Glycemic Control And Depression Among Adults With Type 2 Diabetes Mellitus In Kiambu County

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Abstract
Introduction: Diabetes mellitus has been described as one of the 21st century global health emergencies. DM is among the four non communicable diseases causing 4M deaths annually (WHO, 2017). Glycemic control is measured by use of HbA1c. HbA1c measures glycemic control over the last eight to twelve weeks (WHO 2011). Good glycemic control has been shown to reduce both macro-vascular and micro-vascular complications. Depression is a mental illness characterized by feeling of sadness and loss of interest. It has an impact on how one feels, thinks and acts. It may affect one's day to day activities and quality of life. As per the DSM-5, depression is attributed by one or two of: -diminished or irritable mood or reduced pleasure or interest plus 4 of: loss of energy or fatigue, guilt or feeling of worthlessness, problems concentrating, suicidal ideations, five percent weight gain or loss, change in activity, lack of or increased sleep. These symptoms should have lasted for at least two weeks. Depression can be either mild, moderate or severe. Chronic medical conditions are a risk factor for development of depression. There is bidirectional association between DM and depression. Depression may lead to complications of excessive weight-gain and obesity which are risk factors for T2DM. The study helped in establishing the relationship between glycemic control and depression for optimum patient care

Study Objective: To determine the relationship between glycemic control and development of depression among type 2 diabetes patients in Kiambu county.

Methodology: Multistage sampling method was used to select 1 level 5 facility and 4 level 4 facilities. Simple random sampling was used to recruit 384 participants for this study. The participants signed an informed consent before participating in the study. An interviewer-administered questionnaire was used to collect data.
Results: A total of 380 patients participated in the study. Majority were elderly >60 years. Being widowed (52.8%) or divorced (55.9%) led to higher HbA1c and depression. Having a tertiary education level was associated with higher HbA1c level. Being unemployed, smoking, alcohol intake and obesity were all linked to higher HbA1c level and depression. Respondents who were on both OHAS and insulin and were non-compliant were more likely to have higher HbA1c levels and depression. Participants who had DM-related complications were more likely to have higher HbA1c level and depression. Age >60 years, being female, presence of another chronic illness and family history of mental illness were all linked to depression. Participants who had HbA1c >7% were significantly linked to higher chances of depression in this study.

Conclusion:
From the study, 55.3% had good glycemic control (HbA1c level <7%) while 44.7% had poor glycemic control (HbA1c >7%). The proportion of T2DM patients who had depression were 13% with majority having mild depression (11%). Moderate depression was present in 1% and severe depression was present in 1% of study population. Participants who had HbA1c >7% were significantly linked to higher chances of depression in this study.

I. INTRODUCTION

Globally DM prevalence is 9.3% (463M). Prevalence in urban areas is 10.8% while in rural it is 7.2%. Diabetes has been described as one of the 21st century global health emergencies. Diabetes mellitus is one of the four non communicable diseases causing worldwide 4M deaths annually (1). By 2040 deaths

due to DM are projected to increase by 92% in low-income countries (2). The ACCORD study found increased mortality in patients with poor glycemic control, a 66% mortality increment for every 1% elevation in HbA1c. Increased mortality was noted in patients with HbA1c > 7% (3). A study among the ageing population with T2DM showed that the level of HbA1c in patients with diabetes is linked to lifelong cognitive decline (4). Depression is a mental illness portrayed by feeling sad and loss of interest. There is reciprocal association connecting DM and depression (5). Depression remains under diagnosed in DM patients. Increased screening for depression in DM patients may improve DM outcomes. Major predictors of psychological distress among DM patients include sex, age, presence of comorbidities, duration of T2DM and HbA1c levels. There are no local studies on the relationship between glycemic control and development of depression among T2DM patients. This research will help in establishing the relationship between glycemic control and T2DM for optimum patient care.

II. MATERIALS AND METHODS

The study utilized a cross-sectional analytic study design and it was conducted in Kiambu County, Kenya. The population of the study consisted of T2DM patients who were on follow-up at the selected health facilities. Kiambu county was selected due to its diverse population and it's made up of both urban and rural set ups. It is also ranked 2nd in NCDs prevalence in Kenya.

