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Factors contributing to glycemic control in diabetes mellitus patients complying with home quarantine during the coronavirus disease 2019 (COVID-19) epidemic

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ABSTRACT

Aims: This study assessed factors contributing to glycemic control among diabetes mellitus patients complying with home quarantine during the epidemic of coronavirus disease 2019 (COVID-19).

Methods: We conducted an analytical cross-sectional study by telephone with 1159 patients with type 2 diabetes mellitus (T2DM) and 96 patients with type 1 diabetes mellitus (T1DM) who were discharged from the endocrinology department of a hospital from January 1, 2019, to January 24, 2020. According to their fasting blood glucose (FBG) and 2-h postprandial BG (2hPBG) values, the patients were divided into the well-controlled BG group and the poorly controlled BG group. The main evaluation indicators included sociodemographic variables, health risk variables and adherence to self-management behaviors.

Results: In total, 74.46% of the T2DM patients and 64.89% of the T1DM patients had poor glycemic control. T2DM patients with poor glycemic control were more likely to be older (odds ratio (OR): 1.017 [95% confidence interval (CI) 1.003–1.030]; P = 0.013), have fewer than 12 years of education (OR: 1.646 [95% CI 1.202–2.255]; P = 0.002), lack a BG meter at home (OR: 2.728 [95% CI 1.205–6.179]; P = 0.016), have a lower degree of medication compliance (OR: 1.627 [95% CI 1.076–2.460]; P = 0.021), and engage in less self-monitoring of BG (SMBG) per week (OR: 10.884 [95% CI 5.883–20.139]; P < 0.001). Fewer than 12 years of education (OR: 3.031 [95% CI 1.112–8.263]; P = 0.030) was a risk factor for glycemic control in T1DM.

Conclusions: Glycemic control among patients with T1DM and T2DM during home quarantine amid the COVID-19 pandemic is poor. Our results showed that more eduction, a higher frequency of SMBG, and improved medication compliance may contribute to glycemic control. Therefore, diabetic patients should be advised to increase the frequency of blood glucose measurements during home quarantine and be re-educated regarding the importance of medication compliance.

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1. Introduction

The novel coronavirus disease 2019 (COVID-19) has emerged as a global pandemic, affecting more than 200 countries and claiming tens of thousands of lives to date. COVID-19 is caused by infection by the highly contagious severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. With the novel coronavirus pneumonia epidemic spreading worldwide, the World Health Organization (WHO) and most governments have recommended that the entire human population stay at home [2]. Home quarantine is an effective means to contain the virus. Wuhan was an early COVID-19 outbreak area, and the closure of Wuhan city was an urgent and a sudden government order. For ordinary people, the situation at that time was to carry out home quarantine as required, and it was impossible to predict when Wuhan would be opened. However, home quarantine may render the treatment of some chronic diseases, such as diabetes, inconvenient. Diabetes patients may encounter difficulty in obtaining insulin, blood sugar monitoring and medication from the hospital, performing regular exercises go out, maintaining a balanced diet and so on because of this sudden event. A previous study found that home isolation may cause a large number of patients to fear attending a clinic for healthcare [3]. Diabetes is the most rapidly increasing disease worldwide and poses a substantial threat to human health [4]. The nationwide prevalence of T2DM in China is approximately 10.9% [5], and the incidence rate of diabetes continues to increase. Patients with diabetes have been reported to be susceptible to infection with SARS-CoV-2, and 12% to 20% of COVID-19 patients have DM [6]. Having DM increases the mortality rate of patients with COVID-19 [7]. To minimize potential spread, many hospitals have reduced their outpatient clinic capacities. During the quarantine, a huge proportion of diabetes patients have been in an insecure state due to an inability to undergo routine check-ups and a lack of opportunity to intensify potentially insufficient therapy [8]. Insufficient glucose control can provoke numerous acute and chronic complications that healthcare systems will have to manage after the COVID-19 pandemic. Therefore, adequate self-management of blood glucose (BG) control by diabetic patients during the period of home isolation necessitated by the pandemic is very important. Maintaining good glycemic control not only boosts the innate immune system but also reduces the likelihood of viral infection [9]. Therefore, we conducted this study to investigate risk factors and effective measures for BG control for isolated diabetic patients at home through telephone follow-ups.

