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Research article

Association and interaction between overweight/obesity and suicide attempts in young first-episode and drug-naïve patients with major depressive disorder

Quanfeng Zhu [a,1], Jinjin Wang [a,1], Yali Zheng [a], Xiaoe Lang [b], Xiang-Yang Zhang [c,*]

[a] Affiliated Xiaoshan Hospital, Hangzhou Normal University, Hangzhou, China
[b] Department of Psychiatry, First Hospital/First Clinical Medical College of Shanxi Medical University, Taiyuan, China
[c] Affiliated Mental Health Center of Anhui Medical University, Hefei Fourth People's Hospital, Anhui Mental Health Center, China

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ABSTRACT

Aims: This research's objective was to explore the correlation of overweight/obesity and suicide attempts in young patients with major depressive disorder (MDD) and the related factors of suicide attempts in patients with/without overweight/obesity.
Methods: This study included 520 young patients with MDD who were first-episode and drug-naïve (FEDN), with an average age of 20.50 ± 2.36 years. Height and weight of each subject were measured, and overweight was classified as 24≤BMI<28, and obesity as BMI≥28.Biochemical indicators were detected including blood glucose, lipid, and thyroid function indicators. Depressive symptoms, anxiety symptoms, and psychotic symptoms were evaluated using Hamilton Rating Scale for Depression (HAMD), Hamilton Anxiety Rating Scale (HAMA) and Positive and Negative Syndrome Scale (PANSS) positive subscale, respectively.
Results: Overweight/obesity was a separate factor influencing suicide attempts in subjects($p < 0.05$, OR = 0.57, 95%CI: 0.34–0.95). Higher HAMD, HAMA scores, levels of total cholesterol (TC), thyroid stimulating hormone (TSH), and prevalence of thyroid peroxidase antibody abnormalities were seen in overweight/obese individuals who attempted suicide(all p values < 0.01).While in patients without overweight/obesity, those who attempted suicide had higher HAMD, HAMA, PANSS positive subscale scores, levels of TSH, fasting blood glucose, TC, blood pressure, prevalence of TSH abnormalities, and lower levels of high-density lipoprotein cholesterol(all p values < 0.01).
Conclusions: In young FEDN patients with MDD, overweight/obesity might influence the incidence of suicide attempts and related influences.

1. Introduction

Globally, depression is a very common mental illness, both in adults and adolescents [1,2]. According to statistics, depression's prevalence in female is almost twice as high as in male, and approximately 16 % of the population will be affected by depression during their lifetime [3].Unfortunately, only 30–40 % of patients in remission after a single antidepressant treatment, and the majority of

* Corresponding author. 316 Huangshan Road, Shushan District, Hefei, Anhui Province, 230022, China.
E-mail address: zhangxy@psych.ac.cn (X.-Y. Zhang).
[1] Quanfeng Zhu and Jinjin Wang contributed equally to this work.

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patients do not have a good prognosis [4]. At the same time, depression is very prone to relapse, with statistics showing that more than 75 % of people with depression experience at least 1 or more episodes within 10 years [5]. Failure to receive treatment or unsatisfactory treatment results cause many depressions to eventually progress to major depressive disorder (MDD). With the increasing pressure of modern society, depression is gradually getting younger. Some prospective studies suggested that first episodes of depression are likely to occur in early adolescence, while the prevalence of depression is low before adolescence [6]. And adolescent patients with depression are more likely to experience chronic relapse and poor functioning across the lifespan [7].

MDD is a severely debilitating disease. Important features of patients with MDD are depressed mood, decreased interest, poor nutrition, loss of appetite and sleep disorders [8]. MDD is a serious drain on society's resources, and regarded as the second most important factor contributing to the worldwide burden of chronic illness [9]. In addition, a number of illnesses, including diabetes and heart disease, are more likely to develop in patients with MDD, which further adds to the burden caused by MDD [9]. Most deadly of all, MDD is one of the primary causes of disability in the world [10].

Co-morbid obesity in depressed patients is common, and many epidemiological studies have confirmed a significant correlation between depression and obesity [11]. According to reports, abdominal obesity is most strongly correlated with depression [12]. Abdominal obesity often indicates accumulation of visceral fat in body, which largely represents various endocrine and metabolic disorders, which may be one of the intrinsic reasons for the correlation between obesity and depression [13]. Among obese people, those with metabolic disorders are at significantly greater risk of depression, which provides some basis for above view [13].