A multi-stage cluster sampling method was used to select the health facilities from the clusters. Simple random sampling was then employed to get the study participants. Patients' files were used to get secondary data on the patients HbA1c level in the preceding 3 months.

The sample size was determined using Fischer's formula, considering a desired confidence level of 95 percent, a proportion of the population with the desired characteristic (55 percent), and a degree of precision of 5 percent. The final sample was 384 participants.

Inclusion criteria encompassed patients who were above 30 years and had been on follow up for more than 2 years. Exclusion criteria included patients who had conditions that could interfere with HbA1c level and those who could not adequately respond to the questionnaires. Data was collected using self-administered questionnaires that included both open-ended and closed-ended questions. A pilot study was conducted in Makueni county referral hospital to test the research instruments.

Quantitative data was collected using self-administered questionnaires. Questionnaires were convenient and saved time for both the researcher and respondents. Coded data was analysed using descriptive analysis, and quantitative methods were employed to measure relationships among variables.
Ethical approval was obtained from the relevant ethics committees and permission was obtained from the medical superintendents of the selected facilities. Informed consent was obtained from study participants, and confidentiality and privacy were maintained throughout the study.

III. RESULTS

In the analysis of demographic information, majority were more than 60 years. Most participants were female, married, had secondary education as their highest level, were self-employed, businessmen/women or farmers and lived in an urban set up (Table 1).

Table 1: Socio-Demographic Characteristics of the Study Participants

Characteristic		N=380	%
How old are you?	30- 39 years	23	6.0%
	40- 49 years	63	16.7%
	50- 59 years	131	34.5%
	Above 60 years	163	42.8%
Where do you live?	Rural	188	49.5%
	Town or CITY	192	50.5%
What is your gender?	Male	141	37.2%
	Female	239	62.8%
What is your marital status?	Single	33	8.7%
	Married	240	63.3%
	Divorced	35	9.2%

	Widowed	72	18.9%
What is your level of education?	Primary	133	35.0%
	Secondary	193	50.7%
	Degree or college diploma	54	14.4%
	Postgraduate	0	0.0%
What is your occupation?	Employed	79	20.7%
	Self-employed/ business/ farming	261	68.8%
	Unemployed	40	10.5%

Risk factors of the study participants

Only 3.1% were smokers and 23.6% used alcohol. Majority were overweight (Table 2)

Table 2: Risk factors of the Study Participants

		N	%
Do you smoke?	Yes	12	3.1%
How long have you been smoking?	Less than 1 year	1	8.3%
	1-5 years	9	75.0%
	5-10 years	1	8.3%
	More than 10 years	1	8.3%
Do you take alcohol	Yes	90	23.6%
How often do you drink?	Everyday	4	3.4%
	3-4 days a week	10	11.2%
	Once a week	37	41.6%
	Occasionally	39	43.8%
How many bottles do you drink in one sitting?	1 drink	18	20.2%
	2-3 drinks	64	71.9%
	4-5 drinks	6	6.7%
	More than 5 drinks	2	1.1%
What is the patients BMI?	<19kg/m2 (underweight)	9	.6%
	20-24.9 kg/m2 (normal)	96	25.4%
	25-29.9 kg/m2 (overweight)	225	62.3%
	≥30kg/m2 (obese)	50	11.7%

of the participants had good glycemic control (HbA1c >7%). (Figure 1)

T2DM Management and compliance to treatment

Majority of the participants had been on treatment for 2-9 years, were on oral hypoglycemic agents and reported compliance to treatment (Table 3)

Table 3: Management and compliance of the Study Participants

		N=380	%
How long have you been on treatment for diabetes?	2- 9 years	290	76.1%
	10- 19 years	84	22.3%
	More than 20 years	6	1.6%
What treatment for diabetes are you on?	Oral hypoglycemic agents	328	85.9%
	Insulin only	6	1.8%
	Oral hypoglycemic agents and insulin	46	12.3%
Are you compliant?	Yes	289	76.1%
	No	91	23.9%
Reasons for non-compliance	Lack of finances to refill medications	48	49.5%
	When I feel better, I stop taking medication	36	37.1%
	Forgetfulness	10	10..3%
	Side effects	2	2.4%
	Other	1	0.3%