2. Methods

2.1. Participants

Patients with type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM) who were discharged from January 1, 2019, to January 24, 2020, were followed up by telephone. A total of 1464 patients were enrolled in the study, and 121 (8.27%) patients could not be successfully reached (Fig. 1). Among the remaining 1343 patients, 77 patients with incomplete or repeated information and 16 patients who died were

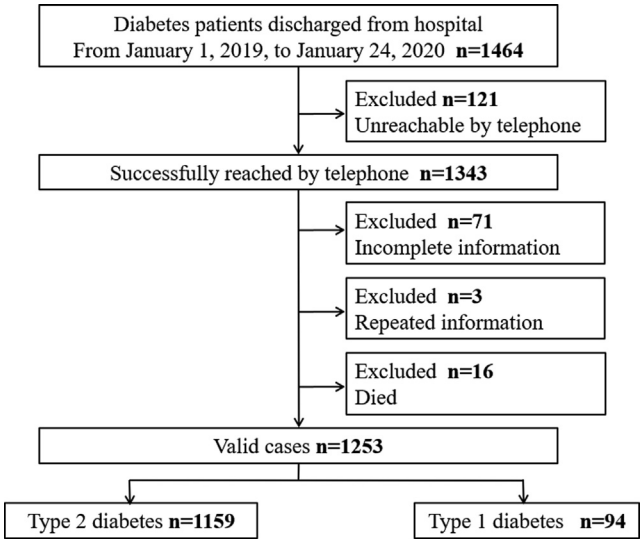

Fig. 1 – Study population. Glycemic control in DM patients who complied with home quarantine during COVID-19.

further excluded. Of the remaining 1253 patients, 1159 (92.50%) patients with T2DM were placed in one group, while 94 (7.5%) individuals with T1DM were placed in a second group. The telephone follow-up period was from March 16 to April 3, 2020. The inclusion criteria were as follows: (1) patients diagnosed with T2DM according to the WHO criteria (1999) [10]; (2) patients diagnosed with T1DM according to the Guidelines for Diagnosis and Treatment of Type 1 Diabetes [11]; and (3) patients or immediate family members who answered the phone and were willing to participate in the follow-up investigation. The exclusion criteria were as follows: (1) T1DM and T2DM patients who could not be contacted by phone after three attempts on different days and (2) patients diagnosed with gestational diabetes or other types of diabetes.

Well-controlled blood glucose (BG) was defined as a fasting blood glucose (FBG) range from 3.9 to 7.0 mmol/L and a concurrent 2-h postprandial BG (2hPBG) range from 3.9 to 10.0 mmol/L. Poorly controlled BG was defined as a lowest FBG less than or equal to 3.9 mmol/L, a highest FBG level exceeding 7.0 mmol/L, a lowest 2hPBG less than or equal to 3.9 mmol/L or a highest 2hPBG level exceeding 10.0 mmol/L during the last 3 months. The standards were set according to the standards of medical care in diabetes [12]. FBG and 2hPBG were obtained by patient reports of self-monitoring blood glucose (SMBG) results from the previous 3 months. The glycosylated hemoglobin (HbA1) value was not included in this study because it must be obtained from venous blood samples, which could not be obtained routinely during the epidemic period.

2.2. Data collection instruments and measurements

Sociodemographic data, health risks and self-care behaviors were collected by phone calls and from hospital records. The information included sociodemographic variables (age, sex, education, marital status, height, weight, etc.), health risk variables (smoking, diabetes duration, hypoglycemia,

the duration of continuous sleep, anxiety level regarding the patient's chief complaint and complications of diabetes diagnosed during hospitalization, such as foot ulcer), and adherence to self-management behaviors (the number of days of following a meal plan per week; the intensity, frequency and duration of exercise per week; compliance with taking medications as directed by the doctor; SMBG; and the performance of foot self-examinations).

A follow-up group of staff members was established by the endocrine department. The group consisted of 15 nurses from the endocrine department. All members had been trained with regard to the follow-up process and the skills and precautions necessary to successfully conduct a telephone follow-up. The follow-up period lasted from March 16 to April 3, 2020. All procedures were approved by the ethics committee of Tongji Hospital affiliated with Huazhong University of Science and Technology Tongji Medical College and complied with the principles of the Declaration of Helsinki. All participants provided oral informed consent. The average follow-up time for each case was approximately 15–20 min, and approximately 80 patients were contacted each day. A professional reviewed and sorted the daily follow-up data to ensure its completeness and accuracy.

