182 (45.3)
Decreased by 25%-50%	125 (31.1)
Mental stress	
No	117 (29.1)
Yes	285 (70.9)
Irritation	
No	151 (37.6)
Yes	251 (62.4)
Feeling low	
No	180 (44.8)
Yes	222 (55.2)
Sleep duration	
No change	99 (24.6)
Decreased	268 (66.7)
Increased	35 (8.7)
Cope with stress[#]	
Watch TV	241 (59.9)
With family	266 (66.2)
Work	52 (12.9)
Hobbies	32 (7.9)
Books	89 (22.1)

[#]One person might have more than one modality to cope with stress, [!]Immunity-boosting food (foods that are known to enhance the immune response for example; citrus fruits, red bell peppers, broccoli, garlic, ginger, spinach, yogurt, almonds, and green tea). CHO=Carbohydrate

Poor glycemic control was significantly associated with weight gain, physical inactivity, insufficient sleep, and mental stress [Table 4]. Ordinary logistic regression analysis for the factors associated with weight gain after lockdown as a result of COVID-19 in diabetic patients

Table 3: Association between weight change during COVID-19 and sociodemographic characteristics and lifestyle behaviors among diabetic patients attending Zagazig Diabetes Clinic, Sharkia Governorate, Egypt 2021

Variables	Weight change			*P*-value
	No change (*n*=45) *N* (%)	Decrease weight (*n*=127) *N* (%)	Increase weight (*n*=230) *N* (%)	
Age (years)				
<45 (*n*=202)	18 (8.9)	69 (34.2)	115 (56.9)	0.25
≥45 (*n*=200)	27 (13.5)	58 (29.0)	115 (57.5)	
Sex				
Male (*n*=222)	33 (14.9)	82 (36.9)	107 (48.2)	<0.001
Female (*n*=180)	12 (6.7)	45 (25.0)	123 (68.3)	
Education				
Below secondary (*n*=12)	0	6 (50.0)	6 (50.0)	<0.001
Secondary (*n*=134)	10 (7.5)	42 (31.3)	82 (61.2)	
University (*n*=226)	23 (10.2)	76 (33.6)	127 (56.2)	
Postgraduate (*n*=30)	12 (40.0)	3 (10.0)	15 (50.0)	
Occupation				
Not working (*n*=124)	6 (4.8)	42 (33.9)	76 (61.3)	0.026
Working (*n*=278)	39 (14.0)	85 (30.6)	154 (55.4)	
Socioeconomic classes				
Low (*n*=57)	6 (10.5)	29 (50.9)	22 (38.6)	<0.001
Moderate (*n*=236)	7 (2.9)	71 (30.1)	158 (66.9)	
High (*n*=109)	32 (29.3)	27 (24.8)	50 (45.9)	
Diabetic medicine				
Oral therapy (*n*=289)	45 (15.6)	104 (36.0)	140 (48.4)	<0.001
Oral and insulin (*n*=113)	0	23 (20.4)	90 (79.6)	
Positive history of COVID-19 infection				
No (*n*=299)	25 (8.4)	105 (35.1)	169 (56.5)	0.001
Yes (*n*=103)	20 (19.4)	22 (21.4)	61 (59.2)	
Quantity of diet				
Same as before (N=108)	25 (23.1)	41 (38.0)	42 (38.9)	<0.001
Eating <25%-50% (*n*=79)	12 (15.2)	52 (65.8)	15 (19.0)	
Eating between 50 and 80% (*n*=39)	3 (7.7)	17 (43.6)	19 (48.7)	
More (*n*=176)	5 (2.8)	17 (9.7)	154 (87.5)	
Meal timing				
The same (*n*=242)	21 (8.7)	87 (36.0)	134 (55.4)	0.026
Delayed (*n*=136)	23 (16.9)	34 (25.0)	79 (58.1)	
Early (*n*=24)	1 (4.2)	6 (25.0)	17 (70.8)	
Quality of diet				
Same as before (*n*=133)	26 (19.5)	52 (39.1)	55 (41.4)	<0.001
More CHO (*n*=63)	6 (9.5)	14 (22.2)	43 (68.3)	
More fruits and vegetables (*n*=184)	7 (3.8)	61 (33.1)	116 (63.1)	
More protein (*n*=12)	6 (50.0)	0	6 (50.0)	
More CHO and fat (*n*=10)	0	0	10 (100.0)	
Sugar consumption				
Same as before (*n*=210)	39 (18.6)	64 (30.5)	107 (51.0)	<0.001
No consumption (*n*=105)	6 (5.7)	49 (46.7)	50 (47.6)	
Increase >25%-50% (*n*=87)	0	14 (16.1)	73 (83.9)	
Fruit consumption				
Same as before (*n*=136)	21 (23.1)	63 (46.3)	52 (38.2)	<0.001
Increased by 25%-50% (*n*=213)	24 (11.3)	58 (27.2)	131 (61.5)	
Decreased by >50% (*n*=23)	0	6 (26.1)	17 (73.9)	
Started eating fruits for the first time (*n*=30)	0	0	30 (100.0)	
Snack frequency				

Contd...

