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Depression and anxiety in patients with type 2 diabetes in Indonesia and Malaysia: do age, diabetes duration, foot ulcers, and prescribed medication play a role?

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ABSTRACT

Patients with type 2 diabetes mellitus (T2DM) are susceptible to mental health issues, impacting medication adherence and diabetes control. This study aimed to evaluate factors associated with depression and anxiety among T2DM patients in Indonesia and Malaysia. A cross-sectional study was conducted in Indonesia and Malaysia from October 2022 to April 2023 among T2DM patients. The study utilised an instrument with patient and disease data and three validated tools to assess depression, anxiety, and medication adherence. Statistical analysis, including binary logistic regression, was performed using SPSS® version 28 software. A study of 606 T2DM patients revealed that 56.5% were at risk of depression, while 41.6% were at risk of anxiety. Older patients with T2DM had lower rates of depression (AOR = 0.41, 0.25–0.68) and anxiety than younger patients. Normal-weight patients were less likely to experience depression and anxiety (AOR = 0.44, 0.27–0.72) than overweight patients. Patients without diabetic foot ulcers had a lower risk of depression (AOR = 0.34, 0.21–0.55) and anxiety than those with foot ulcers. Patients with a shorter duration of diabetes had a higher risk of depression (AOR = 3.27, 1.70–6.30) and anxiety than those with a longer duration. Patients on insulin-based regimens had higher rates of depression and anxiety (AOR = 2.28, 1.20–4.30) than those on metformin-based regimens. Nonadherent patients were more likely to experience depression and anxiety (AOR = 4.30, 2.22–8.32) than patients who adhered to their medication. The prevalence of depression and anxiety is concerning and influenced by factors such as age, diabetes duration, the presence of diabetic foot ulcers, and the prescribed medication regimen. Further efforts are necessary to enhance the mental health of T2DM patients and improve management outcomes.

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Introduction

Living with diabetes can lead to psychological stress and mental disorders due to the demanding nature of self-care practices, emotional burdens, and adjustments to daily activities and social interactions (Robinson et al., 2018). Moreover, epidemiological data have revealed that people with mental disorders are more likely to develop diabetes than the general population (Roy & Lloyd, 2012). Therefore, a bidirectional relationship between diabetes and mental disorders, such as depression and anxiety, has been established to demonstrate how these two comorbidities may affect one another (Pan et al., 2010). Regardless of gender, type of diabetes, or assessment method, depression is twice as common among those with diabetes and may have longer and more recurring symptoms, posing a challenge for managing mental health in this population (Anderson et al., 2001). Among patients with depression, a meta-analysis of 33 articles found a 32% higher risk of developing type 2 diabetes mellitus, which could worsen a patient's prognosis (Yu et al., 2015). This is due to reduced physical activity, increased healthcare needs, and poor medication adherence.

The evaluation of mental disorder risk in people with type 2 diabetes mellitus is crucial for treatment and support planning. The Patient Health Questionnaire (PHQ-9) is a validated instrument for assessing depression symptoms and their severity in patients with diabetes (De Joode et al., 2019). This tool assesses various vegetative, emotional, behavioral, and cognitive symptoms, such as sleep and appetite changes, bad mood, decreased enjoyment, agitation, reduced concentration, guilty feelings, and self-harm thoughts (Kroenke & Spitzer, 2002). Anxiety is also a common mental disorder that affects, in its clinically relevant form, about 14% of individuals living with diabetes, with a reported comorbidity with depression (Grigsby et al., 2002; Katon et al., 2007). Generalised anxiety disorder (GAD), the most common form of anxiety, is reported in 21% of people with diabetes (Chaturvedi et al., 2019). Chronic anxiety may increase individuals' risk of developing type 2 diabetes. Generalised Anxiety Disorder (GAD-7) is a useful instrument for assessing and classifying individuals with type 2 diabetes into one of four risk categories, with moderate to severe anxiety associated with an increased risk of developing diabetes-related complications (Chaturvedi et al., 2019).

Moreover, identifying risk factors for depression and anxiety in people with type 2 diabetes could help manage cases proactively. Previous research has underpinned the potential role of inadequate social support, stressful lifestyles, and developing disease complications in affecting the risk of depression and anxiety among this population (Chaturvedi et al., 2019; Robinson et al., 2018). Although Malaysia and Indonesia face a considerable diabetes burden, research predominantly addresses medication rather than mental health impacts. Psychological research on type 2 diabetes in these Southeast Asian countries is notably insufficient. This study explores mental health variables in T2DM patients, contributing crucial insights for tailored interventions and support in diabetes care. Additionally, recent updates on the prevalence and correlations of depression and anxiety in type 2 diabetes patients in these nations are imperative. Therefore, this study aimed to investigate the factors associated with depression and anxiety among a sample of patients with T2DM in Indonesia and Malaysia.

Methods

Study design

A cross-sectional study was conducted between October 2022 and April 2023 among a sample of patients with type 2 diabetes mellitus in Malaysia and Indonesia.