2.3. *Statistical analysis*

We used SPSS version 22.0 software for all data analyses. Frequencies and percentages were computed for categorical variables, and the means, medians, standard deviations and interquartile ranges were computed for continuous variables. The chi-square test was used to assess relationships between two categorical variables, and continuous variables were compared with the Mann-Whitney *U* test. Logistic regression analysis (forward conditional method, with listwise deletion of cases with missing data) was used to identify predictors of poor BG control. The influential factors with statistical significance ($P < 0.05$) in single-factor analysis were used as dependent variables, and the BG group was used as an independent variable in logistic stepwise regression analysis. Regression estimates are reported with 95% confidence intervals (CIs). A two-sided α less than 0.05 was considered statistically significant. All variables with P value < 0.05 were listed, and all odds ratios (ORs) were determined.

3. Results

3.1. *Characteristics of T2DM*

The effects of sociodemographic factors and health risks on BG control in patients with T2DM. Of 1159 T2DM patients, 296 patients (25.54%) were in the well-controlled BG group. Patients with poorly controlled BG were significantly older (55.0 years old versus 51.0 years old, $P < 0.001$) and had a longer duration of diabetes (6 years versus 2 years, $P < 0.001$) than those with well-controlled BG. BG control was worse in men than in women ($P = 0.006$). The poorly controlled BG group was significantly associated with a lower education level ($P = 0.038$) and a higher proportion of complications ($P = 0.020$). Marital status and current residence were not different between the well-controlled BG group and the poorly controlled BG group (Table 1).

The effect of self-care behavior on BG control in patients with T2DM. A total of 81.3% of the T2DM patients had BG meters at home. Compared with patients without BG meters, patients with BG meters had better glycemic control ($P < 0.001$) and tested their BG more frequently ($P = 0.011$). A total of 372 (32.2%) patients did not perform any SMBG during the epidemic period, 157 (13.5%) patients monitored their BG only once per week, and 629 (54.3%) patients monitored their BG more than two times per week. The number of foot self-examinations performed per week in the well-controlled BG group was higher than that in the poorly controlled BG group ($P = 0.003$). Medication compliance in the well-controlled BG group was higher than that in the poorly controlled BG group ($P = 0.024$). Only 901 (77.8%) T2DM patients followed a doctor's advice and continued to take their medicine according to the previous regimen. Forty-two percent of the T2DM patients used oral therapy for glycemic control, 31% used insulin and oral agents, and 17% used insulin alone. No significant differences in vegetable intake (days/week), exercise, treatment, sleep and anxiety were found between the two groups (Table 2).

3.2. *Characteristics of T1DM*

The effects of sociodemographic factors and health risks on BG control in patients with T1DM. Of the 94 T1DM patients, 33 (35.1%) were in the well-controlled BG group, and 61 (65%) patients were in the poorly controlled BG group. In total, 56% were male. The proportion of men with poor glycemic control was higher than that of women ($P = 0.015$). A total of 48% of the patients had fewer than 12 years of education. The proportion of patients with fewer than 12 years of education was higher in the group with poor glycemic control ($P = 0.038$). The proportion of patients with complications was 58.5%, and the proportion in the poorly controlled group was higher than that in the well-controlled BG group ($P = 0.020$). No significant differences in age or disease course were noted between the two groups (Table 3).

The effect of self-care behavior on BG control in patients with T1DM. Eighty-nine percent of the T1DM patients had BG meters at home. The well-controlled BG group tested their glucose levels more frequently than the poorly controlled BG group ($P = 0.011$). The poorly controlled BG group ate more sweets than the well-controlled BG group ($P = 0.026$). The proportion of patients who were compliant with the medication regimen in the poorly controlled BG group was lower than that in the well-controlled BG group ($P = 0.048$). Twenty-six percent of T1DM patients did not take their medication as directed. Compared with the well-controlled BG group, the poorly controlled group smoked more ($P = 0.034$). No significant differences in vegetable intake (days/week), exercise, sleep duration or anxiety were identified between the two groups (Table 4).

3.3. *Factors associated with BG control in T2DM and T1DM patients*

In T2DM patients, the significant factors influencing BG control ($P < 0.05$) in the single-factor analysis were used as depen-

Table 1 – Comparison of demographic data between T2DM patients with well-controlled and poorly controlled BG.

