Original Article

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Quick Response Code:

Website:
www.jfcmonline.com

DOI:
10.4103/jfcm.jfcm_238_22

# Association between diabetes-related distress and glycemic control in primary care patients with Type 2 diabetes during the coronavirus disease 2019 (COVID-19) pandemic in Egypt

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**Received:** 14-07-2022
**Revised:** 19-09-2022
**Accepted:** 17-10-2022
**Published:** 29-12-2022

## Abstract:

**BACKGROUND:** Diabetes-related distress and glycemic control are of a particular concern to primary care physicians because of the impact of the coronavirus disease 2019 pandemic on diabetic patients' lifestyle, psychological well-being and healthcare access. Our aim was to evaluate the relationship between diabetes-related distress and glycemic control in diabetic patients with Type 2 diabetes mellitus (T2DM) in primary care settings during the pandemic.

**MATERIALS AND METHODS:** This cross-sectional study was conducted at primary healthcare clinics in a rural area in Egypt among 430 patients with T2DM during the period from September 2020 to June 2021. All patients were interviewed for their sociodemographic, lifestyle, and clinical characteristics. Diabetes-related distress was measured by the problem areas in the diabetes scale (PAID), where a total score of ≥40 indicated a severe diabetes-related distress. The most recent glycosylated hemoglobin (HbA1c) measurements were used to indicate the glycemic control. Quantile regression model (0.50 quantile) was used to perform the multivariate analysis to identify significant factors associated with HbA1c level.

**RESULTS:** Most of the participants had a suboptimal glycemic control (92.3%), while 13.3% had severe diabetes-related distress. HbA1c level was significantly and positively correlated with the total PAID score and all its sub-domains. Multivariate quantile regression revealed that obesity, multi-morbidity, and severe diabetes-related distress were the only significant determinants of the HbA1c median level. Obese patients had significantly higher median HbA1c compared to patients who were not obese (coefficient = 0.25, $P < 0.001$). Patients with two or more comorbidities (i.e., multimorbidity) had a significantly higher median HbA1c than patients with single or no chronic comorbidities (coefficient = 0.41, $P < 0.001$). Severe diabetes-related distress was significantly associated with higher median HbA1c compared to nonsevere diabetes-related distress (coefficient = 0.20, $P = 0.018$).

**CONCLUSION:** Diabetes-related distress had a significant association with HbA1c level. Family physicians should implement multifaceted programs to optimize diabetes control and reduce any associated distress.

## Keywords:

Coronavirus disease 2019, Egypt, glycated hemoglobin, problem areas in diabetes scale, Type-2 diabetes mellitus



**How to cite this article:** Elotla SF, Fouad AM, Mohamed SF, Joudeh AI, Mostafa M, El Hayek S, *et al*. Association between diabetes-related distress and glycemic control in primary care patients with Type 2 diabetes during the coronavirus disease 2019 (COVID-19) pandemic in Egypt. J Fam Community Med 2023;30:42-50.

## Introduction

The prevalence of Type 2 diabetes mellitus (T2DM) continues to rise at an alarming rate, presenting a global public health concern.[1] In 2021, the International Diabetes Federation (IDF) reported that worldwide, about 537 million people have DM. This represents 9.8% of adults aged between 20 and 79 years, compared to 8.5% (366 million) in 2011. The IDF expected a further increase to 11.2% (784 million) in 2045. In 2021, Egypt ranked tenth on the list of countries with the highest prevalence rates of DM, with a 20.9% age-adjusted prevalence and 8.4% diabetes-related deaths in people under 60 years.[2]

Successful management of T2DM entails good adherence to the medical regimen, an appropriate diet and lifestyle changes, and regular blood glucose monitoring.[3] The central goal of diabetes management is to achieve an acceptable control of blood glucose, avoid diabetes-related complications, and maintain an adequate quality of life.[4] Suboptimal glycemic control in diabetic patients shows a wide variation, with rates ranging between 40% and 78.8%.[5] A recent Egyptian study reported a 77% prevalence of suboptimal glycemic control in T2DM patients treated in urban primary healthcare settings.[6]