Depression and suicide have a very significant correlation, and depression has been considered a major cause of suicide. According to statistics, persons with MDD are 20 times more likely to commit suicide than persons without the disorder [14]. Around 800,000 individuals kill themselves every year all around the world, half of which occur during episodes of depression [14]. There have been many studies and guidelines that cite depressive symptoms as a risk factor or even a necessary cause of suicidal thoughts and behaviors [15]. However, some studies have also shown a weak or even insignificant association between depression and suicide [16,17].

In recent years, the age of patients with MDD has been trending younger, and the prevalence of obesity in these patients is much higher than in healthy population. Although some current research on adolescents has focused on obesity or suicide [18,19], little is known about the effect of overweight/obesity on suicide risk in adolescents with depression. We hypothesized that overweight/obesity would have a direct or indirect impact on suicide risk in adolescent patients with MDD, and this study aimed to explore the impact of overweight/obesity on suicide attempts in them, as well as the impact of overweight/obesity on related factors of suicide attempts.

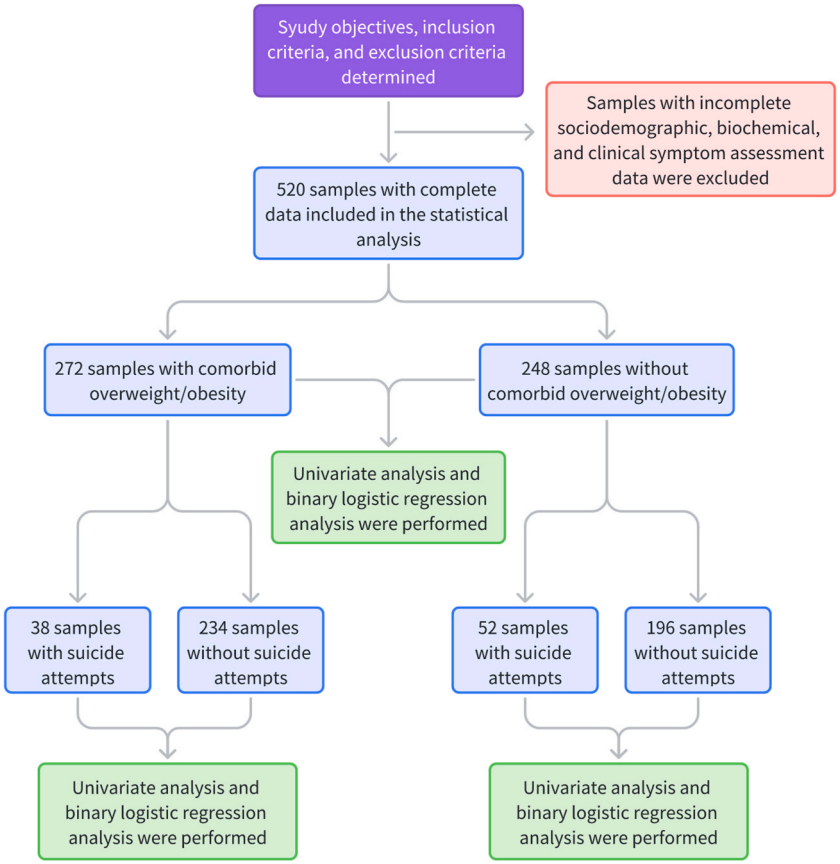

Fig. 1. Flow chart of this study.

2. Methods

2.1. Subjects recruitment

All processes and operations of this study were in accordance with the Declaration of Helsinki and was approved by the Medical Ethics Committee of First Hospital of Shanxi Medical University (No.2016-Y27). And each subject participating in this study has signed a written informed consent.

The inclusion criteria for this study were: (1) Chinese Han population aged from 18 to 25 years; (2) met the diagnosis of MDD after structured clinical interview for the Diagnostic and Statistical Manual, 4th edition (DSM-IV); and (3) first-episode and drug-naïve (FEDN). The exclusion criteria were: (1) drug dependence, alcohol dependence, or history of related medical conditions; (2) patients with persistent infections, undergoing immune enhancement or immunosuppression, or the presence of severe physical illness; and (3) nursing or pregnant women. Based on the aforementioned standards, 520 qualified individuals were chosen from the psychiatric outpatient clinic of the First Hospital of Shanxi Medical University between January 2015–December 2017 after excluding those cases with missing clinical data.

2.2. Study design

This research was cross-sectional, and the main research process was shown in Fig. 1. First, subjects were recruited according to the inclusion and exclusion criteria. After excluding samples with missing demographic information, biochemical indicators, and clinical evaluation data, samples with complete data were included in the subsequent statistical analysis. Next, subjects were categorized into two groups with/without overweight/obesity and univariate and binary logistic regression analyses were performed, at which stage we explored the variables that differed significantly between the two groups of subjects with or without overweight/obesity. Finally, the two groups were subgrouped again according to suicide attempts and again subjected to univariate and binary logistic regression analyses, in which we investigated the risk variables connected to suicide attempts among subjects with or without overweight/obesity, respectively.