Characteristics		Total	Well-controlled blood glucose (n = 296)	Poorly controlled blood glucose (n = 863)	Statistic	P value
Age (years)		54 (45,61)	51.0 (40.0, 58.0)	55.00 (47.0, 62.0)	−5.425[1)]	< 0.001
BMI (kg/m^2)		24.49 (22.1, 26.8)	24.2 (21.5, 27.0)	24.55 (22.3, 26.8)	−1.348[1)]	0.178
Duration of diabetes (year)		5 (1, 10)	2 (1, 10)	6 (1,10)	−4.622[1)]	< 0.001
Complications	Yes	869 (75.0)	198 (22.8)	671 (77.2)	13.856[2)]	< 0.001
	No	290 (25.0)	98 (33.8)	192 (66.2)		
Sex	Male	766 (66.1)	215 (28.1)	551 (71.9)	7.595[2)]	0.006
	Female	393 (33.9)	81 (20.6)	312 (79.4)		
Education	<12 years	575 (49.6)	114 (19.8)	461 (80.2)	19.587[2)]	< 0.001
	≥12 years	584 (50.4)	182 (31.2)	402 (68.8)		
Marital status	Married	1091 (94.1)	275 (23.7)	816 (70.4)	2.389[2)]	0.496
	Unmarried	57 (4.9)	19 (33.3)	38 (66.7)		
	Divorced	1 (0.1)	0 (0)	1 (100)		
	Widowed	10 (0.9)	2 (20.0)	8 (80.0)		
Current residence	Not in Wuhan City but in Hubei Province	676 (58.3)	165 (24.4)	511 (75.6)	4.739[2)]	0.192
	Wuhan City	338 (29.2)	90 (26.6)	248 (73.4)		
	Outside Hubei Province	145 (12.5)	41 (28.3)	104 (71.7)		
FBG (mmol/L)		6.6 (5.7, 7.7)	6.0 (5.5, 6.5)	7.8 (7.8, 8.0)	−14.99[1)]	< 0.001
2hPBG (mmol/L)		9.3 (8.0, 11.0)	8.0 (7.2, 9.0)	11.0 (10.0, 12.3)	−15.58[1)]	< 0.001

1) Z value, 2) χ^2 value.

Table 2 – Comparison of self-management data between T2DM patients with well-controlled and poorly controlled BG.

		Total	Well-controlled blood glucose (n = 296)	Poorly controlled blood glucose (n = 863)	Statistic	P value
Vegetable intake (days/week)		7 (7, 7)	7 (7, 7)	7 (7, 7)	−0.855[1)]	0.392
Dessert consumption (days/week)		0 (0, 1)	0 (0, 1)	0 (0, 2)	−2.204[1)]	0.027
Exercise (days/week)		7 (4, 7)	7 (5, 7)	7 (6, 8)	−1.108[1)]	0.268
Foot self-examination (times/week)		0 (0, 5)	0 (0, 7)	0 (0, 4)	−2.960[1)]	0.003
Sleep duration (h/day)		7 (6, 8)	7 (7, 8)	7 (6, 8)	−1.922[1)]	0.055
Regular meals	Yes	1092 (94.2)	275 (25.2)	817 (74.8)	1.260[2)]	0.262
	No	67 (5.8)	21 (31.3)	46 (68.7)		
Blood glucose meter	Yes	942 (81.3)	288 (30.6)	654 (69.4)	67.045[2)]	< 0.001
	No	211 (18.2)	2 (3.7)	209 (96.3)		
Hypoglycemia	Yes	168 (14.5)	53 (31.5)	115 (68.5)	3.730[2)]	0.053
	No	991 (85.5)	243 (24.5)	748 (75.5)		
SMBG (days/week)	0	373 (32.2)	14 (3.8)	359 (96.2)	154.569[2)]	< 0.001
	1	157 (13.5)	36 (22.9)	121 (77.1)		
	≥2	629 (54.3)	246 (39.1)	383 (60.9)		
Medication plan	No drugs	117 (10.1)	24 (20.5)	93 (79.5)	9.371[2)]	0.021
	OHA	481 (41.5)	145 (30.1)	336 (69.9)		
	Insulin injection	198 (17.1)	42 (21.2)	156 (78.8)		
	OHA + insulin injection	363 (31.3)	85 (23.4)	278 (76.6)		
Medication compliance	Yes	901 (77.8)	244 (27.1)	657 (72.9)	5.059[2)]	0.024
	No	258 (22.3)	52 (20.2)	206 (79.8)		
Exercise intensity	No movement	133 (24.8)	33 (24.8)	100 (75.2)	0.697[2)]	0.448
	Low	321 (27.7)	78 (24.3)	243 (75.7)		
	Moderate	666 (57.5)	176 (26.4)	490 (73.6)		
	High	39 (3.4)	9 (23.1)	30 (76.9)		
Diabetic foot	Yes	32 (2.8)	7 (21.9)	25 (78.1)	0.232[2)]	0.630
	No	1127 (97.2)	289 (25.6)	838 (74.4)		
Smoking	Yes	258 (22.3)	76 (29.5)	182 (70.5)	2.679[2)]	0.102
	No	901 (77.7)	220 (24.4)	681 (75.6)		
Anxiety	None	983 (84.8)	251 (25.6)	732 (74.4)	3.057[2)]	0.548
	Mild	150 (12.9)	35 (23.3)	115 (76.7)		
	Moderate	23 (3.0)	9 (39.1)	14 (60.9)		
	Severe	3 (0.3)	1 (0.3)	2 (66.7)		