Living with DM is a stressful experience since affected patients experience many worries and concerns related to medical management and diabetes-related health risks.[7] Diabetes-related distress was described by Polonsky *et al*.,[8] as the significant negative psychological response to the diagnosis of diabetes, the risk for diabetic complications, self-management needs, and the lack of support from interpersonal relationships, including healthcare providers.[9] Increased diabetes-related distress has been linked with reduced self-management, limited adherence to medications, suboptimal glycemic control, more frequent complications, and poor quality of life.[10-13]

Several studies have reported a substantial relationship between distress and glycemic control in patients with T2DM.[3,14-17] However, the impact of the coronavirus disease 2019 (COVID-19) pandemic on this relationship is not much investigated, particularly in less developed countries. There was a great deal of concern about diabetes during the pandemic because of the increased risk of SARS-Cov-2 infection and its adverse outcomes.[18] In addition, the pandemic has been associated with increased psychological distress, changes in lifestyle (e.g. increased high-caloric foods consumption, physical inactivity, and screen time), and limitations in access to healthcare.[19] These COVID-19-related factors have negatively influenced glycemic control. In their study during the pandemic, Tao *et al*., demonstrated that 25.5% of patients with T2DM achieved an optimal glycemic control.[20]

Therefore, our aim was to assess the relationship between the diabetes-related distress and glycemic control in Egypt during the COVID-19 pandemic, and identify the predictors of glycemic control as measured by the glycosylated hemoglobin (HbA1c) in patients with T2DM attending the primary healthcare clinics (PHC) during the pandemic.

## Materials and Methods

Using a cross-sectional design, we carried out this study at the rural PHC in Ismailia, Egypt, from September 2020 to June 2021. This study relied on our earlier work on mental health and Type 2 diabetes in Egypt during the COVID-19 pandemic.[21] During this period in Egypt, about 182,000 confirmed cases of COVID-19 with about 10,500 deaths, were reported to the WHO.[22] G*Power software (version 3.1.9.6, Franz Faul, Kiel University, Kiel, Germany, 2020) was used to calculate the sample size given a 0.05 $\alpha$-error, an 0.80 power, and a 0.029 effect size (i.e. the estimated regression coefficient of the relationship between HbA1c and problem areas in diabetes scale (PAID) score and after controlling for the type and duration of DM, age, the Short-Form Health Survey-Mental Component Summary-12 and Patient Health Questionnaire-9 scores).[23] The sample size was calculated as 365 but was increased (by about 15%) to a total of 430 patients to maximize the sample size obtained from the available data. Ethical Approval was obtained from the Research Ethics Committee vide Letter No. 4277 dated 10/09/2020, and written informed consent was taken from all participants.

Patients were enrolled if they were ≥18 years old, diagnosed as T2DM for at least 1 year and gave their consent to participate in the study. Exclusion criteria involved a diagnosis of gestational diabetes or a severe mental illness or cognitive impairment (conditions that might prevent them from completing the interview).

All enrolled patients were interviewed. Collected data included demographic characteristics, lifestyle-related factors, and diabetes-related and clinical characteristics. Diabetes-related complications included diabetic retinopathy, neuropathy, nephropathy, cardiovascular, cerebrovascular, or peripheral vascular diseases. The questionnaire also included the PAID scale for assessment of diabetes-related distress. The PAID scale comprises 20 items measured on a 5-point Likert scale from 0 to 4, where 0 refers to "not a problem" and 4 refers to "serious problem."[8] The sum of all items multiplied by 1.25 gives the total score. A rise in PAID score indicates higher diabetes distress, and severe diabetes-related distress is considered if the total score is ≥40.[24] The Arabic translation of the PAID was validated and showed a 0.96 Cronbach's alpha and a 0.97 intraclass correlation.[25] Four sub-domains were previously identified for the of the PAID: (1) Lack of support, (2) Emotional problems, (3) Treatment problems, and (4) Food problems.[26]

