HK J Paediatr (new series) 2026;**31**:69-79

Original Article

Depressive Symptoms in Children with Diabetes Mellitus and Their Associating Factors: An Observational Study in a Single Centre in Hong Kong

CSY ***Chan***, ACC ***Fu***

Abstract

Objectives: To evaluate the prevalence and severity of depressive symptoms in paediatric diabetes mellitus (PDM), and identify factors associated with the development of depressive symptoms. ***Research Design and Method:*** The Patient Health Questionnaire-9 (PHQ-9) was completed by 90 paediatric patients with diabetes from year 2020-2022 who received regular follow up in Princess Margaret Hospital. Data including demographics and characteristics of patients were collected and analysed. ***Results:*** Sixteen out of 90 patients (17.8%, 95% CI: 9.9%-25.7%) reported moderate or above severity of depressive symptoms as defined by a PHQ-9 score ≥10. 13.7% and 12.2% of patients had a PHQ-9 score ≥10 in year 2021 and 2022 respectively, compared to none in year 2020. Higher body mass index (p=0.048), presence of diabetic-related complications (p=0.049), greater number of hospital admissions related to poor diabetic control (p=0.003), poor family dynamics with parental marital conflicts (p=0.002) and parent-child relationship problems (p<0.001), known psychological or behavioural problems (p<0.001) were identified as factors associated with increased risk for developing depressive symptoms. Patients who used continuous glucose monitoring system (p=0.014) and had more frequent blood sugar monitoring (p=0.002) were associated with less risk for developing depressive symptoms. A higher HbA1c value (p=0.023) was found to be positively related to depressive symptoms in the subgroup analysis for patients with type 1 DM but not type 2. ***Conclusion:*** Depressive symptoms are common in PDM patients. Regular mental health screening by using a validated self-reported questionnaire is a cost-effective and reliable method that should be advocated in all eligible PDM patients.

Key words Depressive symptoms; Paediatric diabetes mellitus; PHQ-9

Introduction

Paediatric diabetes mellitus (PDM) in Hong Kong is of increasing prevalence over the past decade. The incidence of type 1 diabetes mellitus (DM) rose from 2.2 per 100,000 person/year between the period 1997-2007 to 4.3 per 100,000 person/year between the period 2008-2017,[1] meanwhile that of type 2 DM increased from 1.27 per 100,000 person/year in 1997-2007 to 3.42 per 100,000 person/year in 2008-2017.[2] DM is a life-long endocrine illness that requires high patient effort and compliance over diet, medications including insulin injections, regular blood sugar level monitoring and frequent hospital follow-ups. Debilitating acute and chronic complications occur with poor glycaemic control, including diabetic ketoacidosis, hypoglycaemia, diabetic nephropathy, neuropathy and retinopathy.

According to the SEARCH for Diabetes in Youth Study involving more than 2600 diabetic youth aged 10-21 in the United States, up to 14% of DM adolescents reported mild

Department of Paediatrics and Adolescent Medicine, Princess Margaret Hospital, 2-10 Princess Margaret Hospital Road, Kwai Chung, N.T., Hong Kong SAR, China

CSY **Chan** (陳倩怡) *MBBS(HK), MRCPCH, FHKAM(Paediatrics)*
ACC **Fu** (傅振祥) *MBChB, FHKAM(Paediatrics),MEDM(CUHK)*

Correspondence to: Dr CSY **Chan**
Email: chansinyicindy524@gmail.com

Received July 21, 2024

depressed mood, while 8.6% reported moderate to severe depressed mood.[3] This percentage is higher compared to the adult DM population in which only 8.3% of them were quoted to suffer from depression.[4] The prevalence of depression in DM adolescents is also much higher compared to non-diabetic adolescents, as only 1.1% of adolescents aged 10-14 and 2.8% aged 15-19 suffered from depression in the general population as reported by the WHO in 2021.[5] Psychological stress and depression can result from difficulty managing multiple daily insulin injections, fluctuating blood sugar levels or morbidity resulting from complications. Simultaneously depression in patients with diabetes also impacts adherence to diabetes care.[6]

Mental health screening in adolescents with diabetes, including depression, is therefore a standard of medical care in diabetes according to latest recommendations.[7] There are validated tools but not usually included in our local metabolic risk assessment module designed for diabetes complication screening.[8]

Regular screening for depressive symptoms in PDM patients allows early identification of patients who are at risk of depression. Timely psychological intervention will lead to better diabetic control and the overall well-being in these patients.

Research Design and Methods

Participants

Our study site, Princess Margaret Hospital, is one of the paediatric endocrinology centres in Hong Kong managing more than 150 PDM patients per year over the past 15 years, out of less than 900 PDM patients across the territory at the time of this manuscript writing.

We aim to conduct an observational study on the prevalence of depressive symptoms in PDM patients and to identify factors associated with depressive symptoms in the Department of Paediatrics and Adolescent Medicine, Princess Margaret Hospital, between the period 1 January 2020 to 31 December 2022.

Eligible participants for this study encompassed individuals diagnosed with any forms of diabetes mellitus, as delineated by criteria including HbA1c ≥6.5%, a 2-hour oral glucose tolerance test glucose level ≥11.1 mmol/L, or a random glucose level ≥7 mmol/L, along with the presence of classical symptoms of diabetes or confirmation on two or more occasions, even in the absence of symptoms. Inclusion criteria stipulated that participants should have undergone regular follow-up at Princess Margaret Hospital, be aged 10 years or older, possessed the ability to comprehend either simple Chinese or English, and have received a standard mainstream school education. Individuals with documented mental retardation, as evidenced in any medical record or those enrolled in special education programs, were excluded due to their compromised capacity to comprehend and complete the Patient Health Questionnaire-9 (PHQ-9) questionnaire.

