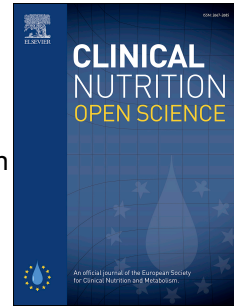


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Samira Rabiei, Mastaneh Rajabian Tabesh, Soodeh Razeghi Jahromi, Maryam Abolhasani



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1 **The association between depression, obesity and body composition in Iranian**
2 **women**

3 Samira Rabiei¹, Mastaneh Rajabian Tabesh², Soodeh Razeghi Jahromi³, Maryam Abolhasani^{2*}

4 ¹ Department of Nutrition Research, National Nutrition and Food Technology Research Institute and Faculty of
5 Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

6 ² Cardiac primary prevention research center, Cardiovascular Diseases Research Center, Tehran University of Medical
7 Sciences, Tehran, Iran.

8 ³ Department of Clinical Nutrition, National Nutrition and Food Technology Research Institute and Faculty of
9 Nutrition Sciences and Food Technology, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

10 ***Corresponding author:** Maryam Abolhasani, Cardiac primary prevention research center, Cardiovascular Diseases
11 Research Center, Tehran University of Medical Sciences, Tehran, Iran.

12 **Phone:** +98 9124862203

13 **Email:** dr_m_abolhasani@yahoo.com

14

15 **ORCID Number of authors:**

16 Samira Rabiei: <https://orcid.org/0000-0002-3606-8969>

17 Mastaneh Rajabian Tabesh: <https://orcid.org/0000-0003-2517-6590>

18 Soodeh Razeghi Jahromi: <https://orcid.org/0000-0002-1889-284X>

19 Maryam Abolhasani: <https://orcid.org/0000-0003-2517-6590>

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26 **Abstract**

27 **Objective:** Depression and obesity are two serious health problems influencing both physical and
28 mental health. Regarding the high prevalence of these two conditions and their high morbidity and
29 mortality rates associated to both, investigation the association between them seems necessary.

30 **Method:** This cross sectional study was conducted on 174 women with $BMI \geq 25 \text{kgm}^2$ who referred
31 to the obesity clinic of Sina hospital, through convenience sampling. Data from anthropometric
32 measurements, Beck Depression inventory-II and body composition were collected and SPSS was
33 used to statistical analysis.

34 **Results:** Mean age of participants was 36.6 ± 8.8 year. The prevalence of dysthymic disorders in
35 obese women was higher than in those with overweight. In women with obesity, the prevalence of
36 severe depression, was higher than mild and moderate depression ($p < 0.001$). According to the
37 linear regression analysis, increasing each score in depression score, increases the fat mass by 0.44
38 kg, significantly ($p < 0.001$).

39 **Conclusion:** Depression and obesity follows a dose response association. According to the
40 association between depression and obesity, focusing on interdisciplinary studies is suggested for
41 the future researches.

42 **Keywords:** Depression, Psychiatric disorders, Obesity, Body composition, Iran

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46 Introduction

47 Depression is a major psychological problem across the world ¹. According to World Health
48 Organization (WHO) almost 800000 people die due to depression, every year². Depression affects
49 almost 350 million people in the world³. It is noteworthy that depression constitutes 35 to 45% of
50 mental health disorders in Iran ¹ and is prevalent in 8% to 20% of Iranian people, may be for the
51 reasons of socio-economic problems ⁴. This disorder can lead to weak performance in social
52 environment, decrease in energy level, dissatisfaction of life, fatigue and even suicide ².
53 Furthermore, depression is accompanied with some chronic diseases such as diabetes, coronary
54 vascular diseases and arthritis and obesity. Depression may worsen outcomes of these diseases⁵. It
55 has recently found that depression as a chronic psychological distress, plays an important role in
56 the increasing trend of obesity around the world ⁶. This is important because according to the report
57 of WHO, overweight and obesity are responsible for 44% , 23% and 7-41% of diabetes, ischemic
58 heart diseases and cancers, respectively⁷.