The most recent measurements of HbA1c (within a period of 12 weeks prior to the interview). Optimal glycemic control was considered if HbA1c levels were <7% in adults, or <7.5% in the elderly over 65 years.[27] Body mass index (BMI) was estimated as weight (kg)/square root of height (meter). Normal, overweight, or obese patients were identified if BMI was 18.5–24.9, 25–29.9, or ≥30.0, respectively.[28] The World Health Organization (WHO) definition of regular physical activity was used to identify regular activity in study participants.[29]

All statistical procedures were carried out using the SPSS® software version 25.0 (IBM Corporation, NY, Armonk, USA). Two-sided *P* values were considered statistically significant if <0.05. Means and standard deviations or medians and interquartile ranges were used to summarize continuous variables. The Kolmogorov–Smirnov test was used to test for data normality. Correlations between age, BMI, diabetes duration, HbA1c, and PAID variables were estimated with Spearman's rank correlation (rho). Statistical significance of the differences across the categorical variables was assessed by Mann–Whitney or Kruskal–Wallis tests, given that all the continuous variables in the study were not normally distributed. Quantile regression model (0.50 quantile) was used to perform the multivariate analysis to identify significant predictors associated with HbA1c level. The variables in the model were identified on the basis of significant bivariate associations. GraphPad® software version 8.0.0 was used to create Figure 1 (San Diego, California USA).

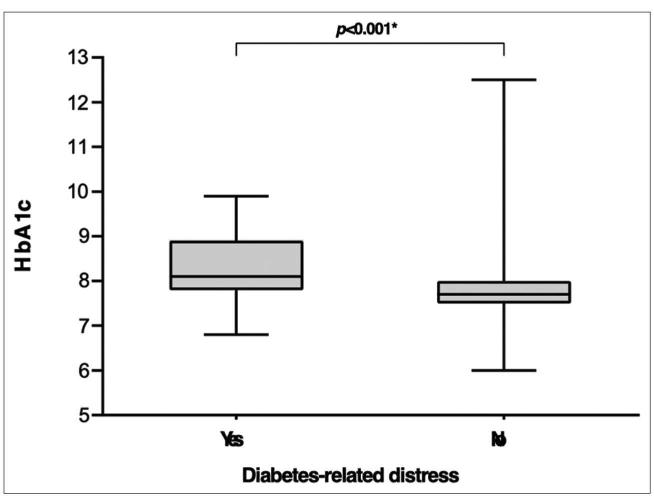


**Figure 1:** Distribution of the HbA1c by the diabetes-related distress status (*n* = 430). HbA1c: Glycated hemoglobin

## Results

The mean age of participants was 48.1 years (±11.6). Most were females (60.7%), married (76.3%), educated (77.2%), and not working or homemakers (58.4%). Family income was inadequate in 25.8% of the patients. About one-third of the patients (30.7%) were smokers, while 28.4% were physically inactive and 32.1% obese. About two-thirds of the patients (65.6%) had had diabetes for at least 5 years and 68.4% were on oral hypoglycemic medications. Oral hypoglycemic medications are described in detail in Table 1. One-fourth of the patients (25.3%) had experienced at least one diabetes-related complication. The most frequent complications were peripheral neuropathy (53.0%), diabetic retinopathy (37.7%), peripheral vascular disease (30.0%), and diabetic nephropathy (23.0%). Only one-third of patients (32.3%) had chronic comorbid diseases (24.9% had hypertension, 12.6% had dyslipidemia, and 18.2% had other chronic diseases), 15.3% had two or more chronic diseases. Only 16 patients (3.7%) had a history of polymerase chain reaction-confirmed COVID-19 infection [Table 2].

Bivariate analysis showed that increased median HbA1c level and PAID score were significantly associated with older age, female gender, married or divorced or widow status, illiteracy or low education, nonwork, insufficient income, increased BMI, smoking, physical inactivity, diabetes diagnosis of long duration, insulin-based regimen, diabetes-related complications, and chronic comorbidities [Table 2].