The investigators have obtained the hospital Institutional Review Board review and approval prior to conducting the study.

Data Collection

The PHQ-9 served as the instrument for evaluating the severity of depressive symptoms among eligible patients. This validated and efficacious self-reported tool is recommended by the American Diabetes Association and the U.S. Preventive Services Task Force for screening depression within the general population, encompassing children and adolescents. The PHQ-9 is a 9-item questionnaire meticulously designed in accordance with the DSM-5 criteria for major depression. Previous studies have substantiated the utility of employing a cut-off score of 11 in the PHQ-9 for screening depression in adolescents, demonstrating a sensitivity of 89.5% and specificity of 77.5%.[9] Our centre uses a cut-off score of 10 or above for screening moderate to severe depression with reference to universal adult guidelines.[10]

Since 2020, the PHQ-9 questionnaire has been administered annually to all PDM patients aged 10 years or above during their scheduled follow-up appointments in our clinic specifically for the screening of diabetes-related complications. The completed questionnaires were gathered and presented to clinicians for score calculation. A total score equal to or exceeding 10 is categorised as indicative of moderate depression, while a score of 15 or higher is deemed as severe depression. Patients scoring 10 or above are proactively referred to clinical psychologists for comprehensive assessment and counselling, provided they have not previously availed themselves of mental health services. These individuals would also undergo additional evaluations by clinicians during subsequent follow-up sessions to determine the necessity of a referral to a child psychiatrist.

Demographics, clinical and laboratory data from PDM patients who had completed the PHQ-9 questionnaire over the period 2020-2022 were gathered from the Clinical Management System, which included age at diagnosis,

duration of diabetes, gender, ethnicity, body mass index (BMI), type of diabetes, treatment regimen received, frequency and mode of blood glucose monitoring, HbA1c values, number of hospital admissions related to poor glycaemic control, presence of diabetic-related complications, socioeconomic state as defined by housing status and eligibility for comprehensive social security allowances, family dynamics included parental marital relationship and parent-child relationship conflicts, family history of psychiatric illnesses, presence of known behavioural or psychological problems and their annual PHQ-9 scores.

Primary and Secondary Outcome

The primary outcome under investigation is the prevalence of depressive symptoms in PDM patients, utilising the PHQ-9 questionnaire as the designated screening tool. Individuals reporting a PHQ-9 score equal to or exceeding 10 on one or more questionnaires spanning the years 2020 to 2022 will be categorised into the "depressive symptoms" group for subsequent analysis. Secondary outcomes encompass the identification of factors correlated with depressive symptoms in PDM patients, as well as the determination of the definitive psychiatric diagnoses for patients registering a PHQ-9 score of 10 or above.

Statistical Analysis

To compare statistical differences between groups, independent-sample t test was used for parametric continuous variables, while Mann-Whitney U test was used for non-parametric continuous variables. Pearson Chi-square test or Fisher's Exact test were used for analysing categorical data. Multiple logistic regression analysis (forward elimination procedure) was performed by including factors found to be significant at the level of $p<0.1$ in the univariate analysis.

Descriptive results were presented by N (%) for categorical variables. Continuous variables were presented by Mean±SD and Median with Interquartile range for parametric and non-parametric variables respectively.

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk. NY, USA computer software). A p-value of <0.05 was considered statistically significant.

Results

Patient Demographics, Characteristics and Prevalence of Depressive Symptoms

The study encompassed a cohort of 90 patients, with 46 (51.1%) identified as male and 44 (48.9%) as female. Of the participants, 48 (53.3%) were diagnosed with type 1 DM and 40 (44.4%) were diagnosed with type 2 DM. One patient each (1.1%) was diagnosed with neonatal DM and Maturity Onset Diabetes of Youth respectively. The majority of the cohort, comprising 82 individuals (91.1%) were identified as Chinese.

A total of 16 out of 90 patients (17.8%, 95% CI: 9.9%-25.7%) disclosed the presence of moderate or more severe depressive symptoms, as discerned through a PHQ-9 score of ≥10. As delineated in Table 1 and Figure 1, the substantial majority of patients, constituting 90%, exhibited either none or minimal depressive symptoms in the year 2020 with none of the participants reported moderate or more severe depressive symptoms. However, an elevated proportion of patients indicated moderate or more severe symptoms in the subsequent years, with percentages of 13.7% in 2021 and 12.2% in 2022, as illustrated in the data. Notably, the statistics presented in Table 1 and Figure 1 reflect the actual number of patients

Table 1 Prevalence of paediatric diabetes mellitus patients with depressive symptoms in year 2020-2022

Severity of depressive symptoms (PHQ-9 score)	Year 2022 (N=90) N(%)	Year 2021 (N=58) N(%)	Year 2020 (N=10) N(%)
No (0)	17 (18.9)	13 (22.4)	1 (10.0)
Minimal (1-4)	38 (42.2)	21 (36.2)	8 (80.0)
Mild (5-9)	24 (26.7)	16 (27.6)	1 (10.0)
Moderate (10-14)	6 (6.7)	6 (10.3)	0 (0.0)
Moderately severe (15-19)	3 (3.3)	2 (3.4)	0 (0.0)
Severe (20-27)	2 (2.2)	0 (0.0)	0 (0.0)

Overall 16/90=17.8% (95% CI: 9.9%-25.7%)

PHQ-9: Patient Health Questionnaire-9

reporting depressive symptoms, as indicated by their annual PHQ-9 scores. Patients are classified in the "moderate to severe depressive symptoms" group if they reported a PHQ-9 score of 10 or higher at least once during the 3-year study period. Consequently, the number of patients reporting depressive symptoms presented each year in Table 1 and Figure 1 may overlap across the three years if they recorded a high PHQ-9 score greater than once during this period.