Table 3: Contd...

Variables	Weight change			*P-value*
	No change (*n*=45) *N (%)*	Decrease weight (*n*=127) *N (%)*	Increase weight (*n*=230) *N (%)*	
No snack (*n*=157)	16 (10.2)	56 (35.7)	85 (54.1)	0.39
2-3 times daily (*n*=176)	24 (13.6)	50 (28.4)	102 (58.0)	
≥4 times daily (*n*=69)	5 (7.2)	21 (30.4)	43 (62.3)	
Ready to cook				
Home cooked (*n*=229)	15 (6.6)	98 (42.8)	116 (50.7)	<0.001
Frozen (*n*=173)	30 (17.3)	29 (16.8)	114 (65.9)	
Skipping meal				
Same as before (*n*=183)	33 (18.0)	53 (29.0)	97 (53.0)	<0.001
Increased by 25%-50% (*n*=140)	12 (8.6)	25 (17.9)	103 (73.6)	
Decreased by >50% (*n*=79)	0	49 (62.0)	30 (38.0)	
Exercise				
No exercise (*n*=194)	27 (13.9)	53 (27.3)	114 (58.8)	0.0004
Aerobic (*n*=113)	18 (15.9)	46 (40.7)	49 (43.4)	
Household works and others (*n*=95)	0	28 (29.5)	67 (70.5)	
Learning healthy tips				
No interest (*n*=39)	0	6 (15.4)	33 (84.6)	<0.001
Same as before (*n*=152)	20 (13.2)	13 (8.6)	119 (78.3)	
Increased (*n*=197)	25 (12.7)	108 (54.8)	64 (32.5)	
Start 1st time (*n*=14)	0	0	14 (100.0)	
Appetite				
No change (*n*=95)	28 (29.5)	21 (22.1)	46 (48.4)	<0.001
Increased by 25%-50% (*n*=182)	0	25 (13.7)	157 (86.3)	
Decreased by 25%-50% (*n*=125)	17 (13.6)	81 (64.8)	27 (21.6)	
Mental stress				
No (*n*=117)	12 (10.3)	41 (35.0)	64 (54.7)	0.6
Yes (*n*=285)	33 (11.6)	86 (30.2)	166 (58.2)	
Sleep duration				
No change (*n*=99)	18 (18.2)	44 (44.4)	37 (37.4)	<0.001
Decreased (*n*=268)	27 (10.1)	72 (26.9)	169 (63.1)	
Increased (*n*=35)	0	11 (31.4)	24 (68.6)	

CHO=Carbohydrate

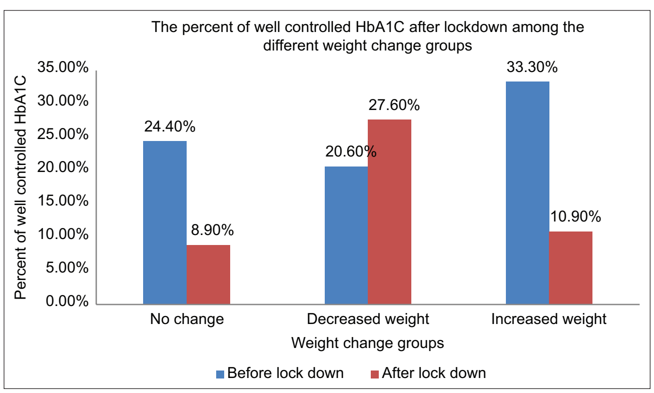

Figure 1: Relation between glycemic control after COVID-19 lockdown and weight change among the studied group

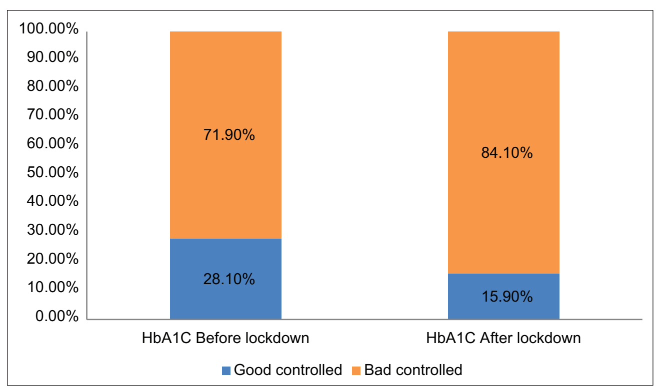

Figure 2: Relation between glycemic control and COVID-19 lockdown among the studied group

demonstrated that the history of confirmed COVID-19 infection, increase in food consumed, earlier meal times, more carbohydrate, fat, and protein, increased sugar consumption, insulin therapy for DM, no exercise, and lack of interest in learning healthy ideas were the most significant factors associated with weight gain during lockdown in the COVID-19 pandemic in diabetic patients [Table 5]. Binary logistic regression analysis for factors associated with poor glycemic control during lockdown in the COVID-19 pandemic in diabetic