Study participants and settings

The inclusion criteria for the study were as follows: Adults with T2DM, ability to understand English or Malay (BM) or Indonesian (BI) (the questionnaire was offered in a bilingual format in each setting), and voluntary agreement to participate in the study. Exclusion criteria encompass individuals with type 1 diabetes, individuals with significant cognitive impairments that hinder questionnaire understanding, individuals with pre-existing psychiatric disorders before diabetes onset, individuals incapable of providing informed consent and individuals lacking fluency in English, Malay, or Indonesian. The study questionnaire was made available online for self-administration by potential participants after reading the study information and filling out an online consent form. The contact details of the study investigators were also available so that all potential participants could place any further queries about the study before participation. The sample size was calculated using OpenEpi, Version 3, an open-source sample size calculator. Considering that one main institution is responsible for data collection in every country, a minimum target sample of 281 patients with T2DM in each country is needed. Initially, we were able to collect responses from approximately 660 T2DM patients. However, only 282 (Malaysia) and 324 (Indonesia) participants met the inclusion criteria after the final screening.

Study tools

Each participant in this study was required to complete a three-part questionnaire as follows:

- Part A: Questions regarding the participants' sociodemographics (gender, marital status, ethnicity, age, employment status, level of education, residency, and monthly income), disease-related conditions, and diabetes control data (HbA1c% and average random blood glucose level). Employed individuals engage in paid or self-employment. Unemployed individuals are not registered under any paid job during data collection. Retired individuals have permanently exited the workforce. Urban areas are characterised by high population density and advanced infrastructure. Rural areas exhibit lower population density, with a focus on agriculture and limited infrastructure. Microvascular complications involve damage to small blood vessels, such as diabetic retinopathy, nephropathy, and neuropathy. Macrovascular complications entail damage to large blood vessels, including cardiovascular disease, stroke, and peripheral arterial disease.
- Part B: The bilingual versions (English and BM/BI) of the Generalized Anxiety Disorder-7 questionnaire (GAD-7) and the Patient Health Questionnaire (PHQ-9).

- Part C: The bilingual version of the Malaysia Medication Adherence Assessment Tool (MyMAAT), a validated tool for medication adherence assessment among patients with T2DM.

All study instruments were previously validated in local languages, necessitating no further translations except for the introductory section, which utilised a forward-backwards translation methodology.

Patient health questionnaire (PHQ-9)

The Patient Health Questionnaire (PHQ-9) is a validated depression assessment tool. Each question offers the following response options and scores: Not at all: 0, Several days: 1, More than half the days: 2, and nearly every day: 3. Participants were required to choose only one response option for each question. The scores for the nine questions were added to give a total score range of 0 to 27. The following total scores indicate the degree of depression: None: 0–4, Mild: 5–9, Moderate: 10–14, Moderately Severe: 15–19, and Severe: 20–27. The cut-off value for PHQ-9 provides the best sensitivity and specificity at 10 and above. Participants who score 10 or above can be classified as having depression (Sherina et al., 2012; Zhang et al., 2015).

Generalised anxiety disorder (GAD-7)

GAD-7 The Generalized Anxiety Disorder 7 (GAD-7) is a recognised anxiety assessment tool. It has seven closed-ended questions with the same response scale described in the PHQ-9. Participants were required to choose only one response option for each question. The scores for the seven questions were added to give a total score range of 0 to 21. The level of anxiety was presented by the total score as follows: Minimal: 0–4, Mild: 5–9, Moderate: 10–14, and Severe: 15–21. A cut-off point of 10 or greater is preferred for identifying generalised anxiety disorders (Spitzer et al., 2006). In 2020, Woon concluded that the Malay version of the GAD-7 is a validated tool for screening for generalised anxiety symptoms among patients with diabetes (Sy-Cherng Woon, 2020).

Malaysia medication adherence assessment tool (MyMAAT)

The Malaysia Medication Adherence Assessment Tool (MyMAAT) is a 12-item self-report questionnaire that uses a Likert scale to assess medication adherence. The Likert scale has five response options: strongly disagree (5), disagree (4), neutral (3), agree (2), and strongly agree (1). Participants were asked to select one response option for each item. The scores for the 12 items were added to yield a total score ranging from 12–60. A score below 54 is considered nonadherence, while a score of 54 and above is considered adherence. MyMAAT was developed and validated among patients with T2DM (Hatah Id et al., 2020). Therefore, it was used in our study as a suitable, cost-effective tool to assess medication adherence among Asian patients with T2DM. In addition, permission to use MyMAAT as a medication adherence tool was granted in this study.

Study procedures and sampling method

Researchers from both institutions in Indonesia and Malaysia prepared the final bilingual questionnaire. The research employed a convenience sampling method

via online mediums. Specifically, the questionnaire was shared on platforms like Facebook and WhatsApp from October 2022 to January 2023. Measures were taken to restrict access to potentially eligible participants to mitigate response bias. Inclusion criteria were clearly defined. Recruitment limitations included an online questionnaire with a study description and informed consent, a bilingual questionnaire in English and local languages, and contact details for study investigators for participant queries. Online platforms were selected to enhance extensive and swift data collection, alleviate spatial and temporal limitations, and promote ease of participation for individuals with mobility impairments. The literature acknowledges the application of these platforms in health system research, accompanied by defined recommendations for effective integration (Manji et al., 2021).