Factors Associated with Depressive Symptoms

Baseline demographics and characteristics of patients, stratified by the presence or absence of depressive symptoms as defined by a PHQ-9 score ≥10 and <10, respectively, are succinctly presented in Table 2a. Patients with elevated BMI (p=0.048), a higher frequency of hospital admissions linked to poor diabetic control (p=0.003), the presence of diabetic-related complications including microalbuminuria, diabetic neuropathy or retinopathy (p=0.049), parental marital conflicts (p=0.002), parent-child relationship problems (p<0.001), and documented psychological or behavioural problems (p<0.001) demonstrated a greater propensity to develop depressive symptoms. Conversely, the utilisation of a continuous glucose monitoring system (CGMS) (p=0.014) and more frequent blood sugar monitoring (p=0.002) emerged as protective factors against the development of depressive symptoms.

Table 2b presented the result of logistic regression. The model was applied to identify significant variables associated with depressive symptoms. Results showed that patients with known psychological or behavioural problems (OR: 6.922, 95% CI: 1.688 to 28.380) and parent-child relationship problems (OR: 15.067, 95% CI: 3.292 to 68.962) were more likely to develop depressive symptoms

Subgroup Analyses for Type 1 and Type 2 DM Patients

In the subgroup analysis focusing on patients with type 1 DM, as illustrated in Table 3a, a discernible association was observed. Patients exhibiting higher HbA1c values (p=0.023), a heightened frequency of acute hospital admissions linked to poor diabetic control (p=0.044), documented psychological or behavioural issues (p=0.033), and instances of parental-child relationship problems (p=0.001) were found to be more predisposed to reporting depressive symptoms. In alignment with the overall analysis, it was noted that patients utilising CGMS (p=0.034) and engaging in more frequent blood sugar monitoring (p=0.003) displayed a reduced likelihood of developing depressive symptoms.

Logistic regression model as shown in Table 3b for patients with type 1 DM showed similar results, with known psychological behavioural problems (OR 25.263, 95% CI 1.784-357.819) and parent-child relationship

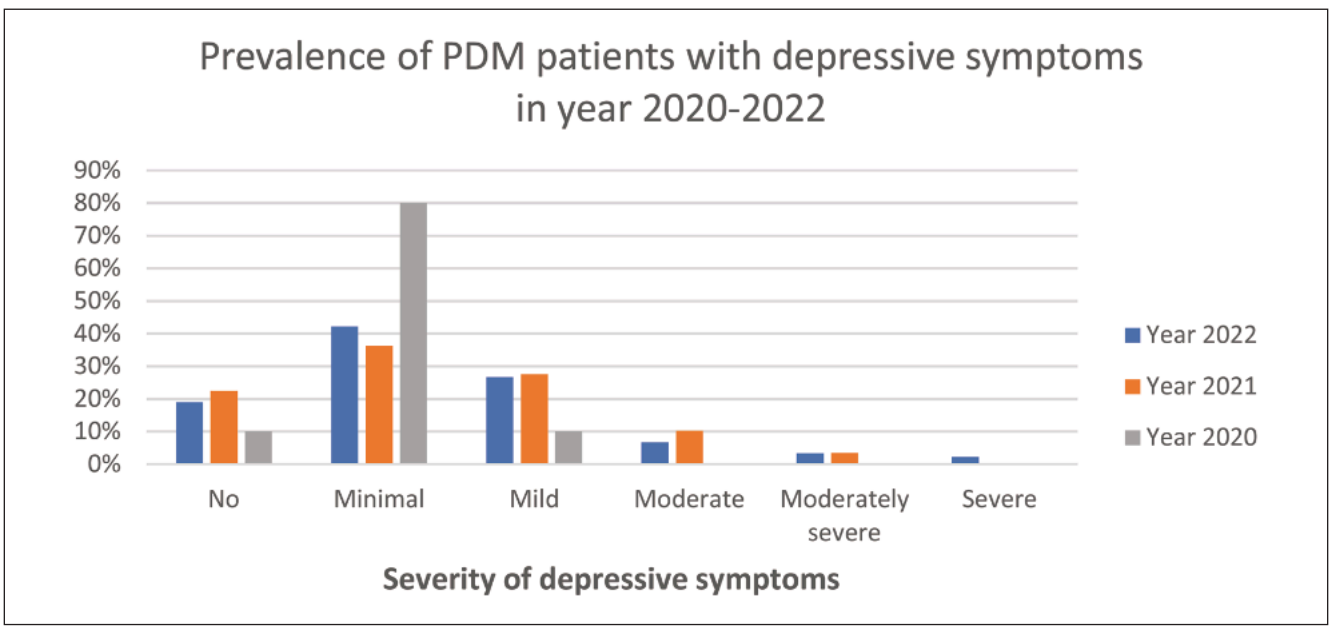

Figure 1. Prevalence of paediatric diabetes mellitus (PDM) patients with depressive symptoms in year 2020-2022.