DM related complications and HbA1c levels of study participants

DM related complications were uncommon among the study participants. Majority reported suffering from another chronic illness. Slightly more than half

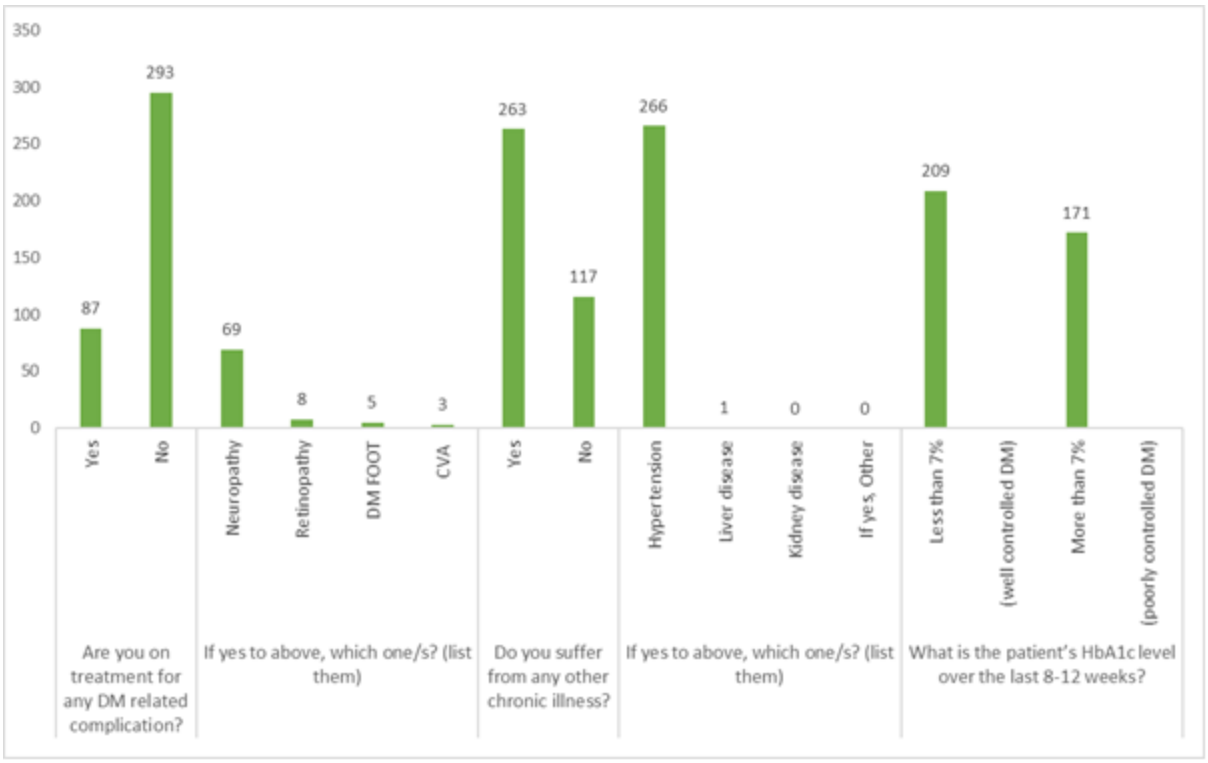

Figure 1: DM related complications and HbA1c level of study participants

Depression level of study participants
Majority had no depression (Figure 2)