59 Considering high prevalence and mortality rates of obesity and depression, both of them are
60 considered as serious health problems⁸. According to “metabolic-mood syndrome” suggested by
61 R.B.Mansour et al, it seems that there is a bidirectional association between depression and obesity
62 ⁹. According to some evidences, fat mass (FM) may worsen depression ^{10 11}. It is interesting to
63 note that the prevalence of depression is high in obese people ¹². It is possible that these two
64 conditions have common causes in some clinical, neurobiological, genetic and environmental
65 aspects ^{9 8,13,14}. Furthermore, Sedaqat, et al showed that dietary pattern of depressed obese Iranian
66 women is different from that of non-depressed obese women¹⁵. On the other hand, it has been
67 suggested that certain genes such as genes encoded glucocorticoids, leptin and dopamine receptors,
68 are involved in pathology of these both disorders. The role of environmental factors especially

69 chronic stress, should also be considered in common etiology of obesity and depression.
70 Inflammatory pathways are of the mechanisms involved in obesity. The effects of inflammatory
71 cytokines on the central nervous system, change the synaptic plasticity and neurogenesis. It is
72 similar to what occurs in depression⁸. The pro-inflammatory cascade generated as a result of the
73 above mechanisms, influences on peripheral resistance to the glucocorticoids, bacterial
74 translocation, releasing of catecholamines and the secretion of TNF- α and IL-6. All of these
75 processes lead to increase in the production of leptin and decrease in production of adiponectin in
76 adipocytes and finally, lead to inflammation and accumulation of fatty tissue¹⁶. Although many
77 cross-sectional studies have documented this association, its significance still remains unclear¹⁷.

78 In addition to depression, dysthymic disorder, is another psychological disorder that is
79 characterized by fluctuating dysphoria which is far less dramatic than major depression,
80 symptomatically¹⁸. Despite clinical outcomes of obesity which have been well studied, its
81 psychological outcomes like depression and dysthymic disorder, are not well understood. On the
82 other hand, most of those studies, have focused on obesity, while the association between
83 psychological disorders and body composition has not been properly investigated. Furthermore,
84 the results of a meta-analysis showed that depression has a stronger association with obesity than
85 with overweight¹³. So, the association between weight and depression may follow a dose-response
86 pattern. We should also note that the risk of depression in some races is higher than others¹⁴, as
87 well, the ratio of FM to FFM. Such that with a similar BMI, percentage of fat mass in some races
88 is higher than in other races¹⁹. Wang, et al also showed that Asian race have lower BMI than
89 Caucasian, while the percentage of fat mass in Asian race is higher than Caucasian²⁰. So, the
90 association between depression and FM may not be similar in different races. Therefore,
91 determining the association between overweight, obesity and depression, needs some more

92 regional investigations. Considering the high prevalence of depression in Iranian people and that
93 there is not enough information on the association between FM and depression in Iranian people,
94 the current study investigated the prevalence of depression in women with overweight comparing
95 with women with obesity and also investigated the association of depression with FM in Iranian
96 women with overweight and obesity, for the first time.

97 **Method:**

98 This cross sectional study was conducted on 174 women with overweight and obesity who referred
99 to the obesity clinic of Sina hospital. The study protocol was approved by the Ethics Committee
100 of Tehran University of Medical Sciences. A consent form was obtained from all participants after
101 being informed of the study objectives and benefits. They also signed an agreement regarding
102 personal information confidentiality. Inclusion criteria were included women 18 to 51 years old,
103 BMI between 25 and 39.9 kg/m², who had no history of major psychotic disorders like
104 schizophrenia and delusional disorder, taking any drugs related to these major disorders and also
105 hormone therapy in the last 6 months. They should not have a history of electroconvulsive therapy,
106 too.

107 Anthropometric Measurements

108 Body weight was measured to the nearest 0.1 kg and height was measured to the nearest 0.1 cm
109 using a standard stadiometer. Weight was measured with light clothing and height was measured
110 without shoes. BMI was then calculated as weight divided by height squared (kg/m²). The
111 classification of obesity status was established according to overweight ($30 > \text{BMI} \geq 25$ kg/m²)
112 and obesity ($\text{BMI} \geq 30$ kg/m²). Waist circumference was taken at the maximal narrowing of the
113 waist from anterior view. Hip circumference was measured at the point of maximal gluteal

114 protuberance from the lateral view. The body composition indices including total fat percentage,
115 total fat mass and total fat-free mass were measured using body composition analyzer BC-418 MA
116 (TANITA, Tokyo, Japan).