Statistical analysis

Data were analysed using SPSS version 28.0. Descriptive statistics were used to show the frequencies and percentages. The scores were calculated and categorised. Given the violation of normal distribution, the Mann-Whitney U test was used to compare PHQ-9 and GAD-7 scores between two-group variables. The Kruskal-Wallis test was used for more than two groups. The Bonferroni correction was used for multiple comparisons. Adjusted p-values were presented for pairwise comparisons. All tests were two-sided, with p-value <0.05 considered significant. Multivariate binary logistic regression was used to ascertain the effects of significant variables that showed association in the bivariate analysis.

Results

Patient information and disease-related characteristics of the participants

A total of 606 patients with type 2 diabetes mellitus (T2DM) were included in the final sample. Approximately 62% were aged 49 years and younger. Most of the patients were female (64.5%), lived in an urban area (70.8%), were employed (58.1%), and had tertiary education backgrounds (61.4%). In addition, 51.5% did not practice weekly exercise, were overweight (41.7%), and 52.1% were classified in the low-income group. Regarding their disease-related characteristics, the majority of the patients had had diabetes for five years or less (57.4%), had been exposed to diabetic education and, received support (65.6%), and did not experience any diabetes complications (52.1%). Referring to the cut-off point of 10 or more to indicate likely depression and anxiety, the prevalence of depression and anxiety risk was 56.5% and 41.6%, respectively. Medication adherence assessments revealed that almost 81% of patients did not adhere to their medications. Nonadherence was more prevalent among those with a higher risk of depression and anxiety. In addition, 48.9% of T2DM patients had uncontrolled levels of HbA1c. There was no association between depression ($p = 0.513$) or anxiety ($p = 0.170$) risk classification and the odds of diabetes control based on HBA1C%. Table 1 displays the distribution of participants' characteristics and disease-related information across the classified depression and anxiety risk groups.

Table 1. Distribution of general characteristics of participants across depression and anxiety assessment groups (N = 606).

Variable	Categories	PHQ-9 Score <10 (Not likely Depression)	PHQ-9 Score 10 and >; (Indicator of likely Depression)	GAD-7 Score <10 (Not likely Anxiety)	GAD-7 Score 10 and >; (Indicator of likely Anxiety)
Gender	Male (*N*=215, 35.5%)	104 (17.2%)	111 (18.3%)	140 (23.1%)	75 (12.4%)
	Female (*N*=391, 64.5%)	159 (26.2%)	232 (38.3%)	211 (34.8%)	180 (29.7%)
Age groups	49 years old and below (*N*=374, 61.7%)	110 (18.2%)	264 (43.6%)	170 (28.1%)	204 (33.7%)
	50 to 64 years old (*N*=183, 30.2%)	121 (20%)	62 (10.2%)	139 (22.9%)	44 (7.3%)
	65 years old and above (*N*=49, 8.1%)	32 (5.3%)	17 (2.8%)	42 (6.9%)	7 (1.2%)
Employment status	Employed (*N*=352, 58.1%)	132 (21.8%)	220 (36.3%)	190 (31.4%)	162 (26.7%)
	Unemployed (*N*=166, 27.4%)	72 (11.9%)	94 (15.5%)	91 (15%)	75 (12.4%)
	Retired (*N*=88, 14.5%)	59 (9.7%)	29 (4.8%)	70 (11.6%)	18 (3%)
Residence	Urban (*N*=429, 70.8%))	162 (26.7%)	267 (44.1%)	223 (36.8%)	206 (34%)
	Rural (*N*=177, 29.2%)	101 (16.7%)	76 (12.5%)	128 (21.1%)	49 (8.1%)
Income	Low (*N*=316, 52.1%))	149 (24.6%)	167 (27.6%)	196 (32.3%)	120 (19.8%)
	Middle (*N*=231, 38.1%)	96 (15.8%)	135 (22.3%)	128 (21.1%)	103 (17%)
	High (*N*=59, 9.7%)	18 (3%)	41 (6.8%)	27 (4.5%)	32 (5.3%)
Diabetes duration	5 years and below (*N*=348, 57.4%)	125 (20.6%)	223 (36.8%)	174 (28.7%)	174 (28.7%)
	6 to 10 years (*N*=164, 27.1%)	70 (11.6%)	94 (15.5%)	95 (15.7%)	69 (11.4%)
	11 years and above (*N*=94, 15.5%)	68 (11.2%)	26 (4.3%)	82 (13.5%)	12 (2%)
Diabetes education and support	Yes (*N*=396, 65.6%)	166 (27.5%)	230 (38.1%)	220 (36.5%)	176 (29.1%)
	No (*N*=208, 34.4%)	97 (16.1%)	111 (18.3%)	131 (21.7%)	76 (12.7%)
Weekly exercise	Yes (*N*=294, 48.5%)	108 (17.8%)	186 (30.7%)	153 (25.2%)	141 (23.3%)
	No (*N*=312, 51.5%)	155 (25.6%)	157 (25.9%)	198 (32.7%)	114 (18.8%)
Body mass index	Underweight (*N*=60, 9.9%)	13 (2.1%	47 (7.8%)	25 (4.1%)	35 (5.8%)
	Normal (*N*=238, 39.3%)	117 (19.3%)	121 (20%)	154 (25.4%)	84 (13.9%)
	Overweight (*N*=253, 41.7%)	102 (16.8%)	151 (24.9%)	134 (22.1%)	119 (19.6%)
	Obese (*N*=55, 9.1%)	31 (5.1%)	24 (4%)	38 (6.3%)	17 (2.8%)
Complication status	No Complication (*N*=316, 52.1%)	142 (23.4%)	174 (28.7%)	176 (29%)	140 (23.1%)
	Micro Complication (*N*=227, 37.5%)	100 (16.5%)	127 (21%)	147 (24.3%)	80 (13.2%)
	Macro Complication (*N*=32, 5.3%)	9 (1.5%)	23 (3.8%)	11 (1.8%)	21 (3.5%)
	Macro & Micro (*N*=31, 5.1%)	12 (2%)	19 (3.1%)	17 (2.8%)	14 (2.3%)

(*Continued*)

Table 1. (Continued).