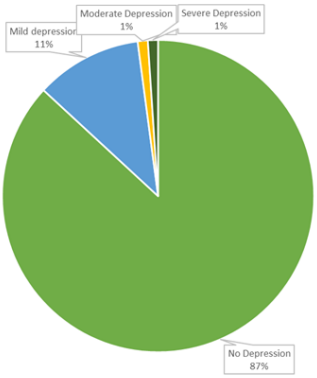

Figure 2: Depression level of study participants

		Depression Level				p-value
		No Depression		Depressed		
		N	%	N	%	
How old are you?	30- 39 years	19	86.4%	4	13.6%	0.021
	40- 49 years	59	95.2%	4	4.8%	
	50- 59 years	118	90.2%	13	9.8%	
	Above 60 years	133	81.1%	30	18.9%	
Where do you live?	Rural	154	82.4%	34	17.6%	0.014
	Town or CITY	173	91.0%	19	9.0%	

What is your gender?	Male	129	91.5%	12	8.5%	0.038
	Female	200	84.0%	39	16.0%	
What is your marital status?	Single	31	93.9%	2	6.1%	0.001
	Married	216	90.3%	24	9.7%	
	Divorced	29	82.9%	6	17.1%	
	Widowed	53	73.6%	19	26.4%	
What is your level of education?	Primary	104	78.2%	29	21.8%	0.001
	Secondary	175	91.1%	18	8.9%	
	Degree or college diploma	50	92.7%	4	7.3%	
	post graduate	0	0.0%	0	0.0%	
What is your occupation?	Employed	74	93.7%	5	6.3%	0.036
	Self-employed/ business/ farming	226	86.5%	35	13.5%	
	Unemployed	31	76.9%	9	23.1%	

Table 4: Socio-demographics and depression level of study participants

Socio-demographics and depression level

Factors such as Age, Area of residence, Gender, marital status, level of education and occupation had a statistically significant relationship with the depression level of the respondents. Those above 60 years, living in the rural areas, having a primary education as the highest level, being divorced or widowed, being female and unemployment were all linked to depression (Table 4)

Risk factors of participants and depression

Smoking, taking alcohol, abusing drugs and the frequency of smoking or alcohol intake had no relationship with the depression level of the respondents. BMI level of the patient had a statistically significant relationship with the depression level of the respondents (Table 5)

Table 5: Risk factors and depression level of study participants

		Depression level				p-value
		No Depression		Depressed		
		N	%	N	%	
Do you smoke?	YES	9	72.7%	3	27.3%	0.150
	NO	322	87.5%	46	12.5%	
How long have you been smoking?	Less than 1 year	2	100.0%	0	0.0%	0.086
	1-5 years	7	87.5%	1	12.5%	
	5-10 years	0	0.0%	1	100.0%	
	More than 10 years	0	0.0%	1	100.0%	
Do you take alcohol	Yes	80	88.8%	10	11.2%	0.526
	No	249	86.2%	41	13.8%	
If yes to the above, how often do you drink?	Everyday	2	66.7%	1	33.3%	0.466
	3-4 days a week	9	80.0%	2	20.0%	
	Once a week	34	91.7%	3	8.3%	
	Occasionally	35	89.7%	4	10.3%	
How many bottles do you drink in one sitting?	1 drink	18	100.0%	0	0.0%	0.143
	2-3 drinks	55	87.3%	8	12.7%	
	4-5 drinks	4	66.7%	2	33.3%	
	More than 5 drinks	1	100.0%	0	0.0%	
Do you	Yes	1	100.0%	0	0.0%	0.717

abuse any drugs?	No	223	88.4%	156	11.6%	
What is the patients BMI?	<19kg/m2 (Underweight)	3	0.0%	6	100.0%	0.006
	20-24.9 kg/m2 (Normal)	79	86.0%	17	14.0%	
	25-29.9kg/m2 (Overweight)	193	86.7%	32	13.3%	
	≥30kg/m2 (obese)	41	87.8%	9	12.2%	

DM treatment and compliance of participants and depression

Length of treatment, type of treatment and compliance with their treatment had a significant effect on the respondents' depression level. Being on treatment for DM for more than 20 years, taking both OHAs and insulin and non-compliance were all significantly associated with depression (Table 6)