117 Beck Depression inventory-II (BDI-II).

118 To assess depression disorder, BDI questionnaire was used. The BDI-II was found to have high
119 internal consistency, high content validity, validity in differentiating between depressed and
120 nondepressed individuals, and good sensitivity to change. The Persian version of this questionnaire
121 was used in the study conducted by Hamidi, et al. It showed a suitable validity ($\alpha=0.92$) and
122 reliability ($r=0.64$)²¹. Participants completed this 21-item self-report inventory. Items are scored
123 on a scale from 0–3, with higher scores reflecting more severe symptoms. Total score of this
124 questionnaire are categorized as below²²:

125 14-19: mild depression

126 20-28: moderate depression

127 29-63: severe depression

128 The BDI-II includes 5 somatic items: loss of energy, changes in sleeping patterns, changes in
129 appetite, loss of interest in sex and tiredness or fatigue.

130 Dietary intake assessment

131 To assess nutritional intake information of participants, 3- day food recalls were completed by
132 trained dietitian. Participants were asked about all the meals and snacks eating during three
133 previous days. Calorie and macronutrients intake were calculated by Nutritionist IV software. The

134 database was modified with reference to the existing national Iranian food composition table,
135 developed by the Iranian National Institute of Nutrition and Food Technology.

136

137 Assessment of Physical Activity (PA)

138 To assess physical activity, International Physical Activity Questionnaire (IPAQ) was used. The
139 Persian version of this questionnaire was validated by Vashghani and colleagues. According to
140 their study, this questionnaire has acceptable validity and reliability (0.33, 0.7, respectively)²³. The
141 IPAQ used in the present study is the long interview-administered version (27 items) which covers
142 4 domains of physical activity including: occupational (7 items), transportation (6 items),
143 household/gardening (6 items) and leisure-time activities (6 items). The questionnaire also
144 includes 2 questions about the time spent on sitting as indicators of sedentary behavior. After
145 multiplying the time dedicated to each activity class by the specific MET score for that activity,
146 physical activity was calculated and reported as MET/min/week²⁴.

147 Statistical Analysis

148 Kolmogorov-Smirnov test determines if variables showed a normal distribution. Parametric and
149 nonparametric descriptive tests were used for data analysis, depend on their normal or abnormal
150 distribution. For descriptive analysis of quantitative data, the Mean and Standard deviation were
151 used. For qualitative data, frequency percentage was reported. To compare more than two
152 continuous variables, Anova test was used with Tukey HSD as posthoc test. Correlates of
153 depression and obesity was evaluated by using regression models. We tabulated adjusted odds
154 ratios (ORs) and 95% confidence intervals (CIs) for correlates of depression and obesity.
155 Considering BDI score as dependent variable and fat mass and BMI as independent variables.

156 Statistical package for the Social Sciences, version 17.0(SPSS, Chicago, IL, USA) was used to
157 analyze the data and P value <0.05 was considered as significant.

158 **Results:**

159 A total of 174 women participated in this study with mean age of 36.6 ± 8.8 year. As table 1 shows,
160 frequency of women who reported history of psychiatric disorders and dysthymic disorder was
161 significantly higher in women with obesity than in women with overweight ($p < 0.001$).
162 Pharmacotherapy and major depressive episode have not any significant difference between
163 overweight and obese women.

164 (Place of table 1)

165 Table 2 shows mean \pm SD of anthropometric measurements, FM, total calorie, calorie percentage
166 of each macronutrients and physical activity level among different levels of depression severity.
167 The results of ANOVA test and post hoc Tukey HSD showed that mean of FM, weight, BMI, WC
168 and HC in women with moderate and severe depression is higher than in those with no
169 depression ($p < 0.001$).