Variable	Categories	PHQ-9 Score <10 (Not likely Depression)	PHQ-9 Score 10 and >; (Indicator of likely Depression)	GAD-7 Score <10 (Not likely Anxiety)	GAD-7 Score 10 and >; (Indicator of likely Anxiety)
Diabetic foot ulcer	Yes (*N*=196, 32.3%)	37 (6.1%)	159 (26.2%)	67 (11.1%)	129 (21.3%)
	No (*N*=410, 67.7%)	226 (37.3%)	184 (30.4%)	284 (46.9%)	126 (20.8%)
Medication regimen	Metformin-based regimen (*N*=250, 46%)	125 (23%)	125 (23%)	165 (30.3%)	85 (15.7%)
	Insulin-based regimen (*N*=99, 18.2%)	33 (6.1%)	66 (12.1%)	50 (9.2%)	49 (9%)
	Metformin + insulin regimen (*N*=153, 28.2%)	65 (12%)	88 (16.2%)	85 (15.7%)	68 (12.5%)
	Other GLDs regimen (*N*=41, 7.6%)	15 (2.8%)	26 (4.8%)	17 (3.2%)	24 (4.4%)
Number of medications	Monotherapy (*N*=224, 41.3%)	98 (18.1%)	126 (23.2%)	133 (24.5%)	91 (16.8%)
	Dual therapy (*N*=149, 27.5%)	80 (14.8%)	69 (12.7%)	103 (19%)	46 (8.5%)
	Triple therapy or more (*N*=169, 31.2%)	60 (11.1%)	109 (20.1%)	81 (14.9%)	88 (16.3%)
MyMAAT Score	Scores 54–60-Adherence (*N*=116, 19.1%)	88 (14.5%)	28 (4.6%)	98 (16.1%)	18 (3%)
	Scores 12–53-Nonadherence (*N*=490, 80.9%)	175 (28.9%)	315 (52%)	253 (41.7%)	237 (39.2%)
HbA1C%	Controlled (*N*=245, 51.1%)	101 (21.1%)	144 (30%)	140 (29.2%)	105 (21.9%
	Uncontrolled (*N*=234, 48.9%)	89 (18.6%)	145 (30.3%)	119 (24.8%)	115 (24.1%)

Comparison of the overall participants' characteristics, depression, and anxiety risk classification among T2DM patients in Indonesia and Malaysia

Differences were found in various characteristics, such as gender, age, income, diabetes duration, and medication regimen, between participants in Indonesia and Malaysia. Participants in Indonesia had higher odds of depression and anxiety compared to their Malaysian counterparts. The prevalence of moderate to severe depression and anxiety was considerably higher in Indonesia. Medication adherence differed significantly between Indonesian and Malaysian patients. There was no significant difference in diabetes control based on HBA1C% between the two countries. Table 2 presents the participants' main characteristics and outcome measures in Indonesia and Malaysia.

Association between total depression and anxiety risk scores and patient-related and disease-related characteristics

The total PHQ-9 and GAD-7 scores were calculated and tested for group differences across several patient- and disease-related characteristics. Due to violating the

Table 2. Comparison of the main characteristics and outcome measures between study participants in Malaysia and Indonesia.