Table 2a Demographics and characteristics for all patients (N=90)

	Overall (N=90)	PHQ-9 score <10 (N=74)	PHQ-9 score ≥10 (N=16)	
	N (%) / Mean±SD / Median (IQR)	N (%) / Mean±SD / Median (IQR)	N (%) / Mean±SD / Median (IQR)	P-value
Gender				0.080
Female	44 (48.9%)	33 (44.6%)	11 (68.8%)	
Male	46 (51.1%)	41 (55.4%)	5 (31.3%)	
Type of diabetes mellitus (DM)				0.602
Neonatal	1 (1.1%)	1 (1.4%)	0 (0.0%)	
Type 1 DM	48 (53.3%)	41 (55.4%)	7 (43.8%)	
Type 2 DM	40 (44.4%)	31 (41.9%)	9 (56.3%)	
Maturity Onset Diabetes of Youth	1 (1.1%)	1 (1.4%)	0 (0.0%)	
Age at diagnosis	10.91± 4.66	10.75±4.69	11.64±4.59	0.490
Duration of diabetes (years)	6.86 (1.09-10.62)	6.86 (4.37-10.62)	6.77 (2.66-11.37)	0.681
Ethnicity				0.629
Non-Chinese	8 (8.9%)	6 (8.1%)	2 (12.5%)	
Chinese	82 (91.1%)	68 (91.9%)	14 (87.5%)	
Body mass index	24.30 (21.26-30.51)	23.35 (21.15-29.66)	28.49 (23.77-33.60)	*0.048
Housing type				0.427
Public housing	49 (54.4%)	38 (51.4%)	11 (68.8%)	
Home Ownership Scheme flat	4 (4.4%)	4 (5.4%)	0 (0.0%)	
Private flat	37 (41.1%)	32 (43.2%)	5 (31.3%)	
Comprehensive Social Security Assistance			0.684	
No	80 (88.9%)	65 (87.8%)	15 (93.8%)	
Yes	10 (11.1%)	9 (12.2%)	1 (6.3%)	
HbA1c value	7.20 (6.3-8.45)	7.15 (6.30-8.10)	8.75 (6.53-10.40)	0.057
Use of Continuous Glucose Monitoring System (CGMS)			*0.014	
No	61 (67.8%)	46 (62.2%)	15 (93.8%)	
Yes	29 (32.2%)	28 (37.8%)	1 (6.3%)	
Frequency of blood sugar monitoring (times per day)			*0.002	
None or < once per day	19 (21.1%)	11 (14.9%)	8 (50.0%)	
1	6 (6.7%)	6 (8.1%)	0 (0.0%)	
2	17 (18.9%)	12 (16.2%)	5 (31.3%)	
3	8 (8.9%)	6 (8.1%)	2 (12.5%)	
≥4	11 (12.2%)	11 (14.9%)	0 (0.0%)	
On CGMS	29 (32.2%)	28 (37.8%)	1 (6.3%)	
Treatment				0.285
Lifestyle modification	5 (5.6%)	4 (5.4%)	1 (6.3%)	
Oral medications only	26 (28.9%)	22 (29.7%)	4 (25.0%)	
Oral medications + once daily long-acting insulin	5 (5.6%)	4 (5.4%)	1 (6.3%)	
Multi-daily doses of insulin (MDI)	44 (48.9%)	38 (51.4%)	6 (37.5%)	
Oral medications + MDI	6 (6.7%)	3 (4.1%)	3 (18.8%)	
Insulin pump	4 (4.4%)	3 (4.1%)	1 (6.3%)	
Presence of diabetic-related complications				*0.049
No	69 (76.7%)	60 (81.1%)	9 (56.3%)	
Yes	21 (23.3%)	14 (18.9%)	7 (43.8%)	
Complications				0.087
No complications	69 (76.7%)	60 (81.1%)	9 (56.3%)	
Microalbuminuria	18 (20.0%)	12 (16.2%)	6 (37.5%)	
Retinopathy	3 (3.3%)	2 (2.7%)	1 (6.3%)	
Neuropathy	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Number of acute hospital admissions related to poor diabetic control	0 (0-1)	0 (0-1)	1 (0-3)	*0.003
Parental marital relationship				*0.002
Normal	80 (88.9%)	70 (94.6%)	10 (62.5%)	
Divorced / Dispute	10 (11.1%)	4 (5.4%)	6 (37.5%)	
Family history of psychiatric problems				0.448
No	87 (96.7%)	72 (97.3%)	15 (93.8%)	
Yes	3 (3.3%)	2 (2.7%)	1 (6.3%)	
Known psychological or behavioural problems				*<0.001
No	74 (82.2%)	66 (89.2%)	8 (50.0%)	
Yes	16 (17.8%)	8 (10.8%)	8 (50.0%)	
Parent-child relationship problems				*<0.001
No	78 (86.7%)	70 (94.6%)	8 (50.0%)	
Yes	12 (13.3%)	4 (5.4%)	8 (50.0%)	

*p<0.05. Continuous variables were analysed by independent-samples t test or Mann-Whitney U test. Categorical variables were analysed by Pearson Chi-square test or Fisher's Exact test.

problems (OR 114.424, 95% CI 5.797-2258.661) being factors associated with depressive symptoms.

In the subgroup analysis for patients with type 2 DM as illustrated in Table 4a, number of acute hospital admissions related to poor diabetic control (p=0.001), poor parental marital relationship (p=0.006), known psychological or behavioural problems (p=0.029) and parental-child relationship problems (p=0.034) are associated with depressive symptoms. Unlike that in type 1 DM, HbA1c value (p=0.144), use of CGMS (p=1) and frequency of blood sugar monitoring (p=0.578) did not result in statistical significance in patients with type 2 DM.