170 (Place of table 2)

171 Distribution of women with overweight and obesity among different levels of depression severity
172 has been shown in figure 1. As this figure shows, in women with overweight, no depression was
173 the most prevalent among different level of depression severity; while in women with obesity, the
174 prevalence of severe depression, was the highest ($p < 0.001$).

175 (Place of figure 1)

176 Table 3 shows the association of depression score with FM and BMI. According to the linear
177 regression analysis, increasing each score in depression score, increases the FM by 0.44 kg,
178 significantly. This association remained significant after adjusting for total calorie intake and MET
179 ($p < 0.001$).

180 (Place of table 3)

181

182 **Discussion**

183 In the current study the prevalence of dysthymic disorder was significantly higher in women
184 suffered from obesity than in women with overweight. Moreover, our results showed that mean of
185 FM, weight, BMI, WC and HC has significant difference among levels of depression severity such
186 that the prevalence of severe and moderate depression was higher than mild and no depression.
187 Our results were in accordance with the study of Pollanka and his colleagues in an American
188 sample. They assessed the association of dysthymic disorder and atypical major depressive
189 disorder (MDD) with weight using the data of National Epidemiologic Survey on Alcohol and
190 Related Conditions waves 1 (2001–2002) and 2 (2004–2005). According to their findings, atypical
191 MDD was a stronger predictor of increases in body mass index and incidence of obesity than were
192 non-atypical MDD, no history of depressive disorder, and dysthymic disorder. Atypical MDD was
193 a stronger predictor of obesity in /Latinos/Hispanics than in non-Hispanic blacks and whites. US
194 adults with atypical MDD are at high risk of obesity and weight gain, and Latinos/Hispanics might
195 be vulnerable to the obesogenic consequences of depressive disorders ²⁵. Results of our study
196 revealed that the same relationship between obesity and dysthymic disorder in Iranian population.
197 Also in agreement to our results, McLean and his colleagues assessed the link between obesity and

198 anxiety/depression using the Hospital Anxiety and Depression Scale (HADS) in a Scottish
199 population. They reported that the prevalence of obesity was higher among patients with
200 depression and anxiety with a significant direct relationship between HADS scores and body mass
201 index ²⁶.

202 Depression might be a strong predictor of obesity for a number of reasons. First, depression leads
203 to hypersomnia and hyperphagia ²⁷ which consequently decreased energy expenditure and
204 increased energy intake, respectively ²⁸. Second, patients with depressive disorders have poorer
205 diet quality than otherwise healthy individuals with a dose dependent manner ²⁹ which could cause
206 higher energy intake. Third, adults with atypical major depressive disorder experienced higher
207 rates of restricted-activity days and disability-days which could reduce energy expenditure ³⁰.
208 Fourth, atypical MDD is defined by more prevalent episodes, earlier onset age, and more severe
209 symptoms ^{30,31}. Therefore, individuals with atypical MDD have greater exposure to depression and
210 its consequent polyphagia. Fifth, weight gain is one of the side effects of some of antidepressants
211 ³². Our results showed that, one score elevation in depression score increases the FM by 0.44 kg.
212 This association remained significant after adjusting for total calorie intake and MET. These
213 findings were in agree with the results of an study by Lasserre et al in Swiss sample ³³. They
214 reported that atypical MDD is a risk factor for higher BMI, fat mass, and waist circumference over
215 5.5 years. In the current study, we extended their findings to the Iranian population. However, in
216 contrast to our results, Lamers et al. showed that BMI fluctuation over the 6 year follow-up had
217 no difference between adults with and without atypical depressive disorder ³⁴. The observed
218 difference could be because in Lamers et al study, unlike to our study, MDD patients were
219 compared with controls.