Variable	Categories		Malaysian (*N* = 282)	Indonesian (*N*=324)
Gender	Male	215 (35.5%)	123 (20.3%)	92 (15.2%)
	Female	391 (64.5%)	159 (26.2%)	232 (38.3%)
Age groups	49 years old and below	374 (61.7%)	92 (15.2%)	282 (46.5%)
	50 to 64 years old	183 (30.2%)	143 (23.6%)	40 (6.6%)
	65 years old and above	49 (8.1%)	47 (7.8%)	2 (0.3%)
Employment status	Employed	352 (58.1%)	131 (21.6%)	221 (36.5%)
	Unemployed	166 (27.4%)	84 (13.9%)	82 (13.5%)
	Retired	88 (14.5%)	67 (11.1%)	21 (3.5%)
Income	Low income	316 (52.1%)	171 (28.2%)	145 (23.9%)
	Middle income	231 (38.1%)	95 (15.7%)	136 (22.4%)
	High income	59 (9.7%)	16 (2.6%)	43 (7.1%)
Diabetes duration	11 years and above	94 (15.5%)	90 (14.9%)	4 (0.7%)
	5 years and below	348 (57.4%)	114 (18.8%)	234 (38.6%)
	6 to 10 years	164 (27.1%)	78 (12.9%)	86 (14.2%)
Diabetic education and support	Yes	396 (65.6%)	181 (30.0%)	215 (35.6%)
	No	208 (34.4%)	101 (16.7%)	107 (17.7%)
Weekly exercise	Yes	294 (48.5%)	99 (16.3%)	195 (32.2%)
	No	312 (51.5%)	183 (30.2%)	129 (21.3%)
BMI	Overweight	253 (41.7%)	120 (19.8%)	133 (21.9%)
	Obese	55 (9.1%)	42 (6.9%)	13 (2.1%)
	Underweight	60 (9.9%)	12 (2.0%)	48 (7.9%)
	Normal	238 (39.3%)	108 (17.8%)	130 (21.5%)
Complication status	No Complication	316 (52.1%)	135 (22.3%)	181 (29.9%)
	Macro Complication	32 (5.3%)	11 (1.8%)	21 (3.5%)
	Micro Complication	227 (37.5%)	116 (19.1%)	111 (18.3%)
	Macro and Micro	31 (5.1%)	20 (3.3%)	11 (1.8%)
Diabetic foot ulcer	With Diabetic Foot Ulcer	196 (32.3%)	20 (3.3%)	176 (29.0%)
	Without Diabetic Foot Ulcer	410 (67.7%)	262 (43.2%)	148 (24.4%)
Medication Regimen Categories	Metformin-based regimen	250 (46.0%)	133 (24.5%)	117 (21.5%)
	Metformin + Insulin regimen	153 (28.2%)	59 (10.9%)	94 (17.3%)
	Insulin-based regimen	99 (18.2%)	44 (8.1%)	55 (10.1%)
	Other GLDs regimen	41 (7.6%)	15 (2.8%)	26 (4.8%)
Number of medications	Monotherapy	224 (41.3%)	124 (22.9%)	100 (18.5%)
	Dual Therapy	149 (27.5%)	91 (16.8%)	58 (10.7%)
	Triple or more therapy	169 (31.2%)	35 (6.5%)	134 (24.7%)
HbA1c%	Controlled	245 (51.1%)	102 (21.3%)	143 (29.9%)
	Uncontrolled	234 (48.9%)	90 (18.8%)	144 (30.1%)
PHQ-9 Score	None-Minimal (0–4)	107 (17.7%)	94 (15.5%)	13 (2.1%)
	Mild (5–9)	156 (25.7%)	112 (18.5%)	44 (7.4%)
	Moderate (10–14)	125 (20.6%)	52 (8.6%)	73 (12.0%)
	Moderately severe (15–19)	126 (20.8%)	13 (2.1%)	113 (18.6%)
	Severe (20–27)	92 (15.2%)	11 (1.8%)	81 (13.4%)
GAD-7 Score	Minimal (0–4)	212 (35.0%)	185 (30.5%)	27 (4.5%)
	Mild (5–9)	142 (23.4%)	61 (10%)	81 (13.4%)
	Moderate (10–14)	131 (21.6%)	24 (4.0%)	107 (17.7%)
	Severe (15–21)	121 (20.0%)	12 (2.0%)	109 (17.9%)
MyMAAT Score	Adherence (54–60)	116 (19.1%)	98 (16.2%)	18 (3.0%)
	Nonadherence (12–53)	490 (80.9%)	184 (30.4%)	306 (50.5%)

assumption of normal distribution, nonparametric tests were employed, and mean ranks were presented for each category. For all pairwise comparisons, adjusted p-values by Bonferroni correction for multiple tests are presented.

Association with depression risk scores

The PHQ-9 scores for males and females were not similar. Females had significantly higher scores than males. Nonadherent patients had higher scores than

adherent patients. Patients who exercised weekly and developed diabetic foot ulcers also had higher scores. There was no significant difference in scores between the controlled and uncontrolled diabetes patients. Younger patients had significantly higher scores than older patients. Those on insulin-based regimens had higher scores than those on metformin-based regimens. Patients with longer diabetes duration had lower scores. Significant differences in depression scores are shown in Table 3.

Association with anxiety risk scores

The GAD-7 scores differed between males and females, with females reporting higher scores. Nonadherent patients and those with diabetic foot ulcers and who exercised weekly also reported higher scores. Younger patients reported higher scores than older ones. Those with a diabetes duration of 11 years or more had lower scores. Insulin-based regimens and triple medications were associated with higher GAD-7 scores. Table 4 displays all the significant differences in anxiety scores.

Determinants of depression and anxiety risk based on the findings of binary logistic regression

Binomial logistic regression was performed to ascertain the effects of all variables that showed significant association with depression and anxiety scores in the bivariate

Table 3. Factors associated with significant differences in the total PHQ-9 score among all participants.