2.3. Sociodemographic information collection

Sociodemographic data, including age, gender, marital status, education, and duration of illness was collected. For each patient, height and weight were measured on admission, and body mass index (BMI) was calculated. According to the BMI criteria of the Chinese population, $24 \leq BMI < 28$ and $BMI \geq 28$ were defined as overweight and obese, separately [20]. In addition, we learned about each subject's suicide attempts in the form of interviews, including number, manner, and timing of suicide attempts.

2.4. Clinical symptoms assessment

To ensure the accuracy of the assessment results, the two psychiatrists in charge of the assessment uniformly attended training in the use of the scales prior to conducting the clinical assessment of this study.

In this study, 17-item Hamilton Rating Scale for Depression (HAMD-17), and 14-item Hamilton Anxiety Rating Scale (HAMA-14) were employed to evaluate patients' depressive symptoms, and anxiety symptoms, respectively.

HAMD-17 (Chinese version, Cronbach's α coefficient >0.8) consists of 17 items, of which 9 items contain 5 options, 1 item contains 4 options, and 7 items contain 3 options, each of which is rated from 0 to 1 and 2 ….. representing symptoms from none to severe, respectively [21,22]. The lowest score of HAMD-17 is 0 for no depressive symptoms and the highest score is 53 for the most severe depressive symptoms.

HAMA-14 (Chinese version) consists of 14 items, each of which is scored using a 5-point Likert scale (0–4, 0: asymptomatic, 4: severe), with a maximum HAMA-14 score of 56, with higher total scores representing more severe anxiety symptoms [23].

In addition, since some studies have reported the association of positive psychotic symptoms with suicide [24,25], the present study applied the Positive and Negative Syndrome Scale (PANSS) positive subscale score to assess positive symptoms in each subject.

PANSS (Chinese version, Cronbach's α coefficient = 0.93) contains three subscales: positive subscale, negative subscale, and general psychopathology subscale [26]. The positive subscale of the PANSS scale used in this study consists of seven items, each using a 7-point Likert scale (1–7, 1: asymptomatic, 7: very severe), which were used to assess the following positive psychotic symptoms in patients: delusion, conceptual disorganization, hallucinatory behavior, excitement, grandiosity, suspiciousness/persecution, and hostility, separately. Higher scores on this scale represent more severe positive psychotic symptoms in patients.

2.5. Detection of biochemical indicators

Each participant was instructed to fast after 8 p.m. the night before and complete the blood sample collection between 6 and 8 a.m. the following day. Subjects were tested for biochemical parameters including blood glucose, blood lipid and thyroid function.

Fasting blood glucose (FBG), total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were tested by ARCHITECT C8000 System (Abbott Laboratories, Irving, TX, USA). Thyroid stimulating hormone (TSH), free triiodothyronine (FT3), free thyroxine (FT4), anti-thyroglobulin antibody (TgAb) and thyroid peroxidase antibody (TPOAb) were tested by Roche C6000 Electrochemiluminescence Immunoassay Analyzer (Roche Diagnostics,

Indianapolis, IN, USA). And blood pressure (BP) was measured by Omron HBP-1300 electronic manometer.

In this study, the diagnostic criteria for TSH abnormalities, TgAb abnormalities, and TPOAb abnormalities were TSH >4.20 mIU/L, TgAb> 115 IU/L, and TPOAb> 34 IU/L, respectively [27].

2.6. Statistical analysis

First, all samples were divided into two groups according to whether they were overweight/obesity, and Kolmogorov-Smirnov Test was used for normality testing of continuous variables. Then, in order to analyze the related factors of overweight/obesity, we performed T-Test (conforming to normal distribution) and Mann-Whitney *U* Test (not conforming to normal distribution) for all continuous variables and Chi-Square Test for all categorical variables, using overweight/obesity as the dependent variable. Next, binary logistic regression analysis was conducted to investigate the extent of effect of overweight/obesity on suicide attempts using suicide attempts as dependent variable, overweight/obesity as independent variable, and variables that differed significantly after above aforementioned univariate analyses as covariates. The same approach was then used to analyze the influences associated with suicide attempts among patients with and without overweight/obesity. In addition, point biserial correlation was used to analyze the association of suicide attempts with other continuous variables in patients with/without overweight/obesity. SPSS 25.0 software was used to perform all statistical analyses for this investigation. P values obtained from all Univariate analyses were corrected by Bonferroni correction, and the corrected p value < 0.05 was considered significant for differences.

