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RESEARCH ARTICLE

Association between Obesity and Depression in Patients with Type 2 Diabetes Mellitus

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Abstract

Background: The prevalence of depression was two-fold higher in diabetic patients versus the general population. The combination of depression and diabetes is an important and complicated public health issue. The presence of metabolic alterations in patients with type 2 diabetes, such as obesity, could increase the severity of depression.

Aim of the Study: The aim of this study was to determine if obesity increases the risk for depression in patients with type 2 diabetes.

Methods: This cross-sectional study was conducted in Shariatpur Sadar Upazila Health Complex and Private Hospitals, Asthma and Diabetes Care Center, Shariatpur, Bangladesh, from March 2020 to August 2020. A total of 339 diagnosed type 2 diabetes mellitus and obesity with symptoms of depression were included in this study. Among them, 53 patients with depression and 286 patients without depression were considered as Group I and Group II, respectively. BMI of ≥30 kg/m2 was considered as obesity. Statistical analyses of the results were obtained using window-based computer software devised with Statistical Packages for Social Sciences (SPSS-22).

Results: Nearly one-third (29.2%) of patients were in the third decade, and the female ratio was 1:1.8. Majority (98.1%) of patients had hyperlipidemia in Group I and 90(31.5%) in Group II. Patients having BMI ≥30 kg/m2 increased Risk 2.14 times with 95% CI 1.03-4.5 to develop depression in patients with type 2 diabetes. Family history of diabetes increased Risk 1.93 times with a 95% CI 1.0-2.8 to develop depression in patients with type 2 diabetes.

Conclusion: Hyperlipidemia, MI, HTN and BMI are traced as the significant determinants of type 2 DM with depression. It can be assumed that patients with type 2 DM and obesity are more likely to suffer from severe depression than those without.

Keywords: Depression, Diabetes, Neuropsychiatric Disorders, Obesity.

1. Introduction

Depression is one of the most common mental health disorders, with a lifetime prevalence estimated at approximately 20% of the worldwide population [1]. According to the World Health Organization (WHO), the global prevalence of depression is about 5%, second only to cardiovascular diseases as the leading cause of functional impairment in patients by the year 2020. Any individual can suffer from depression; however, the risk is higher among those with type 2 diabetes mellitus than in the general population. Nevertheless, obesity and diabetes have emerged