Logistic regression model for patients with type 2 DM as shown in Table 4b showed poor parental marital relationships (OR 44.702%, 95% CI 2.744-728.173, p=0.008) and number of acute hospital admissions related to poor diabetic control (OR 7.285, 95% CI 1.610-32.960, p=0.010) being factors associated with developing depressive symptoms.

Outcome in Patients Screened Positive for Depressive Symptoms

Among the 16 patients with a PHQ-9 score of ≥10, 13 were proactively referred for assessment by either clinical psychologists or child psychiatrists, while 3 opted to decline the referral. Notably, 5 patients (31.3%) were subsequently diagnosed with either dysthymia or depression. For the remaining individuals, one was diagnosed with adjustment difficulty towards illness, another with features of anxiety, and a third with oppositional defiant disorder and attention deficit hyperactivity disorder. At the time of manuscript writing, the remaining patients had not received formal psychiatric diagnoses; however, ongoing follow-up by clinical psychologists or child psychiatrists was planned. Among those referred, the average duration from referral to first assessment by clinical psychologists and child psychiatrists was approximately 8-10 weeks and 3-6 months respectively depending on service availability. This potential delay in mental health assessment may contribute to suboptimal diabetic management due to persistent emotional distress. Among the 5 patients diagnosed with dysthymia or depression, 3 were initiated on antidepressant medications and continued to receive regular psychiatric follow-up care.

Discussion

Similar studies have been published in various countries, yet this is the first study ever done in Hong Kong addressing mental health in PDM patients. This provides novel local data for an ethnically Chinese paediatric population, incorporating a validated screening tool (PHQ-9) into a clinical diabetes assessment framework. Furthermore, we identified culturally relevant psychosocial correlates, including family dynamics such as parent–child relationship problems and marital conflicts, which have not been explored in previous regional studies. We found that 17.8% of PDM patients in our unit reported moderate-or above severity of depressive symptoms, which is similar to figures quoted in the SEARCH for Diabetes in Youth Study in U.S.A. This indicates that diabetic children are prone to developing depressive symptoms worldwide. We also noticed that a larger proportion of patients reported moderate or above severity of depressive symptoms in 2021 and 2022 compared to 2020. A possible postulation for this phenomenon could be attributed to the COVID pandemic, when being home-bound could lead to increased family conflicts, and a lack of physical activity could lead to overweight and subsequently worsen diabetic control.

We identified several factors associated with depressive symptoms. Risk factors including number of hospital admissions related to poor diabetic control, family conflicts with poor parental marital relationship and parent-child relationship problems, and patients with known psychological and behavioural problems were consistent in both overall and subgroup analyses. Patients with higher BMI and the presence of diabetic-related complications were identified as a risk factor in the overall analysis but not in subgroups, while higher HbA1c value was identified as a risk factor in patients with T1DM but not type 2. Certain protective factors for depressive

Table 2b Logistic regression model for depressive symptoms in all patients

Variables	OR (95% CI of OR)	P-value
Known psychological behavioural problems	6.922 (1.688-28.380)	0.007
Parent-child relationship problems	15.067 (3.292-68.962)	<0.001

OR: Odds Ratio; CI: Confidence interval.

Table 3a Demographics and characteristics for patients with type 1 diabetes mellitus

	PHQ-9 score <10 (N=41) N (%) / Mean±SD / Median (IQR)	PHQ-9 score ≥10 (N=7) N (%) / Mean±SD / Median (IQR)	P-value
Gender			0.106
Female	20 (48.8%)	6 (85.7%)	
Male	21 (51.2%)	1 (14.3%)	
Age at diagnosis	8.05±3.99	8.02±4.19	0.986
Duration of diabetes (years)	10.03 (6.86-13.31)	11.72 (6.06-15.98)	0.715
Ethnicity			1.000
Non-Chinese	6 (14.6%)	1 (14.3%)	
Chinese	35 (85.4%)	6 (85.7%)	
Body mass index	22.01 (19.42-23.58)	23.22 (19.32-27.42)	0.405
Housing type			0.340
Public housing	17 (41.5%)	5 (71.4%)	
Home Ownership Scheme flat	1 (2.4%)	0 (0.0%)	
Private flat	23 (56.1%)	2 (28.6%)	
Comprehensive Social Security Assistance			0.562
No	37 (90.2%)	6 (85.7%)	
Yes	4 (9.8%)	1 (14.3%)	
HbA1c value	7.90 (7.15-8.65)	10.30 (8.70-10.40)	*0.023
Use of Continuous Glucose Monitoring System (CGMS)			*0.034
No	15 (36.6%)	6 (85.7%)	
Yes	26 (63.4%)	1 (14.3%)	
Frequency of blood sugar monitoring (times per day)			*0.003
None or < once per day	1 (2.4%)	3 (42.9%)	
1	1 (2.4%)	0 (0.0%)	
2	2 (4.9%)	1 (14.3%)	
3	4 (9.8%)	2 (28.6%)	
≥4	7 (17.1%)	0 (0.0%)	
On CGMS	26 (63.4%)	1 (14.3%)	
Treatment			0.480
Multiple daily doses of insulin	38 (92.7%)	6 (85.7%)	
Insulin pump	3 (7.3%)	1 (14.3%)	
Presence of diabetic-related complications			0.601
No	34 (82.9%)	5 (71.4%)	
Yes	7 (17.1%)	2 (28.6%)	
Complications			0.317
No complications	34 (82.9%)	5 (71.4%)	
Microalbuminuria	6 (14.6%)	1 (14.3%)	
Retinopathy	1 (2.4%)	1 (14.3%)	
Neuropathy	0 (0.0%)	0 (0.0%)	
Number of hospital admissions related to poor diabetic control	1.00 (0.00-1.00)	3.00 (0.00-6.00)	*0.044
Parental marital relationship			0.148
Normal	38 (92.7%)	5 (71.4%)	
Divorced / Dispute	3 (7.3%)	2 (28.6%)	
Family history of psychiatric problems			1.000
No	39 (95.1%)	7 (100.0%)	
Yes	2 (4.9%)	0 (0.0%)	
Known psychological or behavioural problems			*0.033
No	38 (92.7%)	4 (57.1%)	
Yes	3 (7.3%)	3 (42.9%)	
Parent-child relationship problems			*0.001
No	40 (97.6%)	3 (42.9%)	
Yes	1 (2.4%)	4 (57.1%)	