220 Sixth reason for the link between obesity and depression is the rise in systemic inflammation and
221 metabolic dysregulation which have been reported in individuals with depressive disorders ³⁵,
222 Although, it is not yet well defined whether these changes are consequences or causes of obesity.
223 Finally, shared genetic factors could contribute to both future atypical MDD and obesity. As we
224 know by far, obesity is considered as a low grade inflammation ³⁵. The expression of pro-
225 inflammatory cytokines like TNF- α and Interlukin-6 (IL-6) was reported to be elevated in adipose
226 tissue of obese individuals which resulted in higher circulating TNF- α and IL-6 ³⁵. Also an increase
227 in adiponectin secretion from a larger adipose tissue would enhance systemic inflammation ³⁵.
228 Preclinical studies showed an elevation in pro-inflammatory CD8+ T cells after consuming a high
229 fat diet ³⁵. Finally, genetic factors could partially explain the link between obesity and depression.
230 For example, a fat mass and obesity-associated protein (FTO) gene variant was found to be related
231 to greater odds of having atypical MDD ³⁶.

232 **Conclusion**

233 Depression and obesity, both are conditions with serious impact on health, especially considering
234 their high prevalence. Severe depression is more prevalent in women with obesity than in those
235 with overweight. On the other hand, Fat mass increases with the severity of depression. Although
236 there is a relationship between depression and obesity, there is no consistency about the nature and
237 the related mechanisms for their association. According to bidirectional association between
238 depression and obesity, focusing on interdisciplinary studies is suggested for the future researches.

239 **Limitation**

240 Due to the cross-sectional nature of current study, we were not able to assess the causality link
241 between depression and obesity. Also we included only female. Although when considering

242 depressive disorders, there is a sex differentiation between male and female with higher prevalence
243 in female, further studies in both sexes are warranted. Energy and macronutrient intake were
244 recorded based on participants memory, however by using 24-hours recalls for three days we tried
245 to reduce the effect of unwanted under/over reporting.

246 **Acknowledgements:**

247 The authors thank the personnel of obesity clinic of Sina hospital and all women who participated
248 in this study.

249 **Key points:**

- 250 ✓ The prevalence of dysthymic disorders in obese women is higher than in those with
251 overweight.
- 252 ✓ The prevalence of severe depression in obese women, is higher than mild and moderate
253 depression.
- 254 ✓ Fat mass increases with the severity of depression.

255

256 **Disclosure:**

257 **Conflict of interest:** The authors report there are no competing interests to declare.

258 **Data availability statement:** All data were delivered and archived in the Cardiac primary
259 prevention research center, Cardiovascular Diseases Research Center, Tehran University of
260 Medical Sciences, Tehran, Iran.

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382 **Table1- General information of participants**

		BMI categories		P-value
		Obesity	Overweight	
Age*		37.2± 8.9	34.6± 8.2	0.1
Psychiatry history**	Yes	32 (94.1%)	2 (5.9%)	<0.05
	No	105 (76.1%)	33 (23.9%)	
Pharmacotherapy**	Yes	10 (90.9%)	1 (9.1%)	0.3
	No	127 (78.9%)	34 (21.1%)	
Major depression episode**	Yes	12 (92.3%)	1 (7.7%)	0.2
	No	125 (78.6%)	34 (21.4%)	
Dysthymic disorder**	Yes	102 (85%)	18 (15%)	<0.01
	No	35 (67.3%)	17 (32.7%)	

383 *Values are mean± SD

384 ** Values are frequency (%)