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as enormous public health problems not only in the United States (US) but also globally [2]. Previous studies have shown that the prevalence of depression was two-fold higher in diabetic patients versus the general population [3,4]. Khaledi et al. (2019) conducted a meta-analysis of 248 studies around the world and showed that the prevalence of depression in those affected by type 2 diabetes mellitus was 28% [5]. This rate was much higher than the 5% reported for the general population by WHO. Alajmani et al (2019) studied 559 type 2 diabetes mellitus patients in Dubai, United Arab Emirates (UAE) and found that the rate of depression in these patients was 17% [6]. In Vietnam, the prevalence of depression was reported to be 25.6% in a study involving 606 diabetic patients at the centre of Endocrinology (Quang Ngai province) using the PHQ-9 score of 9 as a cutoff [7]. The combination of depression and diabetes is an important and complicated public health issue, though the causal relationship between depression and diabetes is not well understood [1]. Depression can be not only a cause but also a result of hyperglycemia. Diabetes is a chronic condition with a strict treatment regimen that typically includes adherence to medication, diet, and physical activity. Moreover, diabetes can also lead to many complications, including macro- and micro-vascular diseases, neuropathy, and nephropathy [8]. They also stated that diabetes is one of the most common causes of economic burden, comorbidities and an increase in mortality in the world. These factors become a psychological burden for patients, which can lead them down a path towards depression [1]. Furthermore, depressed patients with type 2 diabetes mellitus have worse adherence to dietary, medication, physical inactivity, and metabolic and glucose control problems, which can exacerbate diabetic complications resulting in disease severity and increasing healthcare expenditures, thereby lowering patients' quality of life [9]. Diabetes type 2 is a complex disease where hereditary and metabolic factors interfere [10]. Researchers suggested that there is a correlation between T2DM and mood alterations such as depression and neuropsychiatric disorders, for instance, major depressive disorder, schizophrenia, mild cognitive impairment and suicidal behavior [11,12]. An overactivation of GSK-3 may play an important role in the pathogenesis of the development of schizophrenia and mood disorders such as bipolar disorder and major depression in patients with diabetes mellitus type 2 [13]. Furthermore, it has been suggested that the presence of metabolic alterations in patients with type 2 diabetes, such as obesity, could increase the severity of depression [14].The distinct mechanisms that link obesity to insulin resistance and diabetes mellitus type 2 are related to increased production of adipokines and more adipose tissue as a result; these molecules are involved in many clinical manifestations of diabetes mellitus type 2, and they are also associated with arterial hypertension and cardiovascular disease [15,16]. Moreover, research by Svenningsson et al. (2012) suggested an association between depression and obesity in patients with diabetes mellitus type 2 in both 1genders [17]; this study reported that at least one in five men and one in three women showed depression in diabetic type 2 patients with obesity. It has been hypothesized that obesity and depression are related, and some authors describe the comorbidity between obesity and depression as an epidemic [18]. A meta-analysis synthesizing the results from the previous community-based studies found a modest association (pooled odds ratio = 1.18) between obesity and depression [19]. Most of the studies identified a stronger relationship between obesity and depression in women and in individuals with lower educational levels [18,20]. Soriguer et al. (2012) reported that an estimated 8%-9% of adults worldwide have type 2 diabetes mellitus (T2DM), and a substantial increase in prevalence over time has been observed. The prevalence of T2DM in the Spanish population is even higher (13.8%). The coexistence of diabetes and mental disorders has a strong impact on the patient, with an increased risk of cardiovascular disease (CVD), all-cause mortality and cardiovascular mortality [22,23]. especially as a result of cardiovascular complications of T2DM. In addition, patients with diabetes and mental disorders show poorer compliance with treatment recommendations than patients with T2DM without depression and more frequently have cardiovascular risk factors such as smoking, obesity, sedentary lifestyle and poor glycaemic control, which can impact their health-related quality of life [3]. In a cross-sectional study on patients with T2DM, Alonso-Morán et al. (2014) reported that 9.8% of patients were diagnosed with depression (5.2% men and 15.1% women), and in a study by Nicolau et al. (2016), 27.2% of patients had symptoms of depression [24,25]. However, in these studies, data collection was often based on health surveys or self-reported scales, which yielded heterogeneous data [26]. Thus, mental disorders have not been assessed using a clinical interview as the 'gold standard'. Roy et al. (2012) concluded that depression is a common co-morbid health problem in T2DM outpatients in Bangladesh [4], with more than one-

third of patients reporting elevated depression scores regardless of depression screeners and data collection methods used. Within this sample of outpatients with diabetes, we found that female gender, older age, low income, treatment with combined insulin and oral medications, poorly controlled T2DM, and those with coexisting complications of diabetes were independent risk factors for depression symptoms. However, to our knowledge, research on common mental disorders affecting patients with T2DM is scarce in Bangladesh. Therefore, the present study aimed to estimate the prevalence of depression in patients diagnosed with T2DM and to identify sociodemographic, clinical and psychological factors associated with the occurrence of depression in this population.

2. Methodology and Materials

This is a cross-sectional study. The study was conducted at Shariatpur Sadar Upazila Health Complex and Private hospitals, Asthma and Diabetes Care Center in Shariatpur, Bangladesh. The study duration was one year, from March 2020 to August 2020. In this study using a purposive sampling technique, a total of 339 diagnosed type 2 diabetes mellitus and obesity with symptoms of depression were included. The study population were divided into two groups;

Group I (N=53): Patients with depression

Group II (N=286): Patients without depression

In this study, depression was defined using the validated PHQ-9 tool. The study categorized and graded participants with depression as follows: those with a score of 0 had no depression, 1-4 minimal, 5-9 mild, 10-19 moderate, and 20-27 severe depression. A trained psychologist made the diagnosis following an interview. The BMI was calculated using height and weight, and a BMI of ≥30 kg/m2 was considered obese. The fasting blood glucose and the HbA1C tests were used to diagnose diabetes. A written informed consent was obtained from all patients. A structured questionnaire was used to record all the patients' relevant particulars. Ethical clearance for the study was taken from the IRB (Institutional et al.) and Department of Medicine and concerned authority, the Ethical Committee of Shariatpur Sadar Upazila Health Complex and Private Hospitals, Asthma and Diabetes Care Center.

2.1 Inclusion Criteria

- Participants aged ≥18 years.
- Patients with obese type 2 diabetes mellitus and symptoms of depression.