Table 4: Univariate association between glycemic control after lockdown and weight change, sleep duration, mental stress, and exercise among the diabetic patients attending Zagazig Diabetes Clinic, Sharkia Governorate, Egypt 2021

Variables	HbA1C after lockdown		Odds ratio (95% CI)	*P*-value
	Good glycemic control (*n*=64) *N* (%)	Poor glycemic control (*n*=338) *N* (%)		
Weight change				
No change (*n*=45)	4 (8.9)	41 (91.1)	0.5 (0.2-1.38)	0.1
Decrease weight (*n*=127)	35 (27.6)	92 (72.4)	2.6 (1.67-4.07)	<0.001
Increase weight (*n*=230)	25 (10.9)	205 (89.1)	0.5 (0.3-0.76)	<0.001
Sleep duration				
No change (*n*=99)	22 (22.2)	77 (77.8)	1.6 (1.1-2.5)	0.04
Decreased (*n*=268)	22 (8.2)	246 (91.8)	0.26 (0.16-0.42)	<0.001
Increased (*n*=35)	20 (57.1)	15 (42.9)	4.7 (3.19-7.1)	<0.001
Mental stress				
No (*n*=117)	43 (36.8)	74 (63.2)	7.3 (4.08-13.07)	<0.001
Yes (*n*=285)	21 (7.4)	264 (92.6)		
Exercise				
No exercise (*n*=194)	1 (0.5)	193 (99.5)	0.04 (0.005-0.29)	<0.001
Aerobic (*n*=113)	36 (31.9)	77 (68.1)	3.3 (2.1-5.1)	<0.001
household works and others (*n*=95)	27 (28.4)	68 (71.6)	2.4 (1.52-3.66)	<0.001

CI=Confidence interval, HbA1C=Glycated hemoglobin

patients showed that weight gain and physical inactivity were the most significant predictors for poor glycemic control [Table 6].

Discussion

Our study assessed the changes in dietary habits, and lifestyles in type 2 diabetic patients, who attended Zagazig Diabetes Clinic, Sharkia Governorate, Egypt, during the COVID-19 pandemic. Our findings suggest that the COVID-19 pandemic significantly altered the dietary habits of the surveyed group. In brief, an increased appetite and a greater intake of food with an increase in fruits, vegetables, and immunity-boosting foods were detected. Moreover, they depended mainly on home-cooked food and avoided ordering food from restaurants. These findings are consistent with those of a study conducted in Lebanon,[19] which investigated the impact of quarantine on eating habits and lifestyle behaviors and found that most participants depended mainly on home-cooked food.

This study reported weight gain in the participants during the COVID-19 pandemic. This can be explained by the increased amount of food intake and physical inactivity, as nearly half of the studied group did not do any exercise. Similarly, weight gain and increased caloric intake was observed during the COVID-19 pandemic in Lebanon, Kuwait, Italy, Poland, and France.[10,19-22] More time spent at home, according to Zachary *et al*., could lead to more eating in response to nonnutritive cues, frequent snacking, absence of diet control, and emotional eating.[23] In contrast, a study in India found no significant changes in body weight following lockdown in type 2 diabetic patients. This is likely to be due to significant variations in Indian lifestyle changes during the lockdown because they ate more fresh vegetables and fruits but fewer fried and unhealthy snacks.[24]

Weight gain was significantly more prevalent among those on insulin therapy, which is not surprising. The average glucose or HbA1c before insulin is the main risk factor for weight gain in people on insulin therapy for T2DM.[25]

The COVID-19 pandemic had a major impact on people's lives worldwide. The current study revealed a decrease in physical activity and an increase in sedentary behavior during the pandemic. These findings are in line with other researches that suggest that the COVID-19 pandemic reduced global physical activity.[20,22,26-29]

The majority of the study participants (70.9%) had mental stress, a figure that is higher than the result of 48.8% of the population stressed in a previous study conducted in Egypt to determine the psychological effects of the COVID-19 pandemic on the public.[30] The difference in the target group may be a possible explanation, as diabetes distress affects nearly one-third of adults with T2DM, the result of the emotional burden of worry, frustration, anger, and burnout of managing T2DM; stress is a part of life for diabetic patients.[31]

During the pandemic, more than half of the participants (66.7%) in the study had less sleep. This is higher than that was reported by a previous Egyptian

Table 5: Ordinary logistic regression analysis: Factors associated with weight gain after lockdown due to COVID-19 among diabetic patients