Most of the participants had a suboptimal glycemic control (92.3%), while 13.3% had severe diabetes-related distress (PAID score ≥40). Figure 1 shows that high diabetes-related distress was significantly associated

**Table 1: Distribution of study participants according to the anti-diabetic medications (*n*=430)**

| Type of treatment | *N* (%) |
|---|---|
| Biguanide (metformin) | 27 (6.3) |
| Sulfonylurea | 171 (39.8) |
| DPP-4 inhibitors | 4 (0.9) |
| Biguanide (metformin) plus DPP4 inhibitors | 12 (2.8) |
| Biguanide (metformin) plus sulfonylurea | 57 (13.3) |
| Sulfonylurea plus thiazolidinedione | 18 (4.2) |
| Biguanide (metformin) plus thiazolidinedione | 1 (0.2) |
| Biguanide (metformin) + DPP4 inhibitors + sulfonylurea | 4 (0.9) |
| Insulin containing regimen | 136 (31.6) |

DPP-4=Dipeptidyl peptidase 4

**Table 2: Associations of glycated hemoglobin and diabetes-related distress with the sociodemographic and disease characteristics (*n*=430)**

| Characteristics | *N* (%) | HbA1c | *P-value* | PAID | *P-value* |
|---|---|---|---|---|---|
| Age (years) | | | | | |
| <40 | 109 (25.3) | 7.6 (7.4–7.9) | <0.001* | 8.0 (0.0–18.0) | <0.001 |
| 40–59 | 235 (54.7) | 7.8 (7.5–8.0) | | 12.0 (6.0–23.0) | |
| ≥60 | 86 (20.0) | 8.2 (7.8–9.0) | | 33.0 (12.0–52.0) | |
| Sex | | | | | |
| Male | 169 (39.3) | 7.6 (7.4–7.9) | <0.001* | 10.0 (3.0–20.0) | <0.001 |
| Female | 261 (60.7) | 7.8 (7.5–8.2) | | 15.0 (7.0–29.0) | |
| Civil status | | | | | |
| Single | 20 (4.7) | 7.5 (7.3–7.8) | <0.001* | 0.0 (0.0–5.0) | <0.001 |
| Married | 328 (76.3) | 7.8 (7.5–8.0) | | 13.0 (6.0–24.0) | |
| Divorced or widow | 82 (19.1) | 8.0 (7.7–8.6) | | 23.5 (10.0–46.0) | |
| Educational level | | | | | |
| Illiterate | 98 (21.6) | 8.0 (7.7–8.9) | <0.001* | 27.5 (14.0–52.0) | <0.001 |
| Secondary or less | 267 (62.1) | 7.8 (7.5–8.0) | | 13.0 (7.0–24.0) | |
| College and above | 65 (15.1) | 7.5 (7.3–7.8) | | 0.0 (0.0–7.0) | |
| Job | | | | | |
| Not working/housewives | 251 (58.4) | 7.9 (7.5–8.2) | <0.001* | 19.0 (9.0–34.0) | <0.001 |
| Working a full-time job | 167 (38.8) | 7.6 (7.4–7.8) | | 8.0 (1.0–17.0) | |
| Business owners and freelancers | 12 (2.8) | 7.6 (7.5–8.0) | | 6.0 (1.0–15.0) | |
| Family income | | | | | |
| Sufficient | 319 (74.2) | 7.7 (7.5–7.9) | <0.001* | 10.0 (4.0–20.0) | <0.001 |
| Insufficient | 111 (25.8) | 8.0 (7.7–9.0) | | 28.0 (15.0–51.0) | |
| BMI classification | | | | | |
| Normal | 128 (29.8) | 7.6 (7.4–7.9) | <0.001* | 11.0 (1.0–32.5) | 0.007 |
| Overweight | 165 (38.4) | 7.6 (7.4–7.8) | | 11.0 (5.0–21.0) | |
| Obese | 138 (32.1) | 7.9 (7.7–8.5) | | 15.0 (8.0–26.0) | |
| Life-style characteristics | | | | | |
| Ever cigarette smoking | 132 (30.7) | 7.7 (7.5–7.9) | 0.005* | 11.0 (3.5–20.3) | 0.021 |
| Alcohol drinking | 3 (0.7) | 7.8 (6.8–9.0) | 0.968 | 28.0 (1.0–29.0) | 0.733 |
| Physical inactivity | 122 (28.4) | 8.0 (7.7–9.0) | <0.001* | 25.0 (12.0–49.0) | <0.001 |
| Duration of diabetes (years) | | | | | |
| <5 | 148 (34.4) | 7.6 (7.4–8.0) | <0.001* | 8.5 (2.0–18.5) | <0.001 |
| 5–10 | 173 (40.2) | 7.7 (7.5–8.0) | | 12.0 (6.0–24.0) | |
| >10 | 109 (25.3) | 8.0 (7.8–8.5) | | 24.0 (11.0–41.0) | |
| Antidiabetic treatment | | | | | |
| Oral hypoglycemic drugs | 294 (68.4) | 7.7 (7.5–8.0) | 0.001* | 11.5 (5.0–22.0) | <0.001 |
| Insulin-based regimens | 136 (31.6) | 7.9 (7.5–8.3) | | 20.0 (9.0–40.5) | |
| Number of diabetic complications | | | | | |
| No complications | 143 (33.3) | 7.5 (7.4–7.9) | <0.001* | 8.0 (2.0–15.0) | <0.001 |
| Single | 109 (25.3) | 7.7 (7.5–8.0) | | 13.0 (5.0–23.0) | |
| Two or more | 178 (41.4) | 7.9 (7.6–8.5) | | 22.5 (10.0–38.0) | |
| Number of chronic comorbidities | | | | | |
| None | 291 (67.7) | 7.6 (7.4–7.9) | <0.001* | 9.0 (3.0–19.0) | <0.001 |
| Single | 73 (17.0) | 7.9 (7.5–8.2) | | 22.0 (12.0–33.0) | |
| Two or more | 66 (15.3) | 8.5 (7.9–9.0) | | 34.5 (19.0–59.0) | |
| PCR-confirmed diagnosis COVID-19 | | | | | |
| No | 414 (96.3) | 7.8 (7.5–8.0) | 0.890 | 13.0 (5.0–23.0) | 0.930 |
| Yes | 16 (3.7) | 7.7 (7.5–8.8) | | 16.5 (3.0–26.0) | |