1) Z value, 2) χ^2 value.

Table 3 – Comparison of demographic data between T1DM patients with well-controlled and poorly controlled BG.

		Total	Well-controlled blood glucose (n = 33)	Poorly controlled blood glucose (n = 61)	Statistic	P value
Age (years)		33.72 ± 13.04	30.97 ± 12.36	35.21 ± 13.25	−1.517 1)	0.133
BMI (kg/m^2)		21.12 ± 3.27	20.93 ± 3.42	21.23 ± 3.21	−.411 1)	0.682
Duration of diabetes (years)		2 (1, 9.5)	1 (0.5, 8.0)	2 (1.0, 9.8)	−1.483 2)	0.138
Complications	Yes	55 (58.5)	14 (25.5)	41 (74.5)	5.421 3)	0.020
	No	39 (41.5)	19 (48.7)	20 (51.3)		
Sex	Male	53 (56.4)	13 (24.5)	40 (75.5)	5.968 3)	0.015
	Female	41 (43.6)	20 (48.8)	21 (51.2)		
Education	<12 years	45 (47.9)	11 (24.4)	34 (75.6)	4.308 3)	0.038
	≥12 years	49 (52.1)	22 (44.9)	27 (55.1)		
Marital status	Married	62 (66.0)	24 (38.7)	38 (61.3)	1.038 3)	0.308
	Unmarried	32 (34.0)	9 (35.1)	23 (64.9)		
Current residence	Divorced	66 (70.2)	27 (40.9)	39 (59.1)	4.196 3)	0.123
	Widowed	23 (24.5)	4 (17.4)	19 (82.6)		
	Not in Wuhan City but in Hubei Province	5 (5.3)	2 (40.0)	3 (60.0)		
FBG (mmol/L)		6.3 (5.6, 7.5)	6.0 (5.3, 6.3)	7.5 (7.0, 10.0)	−4.447 2)	〈0.001
2hPBG (mmol/L)		9.2 (7.5, 11.6)	8.0 (7.2, 8.8)	12.0 (10.5, 14.8)	−5.973 2)	〈0.001

1) t value, 2) Z value, 3) χ^2 value.

dent variables, and the level of glycemic control was used as an independent variable in a logistic stepwise regression analysis. The regression model showed that the risk factors for poor BG control included advanced age (OR: 1.017 [95% CI 1.003–1.030]; P = 0.013), fewer than 12 years of education (OR: 1.646 [95% CI 1.202–2.255]; P = 0.002), the absence of a BG meter at home (OR: 2.728 [95% CI 1.205–6.179]; P = 0.016), a lower degree of compliance with medication (OR: 1.627 [95% CI 1.076–2.460]; P = 0.021), and fewer instances of SMBG per week. The effects of different numbers of times of performing SMBG per week on BG control were further analyzed. In terms of glycemic control, the risk of poor BG control in those who measured their BG 0 times a week was 10.884-times higher than that in those who monitored their BG more than 2 times per week (OR: 10.884 [95% CI 5.883–20.139]; P < 0.001), and the risk of poor BG control in those who measured their BG once per week was 2.040-times higher than that of those who monitored their BG 2 times per week (OR: 2.040 [95% CI 1.335–3.117]; P = 0.001) (Table 5).