Factors	Categories with higher PHQ-9 scores (Mean rank)	Categories with Lower PHQ-9 scores (Mean rank)	P value
Gender	Female (318.96)	Male (275.39)	0.003*
Age groups			<0.001**
	49 years old and below (355.36)	50 to 64 years old (218.40)	<0.001
	49 years old and below (355.36)	65 years old and above (225.50)	<0.001
Employment status			<0.001**
	Employed (317.74)	Retired (204.49)	<0.001
	Unemployed (325.80)	Retired (204.49)	<0.001
Education level			0.031
	Tertiary (317.73)	Secondary/primary (279.22)	0.027
Residence	Urban (323.56)	Rural (254.87)	<0.001*
Diabetes duration			<0.001**
	5 years and below (334.25)	11 years and above (196.69)	<0.001
	6 to 10 years (299.46)	11 years and above (196.69)	<0.001
Weekly exercise	Yes (326.40)	No (281.92)	0.002*
Body mass index			<0.001**
	Underweight (388.02)	Normal (277.67)	<0.001
	Underweight (388.02)	Overweight (321.05)	0.046
	Underweight (388.02)	Obese (242.34)	<0.001
	Overweight (321.05)	Normal (277.67)	0.036
	Overweight (321.05)	Obese (242.34)	0.015
Diabetic foot ulcer	Yes (401.05)	No (256.87)	<0.001*
Medication regimen			0.004**
	Insulin-based regimen (310.17)	Metformin-based regimen (248.08)	0.005
Number of medications			<0.001**
	Triple therapy or more (305.05)	Dual therapy (236.58)	<0.001
MyMAAT Score	Nonadherence- Scores 12–53 (329.83)	Adherence- Scores 54–60 (192.28)	<0.001*

*Mann-Whitney test (significance measure at $p < 0.05$).
**Kruskal–Wallis test (adjusted p-values by the Bonferroni correction for multiple tests are presented for pairwise comparisons).

Table 4. Factors associated with significant differences in the total GAD-7 score among all participants (bivariate analysis).

Factors	Categories with higher GAD-7 scores (Mean rank)	Categories with Lower GAD-7 scores (Mean rank)	P value
Gender	Female (322.85)	Male (268.31)	<0.001*
Age groups			<0.001**
	49 years old and below (356.53)	50 to 64 years old (220.08)	<0.001
	49 years old and below (356.53)	65 years old and above (210.27)	<0.001
Employment status			<0.001**
	Employed (319.16)	Retired (203.06)	<0.001
	Unemployed (323.53)	Retired (203.06)	<0.001
Education level			0.003
	Tertiary (321.76)	Secondary/primary (272.05)	0.002
Residence	Urban (323.77)	Rural (254.38)	<0.001*
Income			0.007**
	High (362.79)	Low (287.28)	0.007
Diabetes duration			<0.001**
	5 years and below (336.14)	11 years and above (184.13)	<0.001
	6 to 10 years (302.67)	11 years and above (184.13)	<0.001
Diabetes education and support	Yes (313.54)	No (281.49)	0.032
Weekly exercise	Yes (330.22)	No (278.32)	<0.001*
Body mass index			<0.001**
	Underweight (368.93)	Normal (285.41)	0.006
	Underweight (368.93)	Obese (250.38)	0.002
Diabetic foot ulcer	Yes (400.44)	No (257.16)	<0.001
Medication regimen			0.001**
	Insulin-based regimen (312.33)	Metformin-based regimen (245.77)	0.002
Number of medications			<0.001**
	Triple therapy or more (307.66)	Dual therapy (236.60)	<0.001
	Triple therapy or more (307.66)	Monotherapy (267.44)	0.035
MyMAAT Score	Nonadherence- Scores 12–53 (328.85)	Adherence- Scores 54–60 (196.41)	<0.001*

*Mann-Whitney test (significance measure at $p < 0.05$).
**Kruskal–Wallis test (adjusted p-values by the Bonferroni correction for multiple tests are presented for pairwise comparisons).

analysis. The model was not a poor fit. Therefore, the model explained 39% (Nagelkerke R^2) of the variation in the dependent variable (depression and anxiety). Based on this multivariate assessment, gender, employment status, weekly exercise, and medication combination were not significantly associated with increased odds of depression and anxiety. The findings show that relatively older patients with T2DM (50–64 years) are less likely to be at risk of depression (AOR = 0.41, 0.25–0.68) and anxiety (AOR = 0.47, 0.27–0.80) than younger patients (≤49 years). In addition, those residing in rural areas had lower odds of depression (AOR = 0.55, 0.34–0.88) and anxiety (AOR = 0.44, 0.27–0.72) than those residing in urban areas. Patients with a normal BMI tended to have lower odds of depression (AOR = 0.53, 0.33–0.85) and anxiety (AOR = 0.44, 0.27–0.72) than those with an overweight BMI. In addition, patients who did not have diabetic foot ulcers had a lower risk of depression (AOR = 0.34, 0.21–0.55) and anxiety (AOR = 0.44, 0.28–0.69) than those with diabetic foot ulcers. On the other hand, patients living with diabetes for a short period (≤5 years) were at higher risk of depression (AOR = 3.27, 1.70–6.30) and anxiety (AOR = 5.79, 2.47–13.55) compared to those living with diabetes for an extended period (≥11 years). Patients prescribed insulin-based regimens had higher odds of depression (AOR = 1.90, 1.01–3.60) and anxiety (AOR = 2.28, 1.20–4.30) than metformin-based regimens. Lastly, patients who were nonadherent to their medications were more likely to have depression (AOR = 4.27, 2.43–7.50) and

Table 5. Factors associated with the likely risk of depression and anxiety based on the findings of the binary logistic regression.