2.2 Exclusion Criteria

- Patients diagnosed with type 1 diabetes.
- Articles focused on treatment and complications of diabetes mellitus type 2.
- Publication or clinical trials focused on treating Metabolic and psychiatric diseases.

2.3 Operational Definitions

Obesity: A BMI of ≥30 kg/m2 was considered obesity.

Depression: Depression was defined using the validated PHQ-9 tool. Patients with a score of 0 had no depression, 1-4 minimal, 5-9 mild, 10-19 moderate, and 20-27 severe depression.

2.4 Statistical Analysis

Statistical analyses were done using the Statistical Package for Social Sciences version 22.0 for Windows (SPSS). Quantitative variables were presented as means ± standard deviations and tested by the unpaired t-test. Frequencies and percentages indicated the quantitative observations, and the Chi-Square test was used to analyze them, as cross-tabulation shows. Obesity and depression were considered as dependent variables, and covariates were age, sex, hypertension, education, area of residence, SBP and DBP. Odds ratio with a 95% confidence interval was performed, and $P<0.05$ was considered a statistically significant difference.

3. Results

Most of 286(84.36%) patients were non-depressive and 53(15.63%) patients were depressive (Figure 1). Table 1 shows the distribution of the study patients by socio demographic profiles. It was observed that one fourth (26.4%) patients belonged to age 51-60 years in Group I and 65(22.7%) in Group II. The mean age was 46.26±10.41 years in Group I and 44.26±12.51 years in Group II. Two third (66.0%) patients were female in Group I and 185(64.7%) in Group II. Majority (94.3%) patients were married in Group I and 270(94.5%) in Group II. More than half (52.8%) patients education level were primary in Group I and 140(49.0%) in Group II. More than one third (41.5%) patients employed in Group I and 120(42.0%) in Group II. The difference was statistically not significant ($p>0.05$) between two groups. Table 2 shows the distribution of the study patients by personal history. It was observed that one fourth (73.6%) patients had smoking in Group I and 62(21.7%) in Group II. Seven patients had consumption of alcohol in

Group I and 46(16.1%) in Group II. The difference was statistically not significant (p>0.05) between two groups. Table 3 shows the distribution of the study patients by diabetes mellitus. It was observed that more than three fourth (79.2%) patients belonged to duration ≤10 years in Group I and 271(94.8%) in Group II. The mean duration was 4.87±3.37 years in Group I and 3.70±4.39 years in Group II. More than two third (69.8%) patients had family history of diabetes in Group I and 156(54.5%) in Group II. The difference was statistically not significant (p>0.05) between two groups. The mean BMI was 26.9±0.07 (kg/m^2) in Group I and 24.3±0.20 (kg/m^2) in Group II. The difference was statistically significant (<0.05) between two groups (Table 4). Table 5 shows the distribution of the study patients by clinical features. It was observed that majority (98.1%) patients had hyperlipidemia in Group I and 90(31.5%) in Group II. The difference was statistically not significant (p>0.05) between two groups. Table 6 shows the distribution of the study patients by demographic characteristic. It was observed that more than three fourth (77.4%) patients belonged to BMI ≥30 (kg/m2) in Group I and 176(61.5%) in Group II. More than two third (69.8%) patients had family history of diabetes in Group I and 156(54.5%) in Group II. More than half (54.7%) patients belonged to age <50 years in Group I and 116(40.6%) in Group II. Patient haring BMI ≥30 kg/m2 increased Risk 2.14 times with 95% CI 1.03-4.5 to developed depression in patient with type 2 diabetes. Family history of diabetes increased Risk 1.93 times with 95% CI 1.0-2.8 to developed depression in patient with type 2 diabetes. Age was not significantly associated with depressio

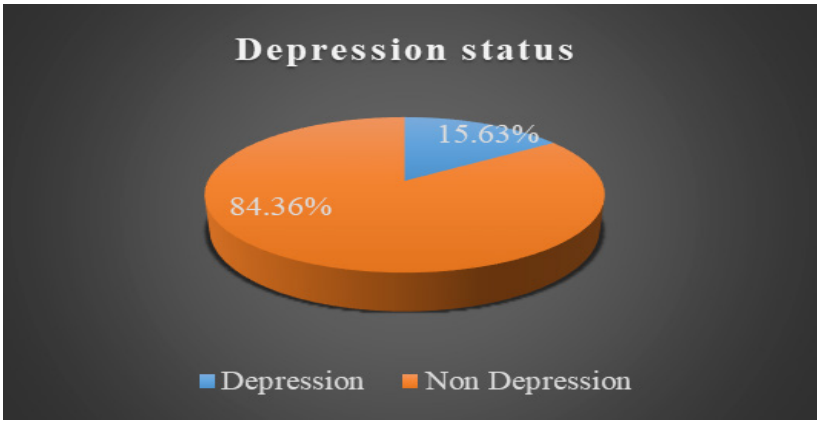

Figure 1. *Pie chart showing distribution of the study patients by depression status.*