Data presented as median (IQR). Mann–Whitney/Kruskal–Wallis tests were used. IQR=Interquartile range, BMI=Body mass index, HbA1c=Glycated hemoglobin, PAID=Problem areas in diabetes, PCR=Polymerase chain reaction, COVID-19=Coronavirus disease 2019

with elevated HbA1c ($P < 0.001$). Table 3 shows that HbA1c level correlated positively and significantly with the total PAID score (rho = 0.271, $P < 0.001$). Likewise, HbA1c showed significant positive correlation with the PAID subdomains (emotional problems: rho = 0.286, $P < 0.001$; treatment problems: rho = 0.200, $P < 0.001$; food problems: rho = 0.180, $P < 0.001$, and lack of support: rho = 0.153, $P = 0.001$).

A multivariate quantile regression analysis was used to evaluate the relationship between diabetes-related distress and the level of HbA1c (at 0.50 quantile), adjusted for other study variables [Table 4]. Variables that showed significant regression coefficients were obesity, multi-morbidity, and experiencing severe diabetes-related distress, given that all other variables were kept constant. Obesity was significantly associated with increased median HbA1c (coefficient = 0.25, $P < 0.001$). Patients with two or more comorbidities (i.e. multi-morbidity) had significantly increased median HbA1c compared to patients with single or no chronic diseases (coefficient = 0.41, $P < 0.001$). Likewise, high diabetes-related distress was significantly associated with an increased median HbA1c compared to patients who had no severe diabetes-related distress (coefficient = 0.20, $P = 0.018$).