*p<0.05. Continuous variables were analysed by independent-samples t test or Mann-Whitney U test. Categorical variables were analysed by Pearson Chi-square test or Fisher's Exact test.
PHQ-9: Patient Health Questionnaire-9; SD: Standard deviation; IQR: Interquartile range

symptoms were also identified in the overall and subgroup analysis for patients with type 1 DM but not type 2, including use of CGMS and more frequent blood sugar monitoring.

We acknowledge that certain associations identified, such as elevated HbA1c, poor diabetic control, and greater number of hospital admissions, may act as confounders rather than independent risk factors. These factors may reflect the bidirectional relationship between depression and diabetes management: depressive symptoms can reduce treatment adherence, while poor glycaemic control and recurrent hospitalisations can exacerbate emotional distress. Similarly, poor family dynamics and parent–child conflicts likely represent overlapping psychosocial pathways affecting both mood and diabetic outcomes. We have clarified this interpretation in the discussion to avoid overemphasis on duplicative clinical implications.

In a study published by Hood from the Boston in Diabetes Care 2006[11] using the Children's Depression Inventory (CDI) questionnaire as a screening tool for depressive symptoms in 145 PDM patients and their parents, female gender, less frequent blood sugar monitoring, higher HbA1c values, higher diabetic-related parent and youth conflicts were found to be factors associated with depressive symptoms. In the SEARCH for diabetes Youth study published in 2006 involving 2672 youths with diabetes,[3] the Centre for Epidemiologic Studies Depression Scale was used for screening, and depressed mood was found to be more common in males with type 2 DM and in those with higher mean HbA1c and frequency of AED visits due to diabetes. In another study published by Janet Silverstein from Florida in Diabetes Care 2015 using CDI as screening questionnaire,[12] depressive symptoms were identified in 13% of type 1 DM patients and 22% of type 2 DM patients, and were associated with lower family income and obesity in type 1 DM patients. A. Picozzi published a study evaluating relationship between depression and glycaemic control in adolescent diabetics in 2019 by using the PHQ-9 questionnaire,[13] female patients, those with longer duration of diabetes, younger age at diagnosis and higher HbA1c were found more likely to develop depression.

Comparing our study results with various similar studies, we can see conflicting results and high heterogeneity in factors associated with depressive symptoms in PDM patients. This can be due to variations in cultural background, ethnicities and healthcare systems in different countries. Despite the above, few factors associated with depressive symptoms quoted above are consistent with findings in our study, including higher HbA1c values, obesity, less frequent blood sugar monitoring, non-CGMS users, family conflicts and number of hospital admissions related to poor diabetic control. Female gender was found to have borderline statistical significance (p=0.08) in association with increased risk of depressive symptoms in our study.

Elevated HbA1c levels signify suboptimal glycaemic control, and the relationship between HbA1c and depression is bidirectional. On one hand, individuals experiencing depressive symptoms may exhibit reduced motivation for adhering to dietary and exercise regimens, resulting in suboptimal glycaemic control. On the other hand, if a patient contends with poor glycaemic control, they face an augmented risk of developing complications associated with hyperglycaemia, such as diabetic ketoacidosis. This heightened vulnerability to complications could contribute to an increased frequency of hospital admissions and disrupt the patient's normal lifestyle, consequently elevating the risk of developing depressive symptoms. Presence of long term diabetic-related complications is also identified as a factor associated with increased risk of depressive symptoms in the overall analysis of our study, which is supported by multiple studies suggesting that elevated HbA1c value directly corelates with the developing of microvascular complications.[14-16]

Obesity is also shown to be related to depression by sharing similar genetic component involved in both pathologies, including glucocorticoid, leptin and dopamine receptor genes.[17] Pro-inflammatory cytokines produced from chronic stress would induce inflammation and accumulation of fatty tissue, while inflammatory cytokines produced from adipose tissue could induce synaptic changes and neurogenesis, in turn causing depression.[18]

Table 3b Logistic regression model for depressive symptoms in patients with type 1 diabetes mellitus

Variables	OR (95% CI of OR)	P-value
Known psychological behavioural problems	25.263 (1.784-357.819)	0.017
Parent-child relationship problems	114.424 (5.797-2258.661)	0.002

OR: Odds Ratio; CI: Confidence interval.