Table 1. *Distribution of the study patients by socio demographic profiles (n=339).*

Characteristics	Group I (n=53)		Group II (n=286)		P value
	n	%	n	%	
Age (in years)					
≤20	0	0	5	1.7	[a]0.274[ns]
21-30	7	13.2	30	10.5	
31-40	9	17	90	31.5	
41-50	12	22.6	77	26.9	
51-60	14	26.4	65	22.7	
61-70	11	20.8	19	6.6	
Mean±SD	46.26±10.41		44.26±12.51		
Range (min-max)	21-70		21-70		
Sex					
Male	18	34	101	35.3	[b]0.849[ns]
Female	35	66	185	64.7	
Marital status					
Married	50	94.3	270	94.5	[b]0.925[ns]
Unmarried	2	3.8	12	4.2	
Divorced	0	0	1	0.3	
Widowed	1	1.9	3	1	

Educational status					
No studies	12	22.6	80	28	[b]0.788[ns]
Primary	28	52.8	140	49	
High school	10	18.9	45	15.7	
University	3	5.7	21	7.3	
Occupation					
Employed	22	41.5	120	42	[b]0.421[ns]
Unemployed	13	24.5	73	25.5	
Retired	15	28.3	59	20.6	
Housewife	3	5.7	34	11.9	

Table 2. *Distribution of the study patients by personal history (n=339).*

Personal history	Group I (n=53)		Group II (n=286)		P value
	n	%	n	%	
Smoking					
Yes	14	26.4	62	21.7	0.447[ns]
No	39	73.6	224	78.3	
Consumption of alcohol					
Yes	7	13.2	46	16.1	0.596[ns]
No	46	86.8	240	83.9	

Table 3. *Distribution of the study patients by diabetes mellitus (n=339).*

Diabetes mellitus	Group I (n=53)		Group II (n=286)		P value
	n	%	n	%	
Duration (in years)					
≤10	42	79.2	271	94.8	
11-20	11	20.8	15	5.2	
Mean±SD	4.87±3.37		3.70±4.39		0.066[ns]
Range (min-max)	0.17-20		0.17-20		
Family history of diabetes	37	69.8	156	54.5	

Table 4. *Distribution of the study patients by BMI (n=339).*

Variables	Group I (n=53) Mean±SD	Group II (n=286) Mean±SD	P value
BMI (kg/m^2)	26.9±0.07	24.3±0.20	0.001[s]
Range (min-max)	16.1-32.5	14.1-32.5	

Table 5. *Distribution of the study patients by clinical features (n=339).*

Clinical features	Group I (n=53)		Group II (n=286)		P value
	n	%	n	%	
Hyperlipidemia	52	98.1	90	31.5	0.907[ns]
MI	6	11.3	6	2.1	
HTN	4	7.5	5	1.7	
IHD	3	5.7	5	1.7	
Hypothyroidism	2	3.8	3	1	

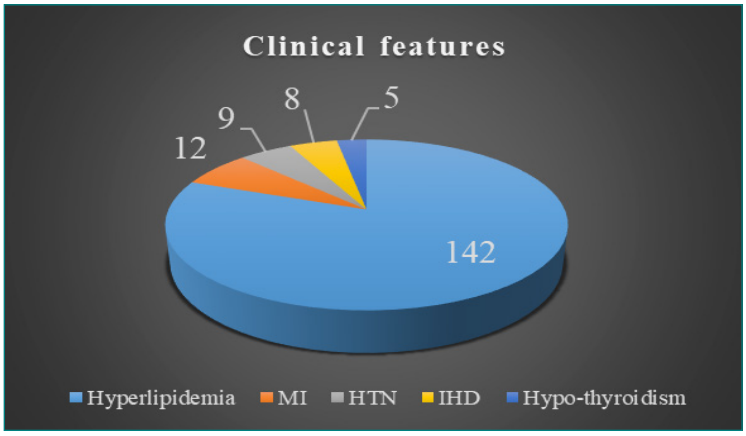

Figure 4. *Pie chart showing distribution of the study patients by clinical features.*