## Discussion

This observational study assessed glycemic control in adult patients with T2DM who attended primary care clinics in Egypt during the COVID-19 pandemic. We found a positive association between HbA1c levels with obesity, multiple comorbidities, and severe diabetes-related distress. Results also highlighted several social determinants for diabetes control and diabetes-related distress in the participants.

The current study showed that about 9 out of 10 participants had a suboptimal glycemic control, a high rate compared to an earlier study in Egypt in which 77% of the study sample had suboptimal glycemic control.[6] However, the latter study was carried out in an urban area in Egypt with a well-established local health system. Moreover, our study was done during the COVID-19 pandemic, which might have interfered with the usual healthcare for patients with chronic illnesses like DM, and affected their physical activity, eating habits and mental well-being.[20]

Previous studies suggested that social determinants such as socioeconomic and psychosocial factors, affect patients' health outcomes, particularly in those with DM.[30,31] According to the WHO conceptual framework, pathways between social determinants and health outcomes are divided into material circumstances, such as living and working conditions, behavioral and biological factors including genetics and lifestyle, psychosocial factors, such as coping styles and diabetes-related distress, as well as local health systems factors.[32]

The study results also indicate that several socioeconomic factors were associated with increased HbA1c levels and diabetes-related distress. Along the same lines, the study

**Table 3: Correlations between glycated hemoglobin and problem areas in diabetes scores (*n*=430)**

| Characteristics | Median (IQR) | Spearman's rho correlation |
|---|---|---|
| PAID subdomains scores | | |
| Emotional problems (0–60) | 11.3 (3.8–22.5) | 0.286 |
| Treatment problems (0–10) | 1.3 (0.0–5.0) | 0.200 |
| Food problems (0–15) | 2.5 (0.0–6.3) | 0.180 |
| Lack of support (0–15) | 0.0 (0.0–1.3) | 0.153 |
| Total PAID score (0–100) | 13.0 (6.0–26.0) | 0.271 |

PAID=Problem areas in diabetes, IQR=Interquartile range

**Table 4: Multivariate quantile regression model: Factors related to glycated hemoglobin (at 0.50 quantile) (*n*=430)**

| Variable | β | SE | 95% CI | *t* | *P*-value |
|---|---|---|---|---|---|
| Age (years) | 0.01 | 0.004 | −0.00–0.01 | 1.74 | 0.082 |
| Female | 0.08 | 0.006 | −0.09–0.26 | 0.95 | 0.341 |
| Married | −0.07 | 0.068 | −0.20–0.06 | −1.04 | 0.301 |
| Illiterate | −0.04 | 0.083 | −0.21–0.12 | −0.52 | 0.601 |
| University education | −0.10 | 0.076 | −0.25–0.05 | −1.25 | 0.211 |
| Working a full-time | −0.05 | 0.071 | −0.19–0.09 | −0.68 | 0.500 |
| Insufficient family income | 0.03 | 0.069 | −0.10–0.17 | 0.49 | 0.626 |
| Ever smoker | 0.10 | 0.084 | −0.07–0.26 | 1.14 | 0.253 |
| Physical inactivity | −0.04 | 0.078 | −0.19–0.12 | −0.46 | 0.645 |
| Overweight | 0.02 | 0.064 | −0.10–0.15 | 0.37 | 0.710 |
| Obese | 0.25 | 0.069 | 0.11–0.38 | 3.60 | <0.001 |
| Two or more comorbidities | 0.41 | 0.094 | 0.22–0.59 | 4.33 | <0.001 |
| Diabetes duration (years) | −0.01 | 0.006 | −0.02–0.01 | −1.25 | 0.213 |
| Oral hypoglycemics | −0.05 | 0.064 | −0.18–0.07 | −0.79 | 0.428 |
| Diabetes-related distress | 0.20 | 0.083 | 0.03–0.36 | 2.37 | 0.018 |
| Intercept | 7.42 | 0.195 | 7.03–7.80 | 37.98 | <0.001 |