In T1DM patients, binary logistic regression analysis showed that having fewer than 12 years of education (OR: 3.031 [95% CI 1.112–8.263]; P = 0.030) was a risk factor for glycemic control. Patients who had received 12 or more years of education had better glycemic control (Table 6).

4. Discussion

During the COVID-19 pandemic, diabetes patients' self-control of their BG levels was not good. Physicians treating patients with diabetes during quarantine should be aware of the impact that social distancing may have on glycemic control. People remaining at home will likely reduce their amount of physical exercise compared to their usual daily routines, and calorie intake will increase in a proportion of subjects, both of which may lead to deterioration in glycemic control [8]. This study showed that 74.46% of T2DM patients had poor glycemic control, which is similar to the rate of 74.0% reported in patients with COVID-19 and pre-existing T2DM [7]. In 2019, a survey of 1512 patients with T2DM in Hunan Province showed that the compliance rates for FBG, 2hPBG, and glycosylated hemoglobin were 25.5%, 22.7% and 19.5%, respectively [13]. During this time, home isolation has both advantages and disadvantages. On the one hand, with the COVID-19 epidemic spreading worldwide, home isolation is an effective means to contain the virus. On the other hand, previous research has shown that the impact of social distancing, quarantine and lockdown on lifestyles likely leads to worsening of glycemic control [14]. First, isolation at home may limit the physical activity of the patients. This survey showed that 321 patients (27.7%) chose low-intensity exercise, such as walking and housework, thus compromising achievement of the standard amount and intensity of exercise in a week. Second, consuming appropriately diverse foods during this period is difficult, and insufficient intake of vegetables and protein during quarantine may lead to poor glycemic control. Patients should change their eating habits to improve their glycemic control. The survey also showed that the frequency of sugar intake in the poorly controlled BG group was higher than that in the well-controlled BG group.

Table 4 – Comparison of self-management data between T1DM patients with well-controlled and poorly controlled BG.

		Total	Well-controlled blood glucose (n = 33)	Poorly controlled blood glucose (n = 61)	Statistic	P value
SMBG (days/week)		3 (1, 7)	6 (2, 13)	3 (1, 6)	−2.531[1)]	0.011
Vegetable intake (days/week)		7 (7, 7)	7 (7, 7)	7 (7, 7)	−1.360[1)]	0.174
Dessert consumption (days/week)		0 (0,2)	0 (0, 1)	0.5 (0, 2)	−2.221[1)]	0.026
Exercise (days/week)		7 (4,7)	7 (3, 7)	7 (4, 7)	−0.444[1)]	0.657
Foot self-examination (times/week)		0 (0,3)	0 (0, 5.5)	0 (0, 0.5)	−1.146[1)]	0.252
Sleep duration (h/day)		8 (7, 8)	8 (7, 8)	8 (7, 8)	−0.238[1)]	0.812
Regular meals	Yes	90 (95.7)	32 (35.6)	58 (64.4)	0.187[2)]	0.665
	No	4 (4.3)	1 (25.0)	3 (75.0)		
Blood glucose meter at home	Yes	84 (89.4)	32 (38.1)	52 (61.9)	3.096[2)]	0.078
	No	10 (10.6)	1 (10.0)	9 (90.0)		
Hypoglycemia	Yes	36 (38.3)	15 (41.7)	21 (58.3)	1.102[2)]	0.294
	No	58 (61.7)	18 (31.0)	40 (69.0)		
Medication plan	No drugs	7 (7.4)	3 (42.9)	4 (57.1)	2.647[2)]	0.449
	OHA	7 (7.4)	3 (42.9)	4 (57.1)		
	Insulin injection	60 (63.8)	23 (38.3)	37 (61.7)		
	OHA + insulin injection	20 (21.3)	4 (20.0)	16 (80.0)		
Medication compliance	Yes	23 (24.5)	12 (52.2)	11 (47.8)	3.894[2)]	0.048
	No	71 (75.5)	21 (29.6)	50 (70.4)		
Exercise intensity	No movement	13 (13.8)	6 (46.2)	7 (53.8)	2.657[2)]	0.448
	Low	18 (19.1)	4 (22.2)	14 (77.8)		
	Moderate	62 (66.0)	23 (37.1)	39 (62.9)		
	High	1 (1.1)	0 (0)	1 (100)		
Diabetic foot	Yes	1 (1.1)	1 (100.0)	0 (0)	1.868[2)]	0.172
	No	93 (98.9)	32 (34.4)	61 (65.6)		
Smoke	Yes	20 (21.3)	3 (15.0)	17 (85.0)	4.508[2)]	0.034
	No	74 (78.7)	30 (40.5)	44 (59.5)		
Anxiety	None	29 (30.9)	25 (33.3)	50 (66.7)	1.455[2)]	0.483
	Mild	55 (58.5)	6 (37.5)	10 (62.5)		
	Moderate	10 (10.6)	2 (66.7)	1 (33.3)		