Table 1
Sociodemographic and clinical characteristics of young FEDN MDD patients with/without overweight/obesity.

Variable	Patients with overweight/obesity (N = 272)	Patients without overweight/obesity (N = 248)	t/χ2/Z	p	Effect size Cohen's d/φ (Phi)
Age	20(18–22)	20(18–22)	−1.07	1	0.08
Duration of illness, months	4(2.5–6)	4(2.5–6)	−0.48	1	0.09
Gender			0.15	1	0.02
Male, n (%)	112(41.2 %)	98(39.5 %)			
Female, n (%)	160(58.8 %)	150(60.5 %)			
Education			−0.03	1	0.01
Junior high school, n (%)	10(3.7 %)	12(4.8 %)			
High school, n (%)	146(53.7 %)	130(52.4 %)			
University degree, n (%)	108(39.7 %)	96(38.7 %)			
Master's degree, n (%)	8(2.9 %)	10(4.1 %)			
Marital status			0.67	1	0.04
Single, n (%)	232(85.3 %)	205(82.7 %)			
Married, n (%)	40(14.7 %)	43(17.3 %)			
HAMD score	30(28–32)	30(28–32)	−0.08	1	0.01
HAMA score	20(18–22)	21(18–23)	−0.63	1	0.06
PANSS positive subscale score	7(7~7)	7(7~7)	−0.08	1	0.02
Systolic BP, mmHg	112(106–118)	110(102–118)	−2.33	0.47	0.18
Diastolic BP, mmHg	74(70–77)	70(68~75.75)	−2.64	0.20	0.20
TC, mmol/L	5.02(4.36–5.89)	5(4.26–5.96)	−0.20	1	0.06
TG, mmol/L	2.04(1.44–2.78)	1.84(1.32–2.83)	−1.33	1	0.06
HDL-C, mmol/L	1.26(1.02–1.42)	1.24(0.99–1.44)	−0.54	1	0.03
LDL-C, mmol/L	2.80(2.22–3.40)	2.85(2.30–3.53)	−1.31	1	0.09
FBG, mmol/L	5.34(4.90–5.78)	5.26(4.89–5.78)	−0.16	1	0.01
TSH, uIU/mL	4.83(3.75–6.33)	4.18(2.78–6.62)	−2.41	0.39	0.14
FT3, pmol/L	5.11(4.53–5.51)	4.90(4.32–5.44)	−1.85	1	0.18
FT4, pmol/L	16.54(14.29–18.93)	16.55(14.72–18.71)	−0.28	1	0.03
TgAb, IU/L	19.12(13.27–27.28)	21.17(14.43–34.61)	−2.04	1	0.03
TPOAb, IU/L	15.43(11.58–28.94)	19.49(12.79–38.02)	−3.14	0.04	0.12
TSH abnormality			9.83	0.04	0.14
Yes, n (%)	172(63.2 %)	123(49.6 %)			
No, n (%)	100(36.8 %)	125(50.4 %)			
TgAb abnormality			1.12	1	0.05
Yes, n (%)	37(13.6 %)	42(16.9 %)			
No, n (%)	235(86.4 %)	206(83.1 %)			
TPOAb abnormality			2.97	1	0.08
Yes, n (%)	56(20.6 %)	67(27.0 %)			
No, n (%)	216(79.4 %)	181(73.0 %)			

All p-values greater than 1 after Bonferroni correction are shown as 1.

t, χ2, Z: the statistical values in T-Test, Chi-Square Test, and Mann-Whitney *U* Test, respectively; HAMD: Hamilton Rating Scale for Depression; HAMA: Hamilton Anxiety Rating Scale; PANSS: Positive and Negative Syndrome Scale; BP: blood pressure; TC: total cholesterol; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; FBG: fasting blood glucose; TSH: thyroid stimulating hormone; TgAb: anti-thyroglobulin antibody; TPOAb: thyroid peroxidase antibody; FT3: free triiodothyronine; FT4: free thyroxine.