Dependent variable=HbA1c, Model=Intercept, age (years), sex (female), marital status (married), education (illiterate), education (university), work (full-time job), family income (insufficient), cigarette smoking (ever-smoker), physical activity (inactive), class of body mass index (overweight), class of BMI (obese), multimorbidity (two or more chronic comorbidities), diabetes duration (years), antidiabetic medications (oral hypoglycemics), and severe diabetes-related distress (PAID ≥ 40). Model fit=Pseudo $R^2$=0.117. SE=Standard error, CI=Confidence interval, HbA1c=Glycated hemoglobin, PAID=Problem areas in diabetes, BMI=Body mass index by Walker *et al*., showed that increased educational level was associated with lower HbA1c values in American patients with T2DM attending primary care.[31] Silva-Tinoco *et al*., also demonstrated that higher level of education of Mexicans with T2DM attending primacy care was linked to better glycemic control.[33] The relationship between educational level and glycemic control is thought to be mediated by an improvement in the knowledge of diabetes and the development of better self-care.[33,34]

Regarding the relation of demographic and clinical characteristics with diabetes control, this study showed that several variables were linked to higher HbA1c levels, including older age, female gender, obesity, physical inactivity, long duration of diagnosis of diabetes, having several diabetes-related complications, and/or associated comorbidities. Comparably, a Chinese study by Lin *et al*., found that older age, long duration of diabetes, higher BMI, as well as multiple diabetes complications had significant association with suboptimal glycemic control.[35] In Malaysia, Mahmood *et al*., also found that living with both obesity and diabetes for more than 5 years were predictors of poor glycemic control. However, in that study male gender and younger age were associated with poor glycemic control, which might reflect different lifestyle factors in the Malaysian population.[36] The relationship between obesity and high HbA1c levels could be related to the insulin resistance observed in obesity. In addition, obese people usually consume excessive carbohydrates and tend to be physically inactive.[6]

Although using insulin-based treatment is the definitive option for patients with long-standing T2DM, the use of insulin-containing regimens was showed to be linked to a worse control of glycemic levels. These results parallel the findings of a longitudinal study conducted in primary care patients with T2DM in Singapore, in which insulin therapy was related to an elevation of HbA1c level ($\geq 1\%$) from 1 year to another.[37] This can be explained by the fact that insulin therapy is usually prescribed for patients who have been diagnosed with T2DM for a long time or have comorbidities that limit the use of oral hypoglycemic agents. In addition, healthcare workers might delay the initiation of insulin therapy or may prescribe sub-therapeutic doses to avoid hypoglycemia. Furthermore, patients may be reluctant to use injectable medications or are fearful of their perceived side effects.[38,39] Therefore, healthcare policymakers should facilitate structured educational programs on diabetes management and the proper use of insulin that target both patients and healthcare providers.

Previous studies supported the beneficial impact of glycemic control on microvasculature in diabetic patients.[40] According to the study results, having two or more diabetes-related complications had a statistically significant association with higher HbA1c levels. Similarly, Fasil *et al*., demonstrated a higher prevalence of diabetes complications if T2DM is uncontrolled. The authors found that an increased rate of diabetes complications was linked with a diagnosis of more than 7 years, obesity, high-risk waist circumference, and a level of serum triglycerides of <150 mg/dl.[41] It is plausible that the link between glycemic control and diabetes complications is bidirectional, with one affecting the other. As uncontrolled diabetes is linked to a higher rate of complications, this subgroup of patients probably faces more difficulties in controlling glycemic levels as a result of polypharmacy and/or end-organ damage.