1) Z value, 2) χ^2 value.

Previous studies have shown that the overall prevalence of T2DM increases rapidly with increasing age [15] and that age is associated with glycemic control [16], which is consistent with our research. Binary regression analysis showed that age was a risk factor for BG control in patients with T2DM, and the median age in the poorly controlled BG group was significantly older than that in the well-controlled BG group among T2DM patients. The reason may be that the function of islet β cells gradually decreases with increasing age, thus weakening the ability to regulate BG levels.

During the COVID-19 epidemic, SMBG is important. The survey showed that T2DM patients with BG meters had better glycemic control than patients without BG meters at home. The outpatient glucose monitoring consensus statement pointed out that SMBG is an essential tool that should be accessible to all patients with diabetes regardless of whether they are receiving insulin treatment [17]. In this survey, 89.4% of the patients with T1DM and 81.3% of the patients with T2DM had portable BG meters. BG meters are the most common and convenient instruments used for SMBG [18]. Having a BG meter at home may be one of the important indicators of good glycemic control. Our research showed that 330 (28.5%) patients with T2DM and 12 (12.8%) patients with T1DM never monitored their BG during the epidemic. The reasons were as follows: first, some patients did not have BG meters or test strips. They had visited the community health center to monitor their BG levels before the pandemic. However, their ability to continue to do so was affected by the epidemic. Second, some patients did not measure their BG at all because of the fear of pain.

The frequency of SMBG in the well-controlled BG group was significantly higher than that in the poorly controlled BG group among T2DM patients. Our regression analysis further indicated that BG was better managed by measuring BG levels approximately two times per week. Previous guidelines indicated that measurement of BG depended on the treatment. For example, for patients with T2DM on basal insulin therapy, SMBG should be performed one to two times per day, and for patients with T2DM on diet/lifestyle therapy only, SMBG should be performed at least two times per week [17]. However, during the COVID-19 epidemic, our study found that performing BG monitoring two times per week was more appropriate and effective. Several reasons may account for the low frequency of SMBG. First, insufficient amounts of test strips limited the number of BG monitoring measurements that could be performed. Some patients were worried that they would not be able to buy test strips during the epidemic and deliberately reduced their BG monitoring frequency. Second, others failed to perform BG monitoring because of a fear of pain. Third, some patients had an incorrect understanding of BG monitoring. They thought that when they did not have any discomfort, BG monitoring was not necessary. Previous studies have confirmed that adequate knowledge of BG management and active SMBG are favorable factors for good glycemic control [19]. Appropriate use of a structured SMBG regimen promotes desired behavioral changes and facilitates therapy optimization, leading to improved clinical outcomes for patients with insulin-treated T2DM [20]. Therefore, reminding patients to monitor their BG during the outbreak by phone or other tools and educating them regarding the importance of SMBG may be important.

More education (≥12 years) was a protective factor affecting glycemic control in both T1DM and T2DM patients. Table 1 and Table 3 show that compared with the group with poorly controlled control, the group with well-controlled BG had a higher proportion of patients with ≥12 years of education [31.2% vs 19.8% among T2DM patients ($P < 0.001$) and 44.9% vs 38.7% among T1DM patients ($P = 0.038$)]. This finding showed that education had a strong positive influence on the treatment of diabetes, which is similar to findings in previous studies [21,22]. During the COVID-19 epidemic, patients with diabetes can acquire knowledge of and skills pertaining to diabetes prevention mainly through the internet. Patients with a high education level have more means to acquire knowledge. Adequate knowledge of and skills pertaining to diabetes self-management, such as engaging in active SMBG, engaging in physical exercise, and preventing the occurrence of ulcers, are all helpful for improving BG and preventing chronic and acute complications of diabetes.