3. Results

Of the 520 young FEDN patients with MDD, 210 were male and 310 were female, 272 were co-morbidly overweight or obese, with a co-morbidity rate of 52.3 %. The mean age of subjects was 20.50 ± 2.36 years and the mean duration of illness was 4.50 ± 2.96 months. There were no notable distinctions between the two groups of subjects with and without overweight/obese on the above sociodemographic variables (all p values > 0.05) (Table 1). In addition, overweight/obese and non-overweight/obese individuals did not differ significantly from one another on the clinical characteristics of HAMD, HAMA, and PANSS positive subscale scores (all p values > 0.05). Compared to those without overweight/obesity, overweight/obese patients had significantly higher prevalence of TSH abnormality, lower levels of TPOAb (both p values < 0.05). After including factors with $p < 0.05$ before correction as covariates (TSH, TgAb, TPOAb, systolic and diastolic BP), overweight/obesity and suicide attempts had a strong association with one another ($p < 0.05$, OR = 0.57, 95%CI: 0.34–0.95). This suggested that overweight/obesity was an independent related factors of suicide attempts.

Among overweight/obese young FEDN patients with MDD, 112 were male and 160 were female, the individuals' average age was 20.60 ± 2.33 years and the average duration of MDD was 4.63 ± 3.17 months. The incidence of suicide attempts was 13.97 % (38/272). Patients with and without suicide attempts did not differ significantly from one another on the above demographic variables (all p values > 0.05). And as shown in Table 2, suicide-attempted individuals had higher HAMD, HAMA scores, levels of TC, TSH, and higher prevalence of TPOAb abnormalities (all p values < 0.01). In addition, suicide attempts were significantly correlated with scores of HAMD ($r = 0.24$, $p < 0.01$), HAMA ($r = 0.24$, $p < 0.01$), and levels of TSH ($r = 0.25$, $p < 0.001$), TPOAb ($r = 0.22$, $p < 0.01$), TC ($r = 0.24$, $p < 0.01$), and systolic BP ($r = 0.21$, $p < 0.01$).

Among young FEDN patients with MDD without overweight/obesity, 98 were male and 150 were female, the average age of patients was 20.40 ± 2.38 years and the average duration of MDD was 4.36 ± 2.72 months. The prevalence of suicide attempts was 20.97 % (52/248). Patients who attempted suicide had higher scores of HAMD, HAMA, PANSS positive subscale, levels of TSH, FBG, TC, systolic and diastolic BP, prevalence of TSH abnormalities and lower levels of HDL-C than those who did not (all p values < 0.01) (Table 2). And suicide attempts were significantly correlated with scores of HAMD ($r = 0.34$, $p < 0.001$), HAMA ($r = 0.38$, $p < 0.001$), PANSS positive subscale ($r = 0.27$, $p < 0.001$) and levels of TSH ($r = 0.42$, $p < 0.001$), TPOAb ($r = 0.31$, $p < 0.001$), FBG ($r = 0.23$, $p < 0.01$), TC ($r = 0.31$, $p < 0.001$), HDL-C ($r = -0.28$, $p < 0.001$), systolic BP ($r = 0.41$, $p < 0.001$) and diastolic BP ($r = 0.31$, $p < 0.001$).

After binary logistic regression analysis, higher rates of TPOAb abnormalities were substantially correlated with risk of suicide attempts ($p < 0.05$, OR = 2.55, 95 % CI:1.14–5.71) in patients with overweight/obesity (Table S1). While in patients without comorbid overweight/obesity, HAMA scores ($p = 0.001$, OR = 1.30, 95 % CI:1.11–1.54) were significantly correlated with risk of suicide attempts (Table S2).

4. Discussion

Our main results showed that: (1) young FEDN patients with MDD with comorbid overweight/obesity had a lower risk of suicide attempts compared with those without overweight/obesity; (2) among overweight/obese patients, those who attempted suicide showed higher scores of HAMD, HAMA, PANSS positive subscale, levels of BP, FBG, TC, and prevalence of TgAb, TPOAb abnormalities, and lower HDL-C levels; (3) HAMA scores, TPOAb levels might be biomarkers to assess suicide attempts.

Some previous studies have tended to link obesity to an increased risk of suicidal behavior because obese individuals have significantly higher rates of emotional problems and mental illnesses such as depression, which are high risk factors for suicide [28,29]. However, this conclusion is too arbitrary because it did not distinguish between ages of patients. It is well known that people's behavior and psychology differ significantly at different ages [30]. In addition, they also failed to distinguish between suicide attempts and suicidal ideation, it has been suggested that males may have more attempts and females may have only suicidal ideation without acting on it [31,32]. And many studies have shown the opposite results, which found that suicide and BMI were negatively correlated. For example, a study by Bjerkeset suggested that people with higher BMI had a lower risk of suicide despite a higher risk of depression [33]. These paradoxical outcomes suggested that suicide may be mediated by mechanisms other than depression. Different cultural backgrounds, different substance use, and other factors can have an impact on suicide. According to our research, young FEDN patients with MDD who were overweight or obese had a decreased risk of suicide attempts. Of course, future studies with larger sample sizes are needed to more accurately explore the relationship between overweight/obesity and suicide risk.