Factors	Wald	AOR	95% CI		*P-value*
			Lower bound	Upper bound	
COVID-19 positive					
No		1	Reference	Reference	
Yes	8.8	3.2	1.06	7.8	0.004
Quantity of diet					
Same as before		1	Reference	Reference	
Eating >25%-50%	5.7	2.7	1.49	4.9	0.017
Eating 50%-80%	8.2	3.9	1.2	6.5	0.004
More	11.1	4.7	1.9	7.6	0.001
Meal timing					
The same		1	Reference	Reference	
Delayed	0.9	0.15	–2.5	2.8	0.01
Early	0.9	0.04	–2.8	2.7	0.001
Quality of diet					
Same as before		1	Reference	Reference	
More CHO	8.7	7.3	2.4	12.2	0.003
More fruits and vegetables	8.6	7.7	2.6	12.9	0.003
More protein	17.1	11.3	5.9	16.7	0.001
More CHO and fat	10.7	10.6	4.2	16.9	0.001
Sugar consumption					
Same as before		1	Reference	Reference	
No consumption	0.017	-0.16	–2.6	2.2	0.8
Increase >25%-50%	8.8	3.15	1.07	5.2	0.003
Diabetic medicine					
Oral therapy		1	Reference	Reference	
Oral and insulin	3.9	2.03	0.04	4.03	0.04
Exercise					
No exercise		1	Reference	Reference	
Aerobic	6.9	2.8	1.7	4.9	0.008
household works and others	23.5	3.9	2.4	5.6	0.001
Learning healthy tips					
Same as before		1	Reference	Reference	
No interest	9.8	18.4	17.2	21.1	0.001
Increased	16.9	25.4	16.9	25.7	0.001

AOR = Adjusted odds ratio, CI = Confidence interval, CHO = Carbohydrate

Table 6: Binary logistic regression analysis: Factors associated with poor glycemic control after lockdown due to COVID-19 among diabetic patients

Factors	Wald	AoR	95% CI		*P-value*
			Lower bound	Upper bound	
Weight change (increased)	10.9	2.13	1.24	3.65	0.001
Exercise (no exercise)	7.2	0.62	0.4	0.9	0.01

AOR=Adjusted odds ratio, CI=Confidence interval

study[30] and an Indian study[32] done on the general population. DM was linked to a higher risk of developing persistent sleep disturbances, according to a Bangladeshi study.[33] Our participants' mental stress and sleep disturbances should be investigated further because they could have an effect on their diet, exercise, and drug compliance. Without medical or psychological advice, these issues become more challenging for patients.

The results of the current study reported a worsening in glycemic control during the lockdown, which is in line with the results of a systematic review[34] of 33 observational studies that concluded that the lockdown revealed a short-term worsening of glycemic parameters in patients with T2DM. Poor glycemic control was significantly associated with reduced physical activity. This agrees with the results of the study that investigated the determinants of glucose control and indicated the same association.[35]

Our results reported a significant association between poor glycemic control and inadequate sleep, which accords with the results of a previous study with the same finding.[36] Reduced sleep duration can lead to lower blood glucose tolerance, insulin resistance, and changes in the secretion of the appetite-controlling hormones ghrelin and leptin.[37] In this study, regression analysis demonstrated that weight gain of the participants was associated with increased HbA1C and poor glycemic control.

This finding is consistent with that of Biamonte *et al*.,[38] in Italy, who discovered a direct link between weight gain and increased HbA1c. Weight gain has been shown to increase insulin resistance and worsen glucose metabolism in people with T2DM.[39,40]

We used HbA1c monitoring data to assess lifestyle and dietary habit changes during the COVID-19 pandemic, both in people with good and poor glycemic control. One of the main strengths of our study is the large study population. However, there were a few limitations in the conduct of the study. The use of a cross-sectional study design may have hampered the generalizability of the findings, and denied us the ability to evaluate other factors on DM control, such as compliance to treatment, follow-up, and DM complications. Generalizability may also be limited by the selected study population, a single center. The patients who come to this center may differ from those of other centers. The responses were subjective and may have been subject to recall bias. Another limitation is that parameters such as sleep and mental stress were not assessed with validated tools.

Conclusion

Our observational study showed that the COVID-19 pandemic and restrictive measures resulted in increased levels of perceived mental stress, insufficient sleep, weight gain, and physical inactivity in the participants. This negatively affected the glycemic control and was associated with increased HbA1C. These findings underline the critical importance of developing public health policies to encourage these patients to live healthy lifestyles that incorporate psychological and nutritional considerations. Finally, we recommend the improvement of telehealth for adequate monitoring, examining, and managing patients with DM and the expansion of the health awareness campaigns through the mass media to promote good dietary habits and a healthy lifestyle.

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Conflicts of interest
There are no conflicts of interest.

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