Table 6. *BMI, Family history of diabetes and Age effect of depression and potential risk factors on type 2 diabetes incidence (n=339).*

Variables	Group I (n=53)		Group II (n=286)		OR (95% CI)	P value
	n	%	n	%		
BMI (kg/m^2)						
≥30	41	77.4	176	61.5	2.14(1.03-4.5)	0.028^s
<30	12	22.6	110	38.5		
Family history of diabetes						
Present	37	69.8	156	54.5	1.93(1.0-3.8)	0.039^s
Absent	16	30.2	130	45.5		
Age (in years)						
≥50	24	45.3	170	59.4	0.56(0.3-0.06)	0.056^{ns}
<50	29	54.7	116	40.6		

4. Discussion

In this study, the distribution of the study patients by socio-demographic profiles showed that almost one-third (29.20%) of patients belonged to age 31-40 years. The mean age was 45.26±11.51 years. Almost two thirds (64.9%) of patients were female, and 119(35.1%) were male. The majority (94.4%) of patients were married, followed by 14(4.1%) unmarried, 4(1.2%) widowed, and 1(0.3%) divorced. Almost half (49.6%) of patients' education level was primary, followed by 92(27.1%) no studies, 55(16.2%) high school and 24(7.1%) university. More than one-third (41.9%) of patients were employed, followed by 86(25.4%) unemployed, 74(21.8%) retired, and 37(10.9%) housewives. In a study, Khan et al. (2019) reported that nearly half (44.2%) of patients were between 41 to 60 years of age, with a mean age of 48.6±18.0 years. Sunny (2019) reported that the mean age in years (mean±SD = 54.3±11.2) was among the study population, which is comparable to our study [27]. In a study, Roupa et al. (2009) reported that among 310 persons with Diabetes Mellitus II, 56 % were women 44% were men, 78 % of the subjects were married, 11% were widowed/divorced, and 10.3% were unmarried [28]. Similarly, Zavala et al. (2018) reported the predominance of obesity and depression in women as compared to men [18]. Regarding education level, most of the studies identified a stronger relationship between obesity and depression in individuals with lower educational levels, which is by our study [18,20]. Kim et al. (2019) reported that about 23.5% of the participants were included in an unschooled category, whereas participants with higher education comprised 27.5% of all participants [29]. Mocan et al. (2016) stated that being in employment was inversely associated with depression (OR 0.595; p=0.012), as shown elsewhere [30]. This aspect suggests that going to work might have a protective role against depression owing to the social support received from co-workers. In a study, Tran et al. (2021) reported that multivariate logistic regression analysis indicated several factors associated with depression in participants: poor economic status, unstable or part-time work, having stress during the past year, without/poor treatment adherence to type 2 diabetes mellitus, and engaging in heavy physical activity or physical activity less than three days per week [1]. In the present study, the distribution of the