A large number of studies have shown that depression is a high risk factor for suicide risk [34,35]. The results of our study were similar, suicide attempt risk was positively correlated with more severe depressed symptoms. In addition, anxiety and individual anxiety sensitivity were considered associated with suicide risk [36]. A study by Wiebenga showed that anxiety disorders were linked to increased risks of suicidal ideation and attempts, and they thought that this association might be related to dysregulation of the immune-inflammatory system [37]. The relationship between psychotic symptoms and suicide has also been investigated in earlier research. Positive symptom was confirmed as a risk factor for suicidal behavior [38,39]. For example, Huang's team found that among patients with schizophrenia, suicide attempts were significantly higher in those with more severe positive symptoms [35]. This may be due to patients' psychotic symptoms such as hallucinations, and delusions that promote their suicidal behavior. In young overweight/obese patients with MDD, we also found a correlation between positive symptoms and higher risks of suicide attempts.

Lipid metabolism has also been associated with suicide risk. Many studies have explored the correlation between levels of lipid, especially TC, LDL-C and suicidal ideation, and have even used lipid levels as biomarkers to predict suicide [40]. For example, studies by Messaoud and Segoviano-Mendoza revealed that lower TC was significantly linked to severe depressive symptoms and suicide attempts [41,42]. Aguglia and Ayesa-Arriola et al. found an association between low LDL-C level and suicidal behavior [43,44]. However, there were studies that reported the opposite view, patients with suicide attempts had significantly higher levels of TC and

Table 2
Influencing factors of suicide attempts in FEDN MDD patients with/without overweight/obesity.