Table 4a Demographics and characteristics for patients with type 2 diabetes mellitus

	PHQ-9 score <10 (N=41) N (%) / Mean±SD / Median (IQR)	PHQ-9 score ≥10 (N=7) N (%) / Mean±SD / Median (IQR)	P-value
Gender			0.456
Female	12 (38.7%)	5 (55.6%)	
Male	19 (61.3%)	4 (44.4%)	
Age at diagnosis	14.64±1.80	14.46±2.42	0.807
Duration of diabetes (years)	4.12 (2.41-5.36)	3.98 (2.05-7.24)	0.833
Ethnicity			0.225
Non-Chinese	0 (0.0%)	1 (11.1%)	
Chinese	31 (100.0%)	8 (88.9%)	
Body mass index	30.43 (25.66-33.48)	32.75 (27.58-39.50)	0.201
Housing type			1.000
Public housing	20 (64.5%)	6 (66.7%)	
Home Ownership Scheme flat	3 (9.7%)	0 (0.0%)	
Private flat	8 (25.8%)	3 (33.3%)	
Comprehensive Social Security Assistance			0.557
No	27 (87.1%)	9 (100.0%)	
Yes	4 (12.9%)	0 (0.0%)	
HbA1c value	6.30 (5.70-6.80)	6.60 (6.05-9.90)	0.144
Use of Continuous Glucose Monitoring System (CGMS)			1.000
No	29 (93.5%)	9 (100.0%)	
Yes	2 (6.5%)	0 (0.0%)	
Frequency of blood sugar monitoring (times per day)			0.578
None or < once per day	10 (32.3%)	5 (55.6%)	
1	5 (16.1%)	0 (0.0%)	
2	9 (29.0%)	4 (44.4%)	
3	1 (3.2%)	0 (0.0%)	
≥4	4 (12.9%)	0 (0.0%)	
Use of CGMS	2 (6.5%)	0 (0.0%)	
Treatment			0.235
Lifestyle modification	4 (12.9%)	1 (11.1%)	
Oral medications only	22 (71.0%)	4 (44.4%)	
Oral medications + once daily long-acting insulin	2 (6.5%)	1 (11.1%)	
Oral medications + multiple daily doses of insulin	3 (9.7%)	3 (33.3%)	
Presence of diabetic-related complications			0.097
No	24 (77.4%)	4 (44.4%)	
Yes	7 (22.6%)	5 (55.6%)	
Complications			0.108
No complications	24 (77.4%)	4 (44.4%)	
Microalbuminuria	6 (19.4%)	5 (55.6%)	
Retinopathy	1 (3.2%)	0 (0.0%)	
Neuropathy	0 (0.0%)	0 (0.0%)	
Number of hospital admissions related to poor diabetic control	0.00 (0.00-0.00)	1.00 (0.00-2.00)	*0.001
Parental marital relationship			*0.006
Normal	30 (96.8%)	5 (55.6%)	
Divorced / Dispute	1 (3.2%)	4 (44.4%)	
Family history of psychiatric problems			0.225
No	31 (100.0%)	8 (88.9%)	
Yes	0 (0.0%)	1 (11.1%)	
Known psychological or behavioural problems			*0.029
No	26 (83.9%)	4 (44.4%)	
Yes	5 (16.1%)	5 (55.6%)	
Parent-child relationship problems			*0.034
No	28 (90.3%)	5 (55.6%)	
Yes	3 (9.7%)	4 (44.4%)	

*p<0.05. Continuous variables were analysed by independent-samples t test or Mann-Whitney U test. Categorical variables were analysed by Pearson Chi-square test or Fisher's Exact test.

PHQ-9: Patient Health Questionnaire-9; SD: Standard deviation; IQR: Interquartile range

Environmental factors also play a role as children with obesity might be stigmatised or teased by peers due to their appearances, leading to depressive symptoms. Our study result supported the postulation that obesity patients with higher BMI are associated with more depressive symptoms thus creating negative impact on diabetic control be they type 1 or type 2.

Family members play a crucial role in providing support and guidance to their children with diabetes. Concepts like carbohydrate counting, sick day rules and managing multiple daily injections are often too complicated for paediatric patients to handle alone. Family conflicts, be they marital conflicts or parent-child relationship problems, would induce additional stress to children hence lead to depressive symptoms.

Use of CGMS and more frequent blood sugar monitoring are protective factors against depressive symptoms. Continuous monitoring of blood sugar levels allow patients to have an all-time overview of their sugar profiles and gain better understanding in the fluctuations of their sugar profiles, thereby preventing prolonged unrecognised hypoglycaemia or hyperglycaemia that could lead to discomfort and long term comorbidities. CGMS also reduces the need of frequent finger-pricking which could lead to pain in children. Frequent blood sugar monitoring, similarly, allows patients to have a better picture on their daily blood sugar levels, hence improving glycaemic control, reducing number of hospital admissions and complications in long run.

One of the limitations in our study is the relatively small sample size and short duration of study period. There was found to be variations concerning factors associated with depressive symptoms in the overall and subgroup analyses. Screening for depressive symptoms was only implemented in our centre since the year 2020, and it is not yet a routine practice to screen for depressive symptoms in PDM patients in other hospitals in Hong Kong. Patient sample in our study was therefore limited to a single centre. A longer study duration and extending routine depression screening to all hospital units in Hong Kong would allow a more comprehensive data collection and analysis to better evaluate and understand depression in PDM patients. Other limitations included the majority of patients being Asians with lack of patients with other ethnicities, and a lack of assessment on the effect of depression treatment on glycaemic control. Also, with the study being conducted mainly during the COVID pandemic, more children, even those without diabetes, might report depressive symptoms related to the pandemic itself, thereby overestimating the prevalence of depressive symptoms in PDM patients. Extending the study to a period after the pandemic would help to provide more relevant data for evaluation.