The results showed that symptoms of diabetes-related distress had a weak positive correlation with HbA1c levels, which is similar to the findings of other studies.[10,23,42-44] Another relevant finding of this study is that diabetes-related distress score was a significant determinant of higher HbA1c levels after controlling other significant variables. This is also replicated in an earlier study of patients with T2DM receiving insulin therapy.[44] Diabetes-related distress can adversely influence HbA1c levels by contributing to deficient self-care activities, concomitant depression, and dysregulating stress hormones.[45,46] Reducing diabetes-related distress may allow diabetic patients to become more responsive to interventions that target glycemic control or self-care.[47] Along the same lines, Fonda *et al.,* found that lower diabetes-related distress was associated with better HbA1c levels and vice versa.[48] Nevertheless, it should be emphasized that the described relationships are only associative and do not imply causality. Moreover, owing to the complex interaction between distress and glycemic control, a reversed causality could not be ruled out, considering the cross-sectional design of the study. Interestingly, a prospective study in a specialized psychosocial care clinic in diabetes showed that there was greater probability of patients with high grades of diabetes-related distress of engaging with the psychosocial interventions provided and achieving mastery of their diabetes through self-care behaviors in addition to improving their diabetes-related distress.[49] Therefore, the integration of diabetes self-management education programs in Egypt's PHC settings can be effective in improving HbA1c level, BMI, comorbidities (e.g. lipid profile and blood pressure),[50] and symptoms of distress.[51]

The study findings revealed that all subdomains of the PAID scale were weakly but significantly correlated with glycemic control, particularly with the domain of emotional problems. In fact, the emotional impact of diabetes on patients was the first domain to be recognized as an important construct of diabetes distress and was later expanded to include negative emotional reactions toward different aspects of daily living as opposed to diabetic patients' coping capability.[52] The significant, but weak correlation of other subdomains reflects the different contributions of each aspect toward diabetes distress and glycemic control, which might vary over time in the same patient and between individual patients. This finding also highlights the importance of addressing the impact of treatment on diabetic patients by providing effective, safe, and tolerable medications, and utilizing community and social services for a targeted holistic approach of diabetes distress. Earlier research also supported the importance of including the emotional problem domain of the PAID scale as an integral part in shorter forms of the scale, such as the five-item PAID, and one-item PAID.[53] Based on these findings, primary care physicians should be encouraged to implement the use of PAID scale in their routine care for diabetic patients. The Arabic translation of the PAID-5 scale is currently available and can be used for Arabic-speaking diabetic patients treated in PHC settings.[54]

Bivariate analysis showed that several demographic and clinical factors were significantly related to both glycemic control and the severity of diabetes distress. However, the multivariate analysis did not confirm this association raising the possibility of confounding factors. The interaction between social determinants of health and clinical outcomes such as glycemic control and diabetes distress, are to be likely complex, with one factor interacting with the other. However, seeing that the study was a cross-sectional design, it would be difficult to establish a temporal association among the study variables. Nevertheless, the study findings imply that being obese, having multiple morbidities and suffering from diabetes-related distress were predictors of poor glycemic control.

The authors acknowledge several limitations to the study. First, causality cannot be determined because of the cross-sectional study design. Second, baseline information on glycemic control were not available, so we could not assess the effect of the COVID-19 pandemic on the studied outcomes. Third, part of the collected data was based on self-reports, which makes social-desirability bias possible. However, this was partially accounted for by using an Arabic-validated scale to evaluate for diabetes-related distress and by collecting objective laboratory data. Despite these limitations, the study findings provide evidence-based guidance for the planning of future interventional programs to improve glycemic control in primary care patients with T2DM.

## Conclusion

Diabetes-related distress, multiple comorbidities, and obesity were significantly associated with worse glycemic control in Egyptian primary care patients with T2DM during the COVID-19 pandemic. Family physicians should actively screen for and manage patients with diabetes distress in a patient-centered approach. Utilizing a multidisciplinary team to combat obesity and manage comorbidities and diabetes distress could be helpful for patients with poor glycemic control.

### Acknowledgment

The authors acknowledge all primary care patients with T2DM who had participated in this study, as well as the administrative authorities of the primary care units where the study was conducted.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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