385

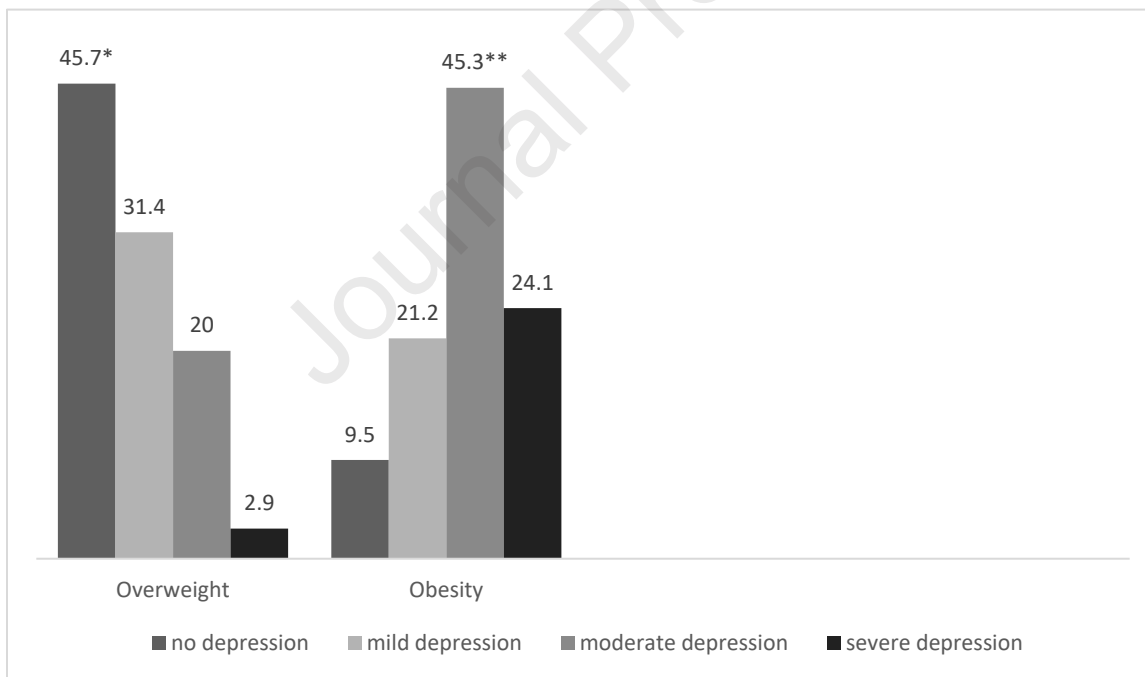
386 **Table2- Mean of anthropometric measurements, fat mass, dietary intake and MET among
387 different categories of depression severity**

	Mean ± SD				P-value
	No depression	Mild depression	Moderate depression	Severe depression	
Weight (kg)	77.1±12.3	83.1±12.1	87.3±11.2	95.8±11.4	*<0.001
Height (cm)	160.3±4.8	160.4±6.2	159.7±6.2	161±5.7	0.7
Waist circumference (cm)	96.9±18.3	104.8±15.5	106.2±15.2	11±10.9	*<0.001

Hip circumference (cm)	110.8±8.6	115.4±8.4	121.2±9.6	114.5±9.6	*<0.001
waist to hip ratio	0.8±0.1	0.9±0.1	0.9±0.1	0.9±0.07	0.2
Body mass index (kg/m²)	29.9±4.1	32.2±4.2	34.1±3.6	36.9±4.2	*<0.001
Fat mass (kg)	29.4±9.5	33.5±8.4	36.1±7.4	42.1±8.6	*<0.001
Total calorie intake (kcal)	1635.9±289.9	1579±286.6	1503.6±345.8	1580.2±303.4	0.2
Calorie percent of protein	13.9±3	13.2±3.3	14.6±4.1	12.8±2.3	0.07
Calorie percent of fat	32.8±9.1	34.1±9.5	32.6±9.1	34.9±9.2	0.6
Calorie percent of carbohydrate	54.9±10	54.5±8.3	54.2±9.5	53.9±9	0.9
MET	616.6±145.8	584.2±153.8	593.2±118.9	572±136.6	0.6

388 * Significant difference between no depression and moderate and severe depression, in order to Tukey HSD

389



390

391 **Figure1- Percentage of different categories of depression severity in women with overweight and**
 392 **obesity**

393 * Significant difference with other levels of depression in women with overweight

394 ** Significant difference with other levels of depression in women with obesity

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400 **Table 3- The association of depression score with fat mass and BMI according to linear**
 401 **regression**

		Beta	t	P-value
Fat mass	Depression score	0.4	6.3	<0.001
	Depression score*	0.4	6.2	<0.001
BMI	Depression score	0.4	7.4	<0.001
	Depression score*	0.5	7.5	<0.001

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* Adjusted for calorie intake and MET

Declaration

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Consent to participate: A signed hand-written informed consent was obtained from each individual before data collection.

Consent for publication: Not applicable

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Code availability: Not applicable

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