Conclusion

Depressive symptoms are common in paediatric patients with diabetes mellitus. Psychological well-being in this group of patients is usually under-addressed by clinicians or healthcare providers. Our findings provide novel evidence in a local Hong Kong population and highlight the interrelationship between glycaemic control, family dynamics, and mental health. Complexity, knowledge requirements in disease management and its long term complications are often creating more distress and frustrations to both patients and their carers than expected. Unrecognised depression in PDM patients would worsen diabetic control and increase their risks for developing diabetic complications.

With this study, we aim to highlight and advocate the importance of regular mental health screening for all PDM patients. Using validated self-reported questionnaire as a screening tool is a cost-effective and reliable way to identify patients who are potentially at risk for depression. Timely referral, diagnosis and management of depression will lead to better disease control and quality of life in these patients. Improving coordination between diabetes and psychological services, including reducing referral delays, could further enhance treatment outcomes. In the future, extending mental health screening to carers of PDM patients might also be useful, as carer stress could also affect patient's diabetic control tremendously.

Table 4b Logistic regression model for depressive symptoms in patients with type 2 diabetes mellitus

Variables	OR (95% CI of OR)	P-value
Parental marital relationship problems	44.702 (2.744-728.173)	0.008
Number of acute hospital admissions related to poor diabetic control	7.285 (1.610-32.960)	0.010

OR: Odds Ratio; CI: Confidence interval.

Declaration of Interest

The authors have indicated they have no conflicts of interest relevant to this article to disclose.

References

1. Tung JYL, Kwan EYW, But BWM, et al. Increasing incidence of type 1 diabetes among Hong Kong children and adolescents: The Hong Kong Childhood Diabetes Registry 2008 to 2017. Pediatr Diabetes 2020;21:713-9.
2. Tung JYL, Kwan EYW, But BWM, et al. Incidence and clinical characteristics of pediatric-onset type 2 diabetes in Hong Kong: The Hong Kong childhood diabetes registry 2008 to 2017. Pediatr Diabetes 2022;23:556-61.
3. Lawrence JM, Standiford DA, Loots B, et al. Prevalence and correlates of depressed mood among youth with diabetes: the SEARCH for Diabetes in Youth study. Pediatrics 2006;117:1348-58.
4. Li C, Ford ES, Strine TW, Mokdad AH. Prevalence of depression among U.S. adults with diabetes: findings from the 2006 behavioral risk factor surveillance system. Diabetes Care 2008;31:105-7.
5. Mental health of adolescents [Internet]. [cited 2024 Feb 20]. Available from: https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health
6. Calkins-Smith AK, Marker AM, Clements MA, Patton SR. Hope and mealtime insulin boluses are associated with depressive symptoms and glycemic control in youth with type 1 diabetes mellitus. Pediatr Diabetes 2018;19:1309-14.
7. American Diabetes Association Professional Practice Committee. 14. Children and Adolescents: Standards of Medical Care in Diabetes-2022. Diabetes Care 2022;45(Suppl 1):S208-31.
8. Hong Kong Reference Framework for Diabetes Care for Adults in Primary Care Settings.
9. Richardson LP, McCauley E, Grossman DC, et al. Evaluation of the Patient Health Questionnaire-9 Item for detecting major depression among adolescents. Pediatrics 2010;126:1117-23.
10. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med 2001;16:606-13.
11. Hood KK, Huestis S, Maher A, Butler D, Volkening L, Laffel LMB. Depressive symptoms in children and adolescents with type 1 diabetes: association with diabetes-specific characteristics. Diabetes Care 2006;29:1389-91.
12. Silverstein J, Cheng P, Ruedy KJ, et al. Depressive Symptoms in Youth With Type 1 or Type 2 Diabetes: Results of the Pediatric Diabetes Consortium Screening Assessment of Depression in Diabetes Study. Diabetes Care 2015;38:2341-3.
13. Picozzi A, DeLuca F. Depression and glycemic control in adolescent diabetics: evaluating possible association between depression and hemoglobin A1c. Public Health 2019;170:32-7.
14. Virk SA, Donaghue KC, Cho YH, et al. Association Between HbA1c Variability and Risk of Microvascular Complications in Adolescents With Type 1 Diabetes. J Clin Endocrinol Metab 2016;101:3257-63.
15. Lind M, Pivodic A, Svensson AM, Ólafsdóttir AF, Wedel H, Ludvigsson J. HbA1c level as a risk factor for retinopathy and nephropathy in children and adults with type 1 diabetes: Swedish population based cohort study. BMJ 2019;366:l4894.
16. Andreasson R, Ekelund C, Landin-Olsson M, Nilsson C. HbA1c levels in children with type 1 diabetes and correlation to diabetic retinopathy. J Pediatr Endocrinol Metab 2018;31:369-74.
17. Blasco BV, García-Jiménez J, Bodoano I, Gutiérrez-Rojas L. Obesity and Depression: Its Prevalence and Influence as a Prognostic Factor: A Systematic Review. Psychiatry Investig. 2020;17:715-24.
18. Ul-Haq Z, Smith DJ, Nicholl BI, et al. Gender differences in the association between adiposity and probable major depression: a cross-sectional study of 140,564 UK Biobank participants. BMC Psychiatry 2014;14:153.