The rate of T2DM medication compliance was 77.8%, and medication compliance was closely related to glycemic control in this survey. Lower medication compliance corresponded to worse glycemic control. Patients with optimal control of their BG levels had significantly better self-reported drug compliance ($P < 0.05$), which is similar to findings in previous studies [23]. Medication compliance can be affected by many factors, such as belonging to the 18- to 35-year-old age group, being single, having a fear of diabetes-

Table 5 – Factors contributing to glycemic control in T2DM patients as examined using binary logistic regression (n = 1159).

Variable	Categories	OR (95% confidence interval)	P
Age		1.017 (1.003, 1,030)	0.013
Education	≥12 years	1.646 (1.202, 2.255)	0.002
	<12 years		
Blood glucose meter	Yes	2.728 (1.205, 6.179)	0.016
	No		
Medication compliance	Yes	1.627 (1.076, 2.460)	0.021
	No		
SMBG (times/week)	≥2		0.000
	1	2.040 (1.335, 3.117)	0.001
	0	10.884 (5.883, 20.139)	0.000

OR: odds ratio, CI: confidence interval.

Table 6 – Factors contributing to glycemic control in T1DM patients as examined using binary logistic regression (n = 94).

Variable	Categories	OR (95% confidence interval)	P
Education	≥12 years <12 years	3.031(1.112,8.263)	0.030

OR: odds ratio, CI: confidence interval.

related complications and feeling worse according to a previous study [24]. During the epidemic, especially in the early stages, the continuous supply of drugs was affected. Ordinary patients with diabetes could not visit a doctor in a timely fashion. Insulin is a common drug used by people with diabetes that must be stored and transported in cold storage. During the COVID-19 outbreak, the cold chain transport of insulin was blocked, creating difficulty in ensuring the continuous supply of insulin. People with diabetes did not visit their physicians for routine clinical appointments. These external factors may have also affected patients' compliance with their medication regimen.

According to our telephone follow-up results, the diet structure, exercise, sleep, hypoglycemia symptoms and anxiety of diabetic patients did not have a particularly significant impact in the epidemic situation. but we found that the telephone follow-up to guide the rational condition monitoring in diabetic patients, especially for diabetic patients without drugs how through diet and exercise to avoid the occurrence of diabetic ketosis, guide patients to identify and prevent hypoglycemia; More importantly, telephone follow-up provided comfort and reassurance to the anxious patients in the closure of city.

Some other authors have suggested that the quality of glycemic control can improve during the COVID-19 era, that the lockdown has not adversely affected metabolic control in diabetics patients, and that HbA1c levels appear to have improved [25]. The results of this study are different from ours, probably due to different criteria for blood glucose control, but using telemedicine during the lockdown and better technologies to help diabetics contact their doctors warrant further attention. In COVID-19 outbreak of this special period, our researchers can't learn glycemic control of patients by face-to-face following-up, also can't through the hospital inspection equipment testing patients' blood glucose, only through a telephone follow-up of patients in SMBG, the glycemic control levels and diabetes self-management behavior status, to simple and effective communication with patients, help patients found that hyperglycemia and hypoglycemia in time, thereby promoting blood sugar stable of diabetic patients during home quarantine. Therefore, telephone follow-up or telemedicine technology will be a good method for diabetes management in future public health emergencies.

5. Limitations

A centralized telephone follow-up was adopted to communicate with patients directly and clarify the situation that the patients were experiencing during the epidemic. All the investigators involved in the follow-up were endocrine department nurses. During the follow-up, they not only investigated basic information but also cared about the suffering of the diabetes patients, attempting to successfully manage their conditions at home and providing targeted health education. The patients and their families expressed their recognition of and gratitude for the investigators. This study has some limitations that must be acknowledged. First, data collection was cross-sectional, and the involved patients were discharged from the same hospital. Additionally, due to the limited telephone time, the researchers may not have had sufficient interactions with the patients.

6. Conclusions

During the COVID-19 epidemic, glycemic control among T1DM and T2DM patients in home quarantine is inadequate. Older age, fewer than 12 years of education, poor medication compliance and less SMBG were risk factors for poor glycemic control. The epidemic has increased the difficultly of controlling BG at home for these patients, and daily SMBG and adherence to the prescribed medication regimen are important. Therefore, diabetic patients should be advised to increase the frequency of blood glucose measurements during home quarantine and be re-educated regarding the importance of medication compliance.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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