Table 6: DM treatment and compliance and depression level of study paricipants

		Depression Scale				
		No Depression		Depressed		
		N	%	N	%	p-value
How long have you been on treatment for diabetes?	2- 9 years	259	89.9%	31	10.1%	0.005
	10- 19 years	65	77.6%	19	22.4%	
	More than 20 years	4	66.7%	2	33.3%	
What treatment for diabetes are you on?	Oral hypoglycemic agents	292	89.3%	36	10.7%	<0.0001
	Insulin only	6	100.0%	0	0.0%	
	Oral hypoglycemic agents and insulin	31	68.1%	15	31.9%	
Are you compliant?	Yes	266	92.4%	23	7.6%	<0.0001
	No	62	68.5%	29	31.5%	
Lack of finances to refill medications	No	26	74.3%	9	25.7%	0.347
	Yes	31	64.6%	17	35.4%	
When I feel better, I stop taking medication	No	28	57.1%	21	42.9%	0.007
	Yes	29	85.3%	5	14.7%	
Forgetfulness	No	52	70.3%	22	29.7%	0.369
	Yes	5	55.6%	4	44.4%	
Side effects	No	57	70.4%	24	29.6%	0.034
	Yes	0	0.0%	2	100.0%	
Other	No	57	69.5%	25	30.5%	0.136
	Yes	0	0.0%	1	100.0%	

DM related complications, presence of other chronic illnesses, HbA1c level and depression

Factors such as treatment for DM related complications, patients HbA1c level and suffering from chronic illnesses had a significant effect on the respondents' depression level. DM related complications and specific chronic illnesses had no significant effect on the depression level of the respondents. High HbA1c level >7% was significantly associated with depression (Table 7)

Table 7: DM related complications, chronic diseases and HbA1c level and depression

		Depression Scale				p-value
		No Depression		Depressed		
		N	%	N	%	
Are you on treatment for any DM related complication?	Yes	58	66.7%	29	33.3%	<0.0001
	No	272	92.8%	21	7.2%	
DM related complications	Neuropathy	46	67.6%	22	32.4%	0.170
	Retinopathy	4	50.0%	4	50.0%	
	DM FOOT	5	100.0%	0	0.0%	
	CVA	1	33.3%	2	66.7%	
Do you suffer from any other chronic illness?	Yes	221	83.3%	42	16.7%	<0.0001
	No	110	96.4%	7	3.6%	
Hypertension	No	0	0.0%	0	0.0%	
	Yes	221	83.1%	45	16.9%	
Liver disease	No	220	83.0%	45	17.0%	0.651
	Yes	1	100.0%	0	0.0%	
Kidney disease	No	221	83.1%	45	16.9%	
	Yes	0	0.0%	0	0.0%	
If yes, Other	No	221	83.1%	45	16.9%	
	Yes	0	0.0%	0	0.0%	
What is the patient's HbA1c level over the last 8-12 weeks?	Less than 7%	202	96.7%	7	3.3%	<0.0001
	More than 7%	128	75.1%	43	24.9%	

IV. DISCUSSION

Sociodemographic characteristics and T2DM

Majority of the study participants were > 60 years (42.8%). This is in agreement with a study done in 2019 which showed that T2DM is more common among the elderly compared to the middle-aged group .

In this study, majority of the participants were female (62.8%). This is in contrast to the diabetes risk assessment tool of the ADA guidelines that lists male sex as a risk factor for T2DM (6). This is explained by the differences in health seeking behavior between the males and females. Married people (62.8%) were more likely to suffer from T2DM in this study compared with those who were divorced, single or widowed. This is the opposite of a study done in Brazil in 2020 which showed that being divorced was associated with higher incidence of T2DM. Individuals who remained married regardless of their significant weight gain were less likely to get T2DM compared to those who divorced (7). Individuals who were living in urban settings (50.5%) were more likely to suffer from T2DM compared to those from the rural setup. This is in agreement to a study done in Peru in 2017, which showed majority of the study participants with T2DM to be urban dwellers (8). Majority of the study respondents with T2DM had secondary education (50.7%) as their highest level. This is in contrast to a study done in North East Iran which concluded that diabetes mellitus was more prevalent among the illiterate (19). T2DM was more prevalent among participants who were self-employed, farmers or businessmen/women (68.8%). This is a contrast to a study done in 2011 that showed that people who were unemployed were at a higher risk of developing T2DM across all models (10).