		Likely risk of Depression			Likely risk of Anxiety		
Variable	Categories	AOR*	P value	95% CI	AOR*	P value	95% CI
Gender	Female	0.874	0.578	0.543–1.406	1.175	0.510	0.727–1.902
	Male	1			1		
Age groups	50–64 years	0.410	0.001	0.248–0.679	0.467	0.005	0.274–0.795
	65 years and above	0.645	0.322	0.271–1.536	0.436	0.115	0.155–1.225
	49 years and below	1			1		
Employment status	Unemployed	1.407	0.205	0.830–2.387	1.631	0.075	0.953–2.792
	Retired	0.767	0.448	0.387–1.521	0.858	0.692	0.400–1.836
	Employed	1			1		
Residency	Rural	0.548	0.013	0.342–0.880	0.442	0.001	0.269–0.728
	Urban	1			1		
Categories of diabetes duration	5 years and below	3.273	<0.001	1.700–6.303	5.786	<0.001	2.470–13.555
	6 to 10 years	2.735	0.005	1.366–5.477	4.498	0.001	1.862–10.870
	11 years and above	1			1		
Weekly exercise	No	0.770	0.239	0.499–1.189	0.801	0.324	0.516–1.244
	Yes	1			1		
BMI	Obese	0.494	0.062	0.236–1.035	0.460	0.048	0.213–0.993
	Underweight	1.207	0.649	0.536–2.716	0.870	0.709	0.417–1.813
	Normal	0.529	0.008	0.330–0.848	0.444	0.001	0.274–0.720
	Overweight	1			1		
Diabetic foot ulcer	No	0.335	<0.001	0.205–0.548	0.441	<0.001	0.282–0.690
	Yes	1			1		
Medication Regimen Categories	Metformin + insulin	1.068	0.814	0.618–1.845	1.199	0.509	0.699–2.057
	Insulin-based	1.906	0.047	1.007–3.605	2.277	0.011	1.203–4.308
	Other GLDs	1.476	0.355	0.647–3.367	3.452	0.004	1.485–8.024
	Metformin-based	1			1		
Monotherapy and drug combination	Dual therapy	0.752	0.341	0.419–1.352	0.797	0.466	0.433–1.467
	Triple or more	0.981	0.953	0.526–1.830	1.327	0.371	0.714–2.465
	Monotherapy	1			1		
MyMAAT medication adherence	Nonadherence	4.270	<0.001	2.430–7.501	4.299	<0.001	2.222–8.316
	Adherence	1			1		

*AOR: adjusted odds ratio.
Significance level ($p < 0.05$)

anxiety (AOR = 4.30, 2.22–8.32) than patients with optimal medication adherence. Table 5 shows the findings of the binary logistic regression of the factors associated with the risk of depression and anxiety.

Discussion

The study investigated depression and anxiety and their associated factors among T2DM patients in Indonesia and Malaysia. Medication adherence and diabetes control were also evaluated concerning mental health assessments. Multiple factors affect the prevalence and severity of depression and anxiety in T2DM patients. The findings provide insight into mental health determinants in two Asian countries with a high disease burden and can inform future initiatives to support healthy coping with the disease and improve treatment outcomes.

In this study, we first assessed the prevalence of depression and anxiety simultaneously using validated tools, namely PHQ-9 and GAD-7. The prevalence of moderate to severe

depression and anxiety varied considerably between Malaysia (12.5% and 6%) and Indonesia (44% and 35.6%, respectively). Overall, 56.5% and 41.6% had moderate to severe depression and anxiety, respectively. This overall finding is relatively higher than previously reported in a Vietnamese study involving 216 T2DM patients, which reported that 23.2% of the population suffered from depression (Tran et al., 2021). Le et al. (2022) studied the rate of depression, specifically in T2DM patients aged 30 to 60 years old, using PHQ-9 and found that 16.9% had depression. A study in Nepal using PHQ-9 reported that 30.4% of T2DM patients had depression, including 19.6% of those with moderate depression (Sharma et al., 2021). However, a study involving 2538 Chinese T2DM patients from Hong Kong and China revealed that only 6.1% were depressed based on the PHQ-9 score (Zhang et al., 2015). Another study that utilised the Hospital Anxiety and Depression Scale (HADS) found that 40.3% of T2DM patients had depression (Ganasegeran et al., 2014). Similarly, a Pakistan-based study showed that 50% of T2DM patients were depressed, according to HADS (Zuberi et al., 2011). Another Malaysian study that used the Depression, Anxiety, and Stress Scale (DASS) stated that the prevalence of depression among T2DM patients was 11.5% (Kaur et al., 2013).

Concerning anxiety assessment, Thour et al. s previous findings (Thour et al., 2016) reported that 12% of T2DM patients in India presented with anxiety symptoms. In contrast, a Nepal study involving 296 T2DM patients using the GAD-7 reported a lower overall anxiety prevalence (25%) than our study (Sharma et al., 2021). A study using the Depression, Anxiety, and Stress Scale (DASS) revealed that the prevalence of anxiety among Malaysian T2DM patients was 30.5% (Kaur et al., 2013). Another local study mentioned that 31.4% of T2DM patients suffered from anxiety according to their HADS scores (Ganasegeran et al., 2014). Meanwhile, a study from Mexico showed that 55.10% of T2DM patients were positive for anxiety, according to the Hamilton Anxiety Rating Scale results (Tovilla-Zárate et al., 2012). The variabilities in the prevalence rate of depression and anxiety might be due to the different instruments used to screen for mental health problems, the patients backgrounds, characteristics, and the setting of the studies.