study patients by personal history showed that 76 (22.4%) patients had smoking and 53% patients had consumption of alcohol. In a similar study, Roupa et al. (2009) observed that 61.6% of the participants were no smokers, while 38.4 % were smokers [28]. In established T2D, Geade et al. (2016) reported that cigarette smoking is a relatively weak modifiable risk factor [31]. Salinero-Fort et al. (2018) observed that the variables inversely associated with depression were being employed (OR 0.595; 95%CI 0.397 to 0.894; p=0.012), low physical activity (OR 0.552; 95%CI 0.408 to 0.746; p≤0.001), systolic blood pressure (OR 0.982; 95%CI 0.971 to 0.992; p=0.001), current alcohol use (OR 0.726; 95%CI 0.552 to 0.954) [23]. In this study, regarding the distribution of the study patients by diabetes mellitus, it was observed that the majority (92.33%) of patients belonged to a duration ≤10 years. The mean duration was 4.28±3.89 years. More than half (56.9%) of patients had a family history of diabetes. Darwish et al. (2018) reported that the durations of diabetes <10 years or >30 years were associated with increased odds of depression [33]. The increase in depression with longer durations of diabetes was shown to be mediated by increased frailty scores [34]. Salinero-Fort et al. (2018) reported that although there would be quite a possibility of association with a positive family history, no statistically significant differences were observed between patients with depression and psychologically healthy subjects with a family history of diabetes [23]. In this study, regarding the distribution of the study patients by clinical features, it was observed that more than one-third (41.9%) patients had hyperlipidemia, followed by 12(3.5%) MI, 9(2.7%) HTN, 8(2.4%) IHD and 5(1.5%) hypothyroidisms. It is worth mentioning that as well as being the diagnostic hallmark of T2D, hyperglycemia is the principal determinant of microvascular complications of T2D and plays an important role in the pathogenesis of CVD. However, in established T2D, it is a relatively weak modifiable risk factor compared with hypertension and dyslipidemia [31,35]. Petrie et al. (2018) reported that although T2D and hypertension are each complex and heterogeneous phenotypes associated with an elevated risk of life-threatening cardiovascular disease (CVD) [36]. However, the frequent coexistence in the same individual is not a coincidence because aspects of the pathophysiology are shared by both conditions, particularly those related to obesity and insulin resistance. Hypertension is an important risk factor for diabetes-associated vascular complications because hypertension itself is characterized by vascular dysfunction and injury. The distinct mechanisms that link obesity to insulin resistance and diabetes mellitus type 2 are related to increased production of adipokines and more adipose tissue as a result; these molecules are involved in many clinical manifestations of diabetes mellitus type 2, and they are also associated with arterial hypertension and cardiovascular disease [15,16]. Authors reported that T2D confers an approximate 2-fold elevation in CVD risk, equivalent to a previous myocardial infarction [36,37]. Moreover, patients with T2D have poorer outcomes after an acute coronary syndrome and higher rates of reinfarction and heart failure. Wang (2013) reported that there is a deep underlying relationship between diabetes mellitus and thyroid dysfunction [38]. Many studies have evidenced complex, intertwining biochemical, genetic, and hormonal malfunctions mirroring this pathophysiological association [39]. Hypothyroidism (Hashimoto's thyroiditis) or thyroid overactivity (Graves' disease) has been investigated to be associated with diabetes mellitus. A meta-analysis reported a frequency of 11% in thyroid dysfunction in the patients of diabetes mellitus [40]. Autoimmunity has been implicated to be the major cause of thyroid dysfunction-associated diabetes. In this study, regarding the distribution of the study patients by socio-demographic profiles, it was observed that one-fourth (26.4%) of patients belonged to age 51-60 years in Group I and 65(22.7%) in Group II. The mean age was 46.26±10.41 years in Group I and 44.26±12.51 years in Group II. Two-thirds (66.0%) of the patients were female in Group I, and 185(64.7%) were female in Group II. The majority (94.3%) of patients were married in Group I and 270(94.5%) in Group II. More than half (52.8%) of patients' education level was primary in Group I and 140(49.0%) in Group II. More than one-third (41.5%) of patients were employed in Group I and 120(42.0%) in Group II. The difference between the two groups was statistically insignificant (p>0.05). Singh et al. (2014) reported a mean age of 44 years [41]. Zhang et al. (2010) found more females (58.4%) in the study group [42]. Raval et al. (2010) from India examined 300 cases of diabetes, of which the mean age was 54.2±10 years [43]. They found a strong association between depression and age (>54), neuropathy, nephropathy, body mass index (BMI) (>25), income >5000 INR/month, diabetic foot and pill burden. Park et al. (2015) reported that the unemployed participants had 2.40 [95% confidence interval (CI) 1.21-4.76], and the low-income participants had 2.57 (95% CI 1.52-4.35) [44]. In this