Individual risk factors and T2DM

Among the study participants with T2DM, 3.1% were smokers. This is in agreement with studies done that showed cigarette smoking to be an independent predictor of T2DM. A study conducted among individuals of European ancestry demonstrated a causal link between smoking and T2DM (11). Another study conducted in Japan estimated that18.8% of T2DM cases in men and 5.4% of T2DM cases in women were attributable to smoking (12).

This is due to insulin resistance caused by nicotine. Only 23.6% among the study respondents reported alcohol intake. This in agreement to studies which have shown that chronic alcohol use is a potential risk for T2DM due to insulin resistance and pancreatic beta-cell dysfunction (13). Higher BMI was common among the study participants (62.3%). This is consistent with data from SHIELD (The Study to Help Improve Early evaluation and management of risk factors Leading to Diabetes) and NHANES (National Health And Nutrition Examination Surveys) which reported that patients with higher BMIs are at an increased risk of developing T2DM (14). This is because obesity is associated with insulin resistance and beta cell dysfunction.

Treatment of T2DM, comorbidities and complications

Majority of the study participants were on OHAs. This is in line with the ADA 2020 guidelines which recommends use of metformin as first line for patients with T2DM (7). Most participants reported no complications (77%). This is in contrast to a study done in Gondar Hospital which showed that DM complications were common among patients with T2DMattending DOPC. It concluded that appropriate action is required to enhance glycemic control and prevent complications (15). This could be due to the level of care between the two study areas. In this study, majority of patients were attended to at the lower-level facilities which were unable to handle most complications hence the fewer number of patients with DM related complications. Presence of chronic diseases was evident in 69.4% with majority having hypertension (99.6%). This is comparable to a study done in 2016 which concluded that majority of patients with T2DM have multiple comorbidities (16). This is because diseases such as hypertension, ischemic heart disease, nephropathy and retinopathy have similar pathophysiologic risk profile to T2DM and are expected outcomes of T2DM or complications. poor glycemic control was common. It concluded that appropriate action is required to enhance glycemic control and prevent complications (15). This could be due to differences in the level of care between the two studies. Majority of the participants had good glycemic control (54.9%). This is in contrast to a study involving patients attending University of Gondar Hospital DOPC which showedpoor glycemic control was common. It concluded that appropriate action is required to enhance glycemic control and prevent complications (15). This could be due to differences in the level of care between the two studies.

Sociodemographic characteristics and depression

According to this study, Age had a statistical significance to depression. Participants >60 years (18.9%) were more likely to suffer from depression. This is in contrast to CDC 2019 national health interview survey which showed that depression was higher in those aged 18-29 years old (21.0%), followed by 45-64 years old (18.4%), >65 years (18.4%) and 30-44 years (16.8%). Majority of the participants in this study were elderly hence the discrepancy. Area of residence (0.014) was significantly associated with depression. Those who lived in the rural areas (17.6%) were more likely to suffer from depression compared to those in urban settings. This is in contrast to an American study among African-American and non-Hispanic white women which showed prevalence of depression was higher among those who lived in urban setups (17). This is possible due to differences in urbanization between the two countries. Gender had a statistical significance to depression in this study. Being female (16%) led to higher chances of getting depression. This is in line with a study done in 2019 which showed that women are more likely to suffer from and receive a diagnosis of depression compared to men (18). This is due to hormonal changes which may trigger depression. Another study conducted in a tertiary facility in Pakistan also showed that female gender was significantly associated with depression among T2DM (19). Marital status had a significant association with depression. Being divorced (17.1%) was associated with depression in this study. This compares well with a study done in 2017 which showed that prevalence of major depression is higher among individuals who are separated, divorced or widowed (20). This could be explained by the lack of moral support and lack of sharing of responsibilities among these groups. Level of education had a significance association with depression. Having primary education (21.8%) as the highest level was

linked to depression in the study. This is in contrast to a Canadian Community Health survey that showed that education level was inversely associated with depression (21). This could be as a result of differences in education level between the two countries. Occupation had a statistically significant relationship with the depression level of the respondents. Those who were unemployed (33.1%) were more likely to suffer from depression. This is in agreement to a study done among older adults in Finland, Spain and Poland which concluded that low socio-economic status is linked to an increased risk of depression (21). This is explained by the stress of struggling to provide basic needs to their families.