Medication nonadherence is a common problem among all patients, including those with chronic diseases. The present study revealed approximately 19% optimal adherence, as assessed by MyMAAT. However, a previous meta-analysis reported higher medication adherence at a rate of 34.4% among patients with T2DM, as assessed using MMAS-8 or MALMAS (Teng et al., 2022). In addition, two local studies using MMAS-8 reported that 44.7% and 43% of T2DM patients at different places showed low medication adherence (Chew et al., 2015; Jannoo & Mamode Khan, 2019). Moreover, depression has been reported to be a robust determinant factor of medication nonadherence among T2DM patients (Chew et al., 2015). In addition, a study in West Virginia mentioned that T2DM patients with depression exhibited lower adherence to oral hypoglycemic agents (OHAs) compared to patients without depression (Kalsekar et al., 2006). Medication nonadherence among T2DM patients could be accidental or intentional, where most patients forget to take the medications and achieve treatment goals (Sankar et al., 2018). In addition, one study found that T2DM patients with probable depression did not take their medication as prescribed, disregarded food restrictions, and neglected foot care (Zhang et al., 2015). The findings showed that nonadherent patients with T2DM were more than four times at risk of developing depression and anxiety. Previous studies also

reported that patients with T2DM and depression were more likely to be nonadherent to medication regimens (Mohamed et al., 2022; Sankar et al., 2018; Zhang et al., 2015). This suggests a link between these two comorbidities and the odds of maintaining optimal medication adherence.

Concerning uncontrolled diabetes based on HbA1c%, our findings did not support a significant association between controlled diabetes status and depression or anxiety. Similarly, a study using the Center for Epidemiological Studies Depression (CES-D) and the Zung Self-Rating Anxiety Scale (SAS) to assess depression and anxiety indicated that depression was not significantly related to HbA1c. In contrast, anxiety positively correlates with HbA1c among diabetes patients (Kendzor et al., 2014). In addition, previous studies emphasised the significant relationship between HbA1c and depression, in which depressed patients had higher HbA1c levels and were less likely to achieve target HbA1c than patients without depression (Sankar et al., 2018; Zuberi et al., 2011). In the present study, the lack of a significant association between depression and anxiety and diabetes control may imply a lack of a direct relationship. However, it cannot exclude the indirect relationship mediated through other factors, such as medication adherence, directly related to diabetes control and significantly affected by depression or anxiety.

Although previous research supported a relationship between keeping an exercise routine and having high mental wellbeing scores (Elnaem et al., 2022), the present study's findings did not support that exercise predicts the risk of depression or anxiety. Moreover, the present study supported the idea that patients with a normal BMI were at lower risk for depression than those overweight. Similarly, previous research reported that a higher BMI was associated with an increased risk of depression and anxiety (Roupa et al., 2009). This could highlight other dimensions that contribute to mental health among this population.

This study updates the current mental health assessment and associated factors among patients with type 2 diabetes in Indonesia and Malaysia. It highlights points to be considered for optimising diabetes care in two countries with heavy disease burdens. However, the study has several limitations. Methodological limitations include cross-sectional design, which restricts causal conclusions. Online data collection potentially engenders sampling bias. Self-reported questionnaires may lead to recall inaccuracies. Convenience sampling undermines generalizability. Sample representation limitations underscore that recruitment occurred exclusively through online channels where participants without internet access were excluded. The experiences of patients with low digital literacy remain unaddressed. Non-English speakers or those unfamiliar with Malay or Indonesian were not included. Patients with significant cognitive impairments were also excluded. Data collection constraints involve recruitment methods that may have introduced selection bias.

Conclusion

The study sample had concerning levels of depression and anxiety, especially in Indonesia. The prevalence of depression and anxiety was affected by the patient's age, diabetes duration, presence of diabetic foot ulcers, prescribed medication regimen, and medication adherence. More efforts are needed to improve mental health support for patients with T2DM in these two countries to optimise

management outcomes. This study advocates for mental health interventions in type 2 diabetes patients in Indonesia and Malaysia with recommendations for clinical practices to implement targeted mental health screening for specific demographics and develop strategies for patient support, including specialised mental health programs focusing on early intervention and counselling. In addition, comprehensive mental health assessments should be integrated into diabetes management, and culturally relevant strategies should be formulated. Finally, future research would be directed to conducting longitudinal studies assessing mental health trajectories and establishing standardised screening tools for Southeast Asian populations.

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Conceptualization, MHE, methodology, MHE, NSB; validation MHE, TTK, DL, and SR; writing – original draft preparation, MHE, NSB; writing – review and editing, MHE, MEE, DL and SR, all authors have read and agreed to the published version of the manuscript.

Data availability statement

All the data presented within this manuscript and the raw data are available upon request.

Ethical approval

Formal ethical approval for this study was first obtained from the IIUM Research Ethics Committee (IREC 2022–231). An additional ethical declaration was obtained from Universitas 17 Agustus 1954 Jakarta (No.68/KEPK-UTA45JKT/EC/EXE/07/2023). Participants were briefed on the strict confidentiality of their information and the anonymous use of their data for scientific research purposes only. By approving the online consent form at the beginning of the online survey, the participants were deemed to have consented to participate in the research. They were

also free to withdraw their consent during the study. All incomplete forms were disregarded in the final data analysis.

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