Variable	Patients with overweight/obesity					Patients without overweight/obesity				
	Patients with suicide attempts (N = 38)	Patients without suicide attempts (N = 234)	t/χ2/ Z	p	Effect size Cohen's d/φ (Phi)	Patients with suicide attempts (N = 52)	Patients without suicide attempts (N = 196)	t/χ2/ Z	p	Effect size Cohen's d/φ (Phi)
Age	21(18.75–24)	20(18–22)	−1.24	1	0.23	20.5(19–23)	19(18–22)	−2.03	1	0.29
Duration of illness, months	3.5(2.5–8)	4(2.5–6)	−0.61	1	0.25	4.5(2.63–7)	3.5(2.5–5)	−2.09	0.87	0.35
Gender			0.34	1	0.04			1.21	1	0.07
Male, n (%)	14(36.8 %)	98(41.9 %)				24(46.2 %)	74(37.8 %)			
Female, n (%)	24(63.2 %)	136(58.1 %)				28(53.8 %)	122(62.2 %)			
Education			−0.76	1	0.05			−0.84	1	0.06
Junior high school, n (%)	2(5.3 %)	8(3.4 %)				3(5.8 %)	9(4.6 %)			
High school, n (%)	17(44.7 %)	129(55.1 %)				29(55.8 %)	101(51.5 %)			
University degree, n (%)	18(47.4 %)	90(38.5 %)				19(36.5 %)	77(39.3 %)			
Master's degree, n (%)	1(2.6 %)	7(3.0 %)				1(1.9 %)	9(4.6 %)			
Marital status			0.62	1	0.05			0	1	0
Single, n (%)	34(89.5 %)	198(84.6 %)				43(82.7 %)	162(82.7 %)			
Married, n (%)	4(10.5 %)	36(15.4 %)				9(17.3 %)	34(17.3 %)			
HAMD score	32(30–33)	30(28–32)	−3.73	0.005	0.71	32(30–34)	30(27–32)	−4.98	<0.001	0.87
HAMA score	22(20–24)	20(17–22)	−4.09	0.001	0.76	22(21–25)	20(18–22)	−5.27	<0.001	0.93
PANSS positive subscale score	7(7~11.25)	7(7~7)	−2.52	0.28	0.38	7(7~12.5)	7(7~7)	−3.78	0.004	0.59
BMI, kg/m^2	25.38(24.97–26.53)	25.49(24.56–26.45)	−0.17	1	0.28	22.54(21.67–23.31)	23.12(22.13–23.49)	−1.87	1	0.36
Systolic BP, mmHg	115(110–124)	112(105–118)	−2.69	0.17	0.55	119(110.25–127)	108(101–115)	−5.61	<0.001	1.01
Diastolic BP, mmHg	75(72~79.25)	74(69.75–76)	−2.57	0.25	0.51	75(70–80)	70(68–75)	−4.25	<0.001	0.75
TC, mmol/L	5.74 ± 1.21	5.00 ± 1.02	4.06	0.002	0.67	5.70(5.05–7.03)	4.82(4.18–5.73)	−4.78	<0.001	0.79
TG, mmol/L	2.03(1.55–2.87)	2.04(1.43–2.78)	−0.19	1	0.03	1.83(1.34–2.96)	1.84(1.3–2.76)	−0.46	1	0.10
HDL-C, mmol/L	1.13(0.89–1.31)	1.27(1.09–1.42)	−2.33	0.47	0.38	1.04(0.84–1.25)	1.27(1.04–1.46)	−4.46	<0.001	0.71
LDL-C, mmol/L	3.23 ± 1.22	2.78 ± 0.86	2.18	0.83	0.43	3.15(2.56–3.65)	2.72(2.28–3.46)	−2.14	0.79	0.31
FBG, mmol/L	5.66 ± 0.76	5.34 ± 0.63	2.89	0.10	0.47	5.66(5.21–6.11)	5.23(4.84–5.69)	−3.64	0.007	0.55
TSH, uIU/mL	6.34(4.32–8.30)	4.73(3.67–6.04)	−3.56	0.009	0.66	7.45(4.81–8.89)	3.62(2.35–5.66)	−6.06	<0.001	1.09
FT3, pmol/L	4.745(4.26–5.73)	5.12(4.55–5.48)	−0.56	1	0.07	4.58(4.18–5.37)	4.98(4.39–5.44)	−1.30	1	0.18
FT4, pmol/L	16.99 ± 3.22	16.77 ± 3.16	0.40	1	0.07	16.80 ± 3.22	16.68 ± 2.88	0.27	1	0.04
TgAb, IU/L	22.62(16.14–121.11)	18.62(13.09–25.46)	−2.39	0.40	0.16	29.03(15.43–164.6)	19.67(13.93–28.89)	−2.80	0.12	0.19
TPOAb, IU/L	30.55(12.70–106)	15.26(11.41–25.27)	−2.95	0.08	0.46	24.72(15.38–222.92)	17.68(12.58–32.2)	−2.96	0.07	0.66
TSH abnormality			4.69	0.73	0.13			22.52	<0.001	0.30
Yes, n (%)	30(78.9 %)	142(60.7 %)				41(78.8 %)	82(41.8 %)			
No, n (%)	8(21.1 %)	92(39.3 %)				11(21.2 %)	114(58.2 %)			
TgAb abnormality			6.07	0.33	0.15			8.95	0.07	0.19
Yes, n (%)	10(26.3 %)	27(11.5 %)				16(30.8 %)	26(13.3 %)			
No, n (%)	28(73.7 %)	207(88.5 %)				36(69.2 %)	170(86.7 %)			
TPOAb abnormality			12.51	0.01	0.21			7.80	0.13	0.18
Yes, n (%)	16(42.1 %)	40(17.1 %)				22(42.3 %)	45(23.0 %)			
No, n (%)	22(57.9 %)	194(82.9 %)				30(57.7 %)	151(77.0 %)			

All p-values greater than 1 after Bonferroni correction are shown as 1.
t, χ2, Z: the statistical values in T-Test, Chi-Square Test, and Mann-Whitney *U* Test, respectively; HAMD: Hamilton Rating Scale for Depression; HAMA: Hamilton Anxiety Rating Scale; PANSS: Positive and Negative Syndrome Scale; BP: blood pressure; TC: total cholesterol; TG: triglyceride; HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; FBG: fasting blood glucose; TSH: thyroid stimulating hormone; TgAb: anti-thyroglobulin antibody; TPOAb: thyroid peroxidase antibody; FT3: free triiodothyronine; FT4: free thyroxine.

LDL-C [45,46]. There are many reasons for these variable results, such as the different age stages of patients and the dietary habits of different regions. The present research suggested that among young overweight/obese patients with MDD, those with suicide attempts had significant higher TC and lower HDL-C. However, it is not possible to simply correlate these lipid levels with suicide risk, because suicide behavior may involve a variety of complex physiological, psychological, and environmental factors, and using a single blood lipid level as a biomarker of suicide may be arbitrary [40].

Levels of FBG and BP were comparatively elevated in MDD individuals who had attempted suicide [47]. According to research, glucose metabolism disorders can accelerate the development process of MDD, and blood glucose levels can affect patients' depressive symptoms through many ways such as metabolic factors, signaling pathways, and genetic factors. Abnormal glucose metabolism leads to a loss of serotonin activity in the brain, which may be associated with depressive behavior [48]. In the current research, we similarly found an association between the risk of suicide attempts and higher levels of glycemic lipid levels.