Individual risk factors and depression

Smoking (83.3%) was associated with depression though not statistically significant. This is in agreement with lot of studies that show a positive link between smoking and mental conditions though Literature is divided on this association (22) Taking alcohol (88.8%) was associated with depression though not statistically significant. This is in contrast to a study done in a Kenya psychiatric referral hospital which showed a positive association between major depression, panic disorder and alcohol use (23). Although studies have confirmed the association between the two, they have been unable to describe their relationship. The association has been shown to have a prevalence of 16- 68% (23). Participants who took alcohol everyday (33.3%) were more likely to suffer from depression though this association was not statistically significant. Alcohol causes inhibition leading to relaxation and reduced anxiety. This however wears off quickly leading to more negative feelings such as depression. This helps to explain the contradicting results in different studies. Drug abuse of the study participants had no impact on depression in this study. This is comparable to a study done in 2006 that concluded that the association between drug abuse and depression is not well understood (24). This could be due to difficulties in determining what led to the other. BMI level of the patient had a statistically significant relationship with the depression level of the respondents. Those who were underweight (100%) were more likely to be depressed. This is in contrast to a study on association of obesity and depression which have given contradictory outcomes. Some research discovered a positive link while others found a negative link but some found no link between the two (25). It however agrees with a meta-analysis and systematic review of longitudinal studies which concluded there was evidence for a significant U-shaped association between depression and BMI (26). This is because being overweight is a major source of dissatisfaction and sadness.

T2DM treatment compliance and depression

Length of treatment was significantly linked to depression level. Individuals who had been on treatment for T2DM for >20 years were more likely to suffer from depression. This is in line with studies that have shown that duration of T2DM <10 years and >30 years is associated with increase in odds ratio for depression, while 10-30 years' duration is not (27). Another study done in South Korea showed that depression was associated with longer duration of DM in elderly males with T2DM (28). This is due to negative thoughts and low mood because of the T2DM. Type of treatment had a significant link to depression. Participants who were on both OHAs and insulin were more likely to get depression compared to those who were on OHAs alone. This is comparable to a study done in 2012 that showed that the risk of depression was higher in patients receiving both OHAs and insulin (29). This is due to stress associated with daily insulin injections. Compliance to treatment had a significant effect on the respondents' depression level. Non-compliance was significantly associated with depression in this study. This is in contrast to a study done in 3 Chinese hospitals which showed no association between adherence to anti-DM medication and depression (30). This could be due to differences in the two populations.

Comorbidities and complications of T2DM against depression

Being on treatment for DM related complications was significantly linked to depression. This is in agreement to a study done in 2011 which concluded that depression was significantly linked to DM complications like diabetic nephropathy, retinopathy, erectile dysfunction, neuropathy and macro-vascular complications. This is due to stress associated with

these complications. Presence of another chronic illnesses had a significant effect on the respondents' depression level though the specific chronic illnesses were not linked to depression. This is in agreement to a study done in 2005 which showed a positive association between chronic illnesses and depression (31). This may be due to stress associated with the chronic illness.

HbA1c level and depression

High HbA1c level >7% was significantly associated with depression ($p<0.0001$) in this study.

CONCLUSION

Among the study participants, 55.3% had good glycemic control (HbA1c level <7%) while 44.7% had poor glycemic control (HbA1c >7%)

The proportion of T2DM patients in this study who had depression were 13% with majority having mild depression (11%). Moderate depression was present in 1% and severe depression was present in 1% of study population.

Participants who had HbA1c >7% were significantly linked to higher chances of depression in this study.

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