study, the distribution of the study patients by personal history showed that one-fourth (73.6%) of patients had smoking in Group I and 62(21.7%) in Group II. Seven patients had consumption of alcohol in Group I and 46(16.1%) in Group II. The difference between the two groups was statistically insignificant (p>0.05). Park et al. (2015) reported that the participants who are currently smoking had 2.03 (95% CI 1.10-3.73), and those without regular exercise had 1.91 (95%CI 1.17-3.14) times higher odds of depression in the severe-depression group, compared with the without-depression group [45]. In this study, regarding the distribution of the study patients by diabetes mellitus, it was observed that more than three-fourths (79.2%) of patients belonged to duration ≤10 years in Group I and 271(94.8%) in Group II. The mean duration was 4.87±3.37 years in Group I and 3.70±4.39 years in Group II. More than two-thirds (69.8%) of patients had a family history of diabetes in Group I and 156(54.5%) in Group II. The difference between the two groups was statistically insignificant (p>0.05). In a study, Kim et al. (2019) reported that a total of 154 participants with T2DM were included in the analysis; the mean T2DM duration was 12.8 years, which is in accordance with our study [29]. They also stated that the duration of diabetes has been reported to influence the development of depression, and the longer the duration of T2DM, the risk for developing diabetic complications and healthcare expenditures increases, resulting in a higher risk of psychological illnesses. In the present study, the mean BMI was 26.9±0.07 (kg/m2) in Group I and 24.3±0.20 (kg/m2) in Group II. The difference was statistically significant (<0.05) between the two groups. In a study, Roupa et al. (2009) observed that extremely obese individuals with a BMI > 35 exhibit more anxiety 52.5 % and depression 35.4 % in comparison to overweight and obese people [28]. They also reported that a high BMI also favors the occurrence of a modest-severe symptomatology of anxiety, as the relative risk increases of 3.9 % per one BMI unit increase. As for the depression parameter, women were presented with a 3.3 times higher probability of depression of modest-severe symptomatology, with the risk increasing by 4% for any further BMI unit.In this study, regarding the distribution of the study patients by clinical features, it was observed that the majority (98.1%) of patients had hyperlipidemia in Group I and 90(31.5%) in Group II. The difference between the two groups was statistically insignificant (p>0.05). Almost comparable observations were reported by authors [45]. De Hert et al. (2009) also emphasized the low rates of treatment for hypertension, dyslipidaemia and diabetes to manage depression [46]. They stated that the relative beneficial effects of lipid lowering with statins are similar in older and younger patients with diabetes, and the absolute benefit is typically greater in older than in younger patients. In this study, the distribution of the study patients by demographic characteristic showed that more than three-fourths (77.4%) of patients belonged to BMI ≥30 (kg/m2) in Group I and 176(61.5%) in Group II. More than two-thirds (69.8%) of patients had a family history of diabetes in Group I and 156(54.5%) in Group II. More than half (54.7%) of patients belonged to age <50 years in Group I and 116(40.6%) in Group II. Patients having BMI ≥30 kg/m2 increased risk 2.14 times with 95% CI 1.03-4.5 to develop depression in patients with type 2 diabetes. Family history of diabetes increased risk 1.93 times with a 95% CI 1.0-2.8 to develop depression in patients with type 2 diabetes. Age was not significantly associated with depression. By our findings, Roupa et al. (2009) reported that extremely obese individuals with a BMI >35 exhibit more anxiety, 52.5% and depression, 35.4%, when compared to overweight and obese people [28]. Moreover, they stated that a high BMI also favors the occurrence of a modest-severe symptomatology of anxiety, as the relative risk increases of 3.9 % per one BMI unit increase as for depression parameter. Regarding the age of study subjects, Khan et al. (2019) reported that nearly half (44.2%) were between 41 and 60 years of age, with a mean age of 48.6 ± 18.0 years, which is comparable to our study [47]. In another study, Sunny (2019) reported that the mean age in years (mean ± SD = 54.3 ± 11.2) was among the study population [27]. Salinero-Fort et al. (2018) reported that although there would be a chance of association with a positive family history, no statistically significant differences were observed between patients with depression and psychologically healthy subjects with a family history of diabetes [35].

Limitations of the study: Relatively small sample size of our study population. Single center for patients' selection with short duration.

5. Conclusion

In this study, hyperlipidemia, MI, HTN and BMI are traced as the significant determinants of type 2 DM with depression. It can be inferred that patients with type 2 DM and obesity are more likely to suffer from severe depression than those without. Given the high

prevalence of depression among patients with type 2 DM, awareness of depression in DM should be raised among clinicians. Nevertheless, screening of patients with type 2 DM for co-morbid depression and its risk factors is also recommended. Therefore, it could be assumed that this study protocol on diabetes and depression will bring to light knowledge gaps in the area and offer insight for future research works.

6. Recommendation

Overall, more randomized clinical trials with larger patient cohorts with obesity and depression in T2DM patients are still essential for further data generation to reveal the ill-explored facts while resolving prevailing issues and controversies. Moreover, further multicenter research works with an extensive study population are needed to formulate strategies that appear warranted in the appropriately directed management.

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