There are no uniform conclusions about the relationship between thyroid function and suicide risk. Several related studies have shown that thyroid function abnormalities such as autoimmune hypothyroidism and positive anti-thyroid antibodies were associated with higher risk of suicide [49]. Thyroid hormones may influence suicidal behavior by regulating neurotransmitters such as serotonin and norepinephrine [50]. Additionally, thyroid peroxidase antibodies are associated with characteristic signs of depression, all of which may be mechanisms by which thyroid function affects suicide [51]. In current research, abnormal TgAb and TPOAb levels were connected to a higher incidence of suicide attempts.

This research focused on the correlation of overweight/obesity and suicide attempts in young FEDN patients with MDD. Regardless of whether individuals were overweight/obese, we discovered that elevated levels of TSH and TC were linked to an increased likelihood of suicide attempts. The difference was that in overweight/obese patients, most of them suffered from TSH abnormalities regardless of whether they had suicide attempts, whereas in patients without overweight/obesity, the majority of patients without suicide attempts had normal TSH levels, and the prevalence of TSH abnormalities was higher in those who had suicide attempts. As for TC levels, significantly more patients with suicide attempts had abnormal TC levels, regardless of whether they were accompanied by overweight/obesity. We observed the correlation of HDL-C and suicide attempts only in patients without overweight/obesity, whereas in overweight/obese individuals, the difference in HDL-C levels between patients with/without suicide attempts was not as pronounced. Previous studies have found that BMI can alter the relationship between HDL-C and stroke, and the researchers found a negative relationship between HDL-C levels and stroke risk in subjects with BMI <24 kg/m^2, while no such association was found in subjects with BMI >24 kg/m^2 [52]. Our findings seem to suggest that BMI can also modify the correlation between HDL-C levels and suicide attempts in subjects. Furthermore, it is interesting to note that we found significant associations between FBG, BP and suicide attempts only in patients without overweight/obesity; however, if the correction criterion for p-values is reduced from Bonferroni correction to False discovery rate (FDR) correction, the associations between FBG, BP and suicide attempts will be seen in all patients, with or without overweight/obesity. Of concern is that higher blood pressure and glucose levels are still associated with risk of suicide attempts, although they are within normal baseline levels. This seems to suggest the importance of keeping blood pressure and glucose levels reasonably low, although the mechanism of this correlation still needs further study.

We acknowledge some limitations of our study. First, the characteristics of cross-sectional study predetermined that our samples were all from the same time period, and therefore the conclusions obtained may be subject to a high degree of chance. Second, our study did not set up a healthy control group, and did not analyze some sensitive factors of suicide, such as work stress, life stress, and environmental factors. Third, the samples in this study were all from the same region, so the generalizability of the findings may be limited. Fourth, multiple subtypes of MDD were present in the patients included in this study, such as MDD with psychotic features. Fifth, this study used the data we collected in the past, which belongs to the reuse of clinical data, which to some extent is not good for the real-time nature of research data. Sixth, confounding factors such as smoking, which may contribute to suicide attempts, were not assessed in this study.

5. Conclusion

The role of obesity on suicide attempts among young MDD patients is being examined for the first time in this study. We found that among young FEDN patients with MDD, the risk of suicide attempts was conversely lower in overweight/obese individuals. Patients who attempted suicide had higher levels of TC and TSH and more severe symptoms of depression and anxiety, regardless of whether they were overweight/obese. The correlation between higher blood glucose, pressure and risk of suicide attempts, on the other hand, was more often seen in patients without concomitant overweight/obesity. We believe that the correlation between obesity and suicide risk could next be explored in different subtypes of depression or other psychiatric disorders, as well as the use of longitudinal studies to continue to explore whether there is an effect of weight loss on the intensity of suicidal ideation in obese patients with MDD.

CRediT authorship contribution statement

Quanfeng Zhu: Writing – original draft. **Jinjin Wang:** Writing – review & editing. **Yali Zheng:** Formal analysis, Data curation. **Xiaoe Lang:** Data curation. **Xiang-Yang Zhang:** Writing – review & editing, Project administration.

Data availability statement

All raw data supporting the findings of this study are available with the consent of the corresponding author.

Ethics approval and consent to participate

Written informed consent was drawn up prior to the start of this study, and all subjects participating in this study signed a written informed consent form to indicate their agreement to the publication of all images, clinical data, and other data contained in the article.All procedures involving human subjects/patients in this study and all the contents in methods were approved by the Medical Ethics Committee of First Hospital of Shanxi Medical University (No.2016-Y27).

Consent for publication

Not applicable.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e40154.

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