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Original Article

Assessment of Overweight and Obesity Status in Patients with Depression Referred to Baharloo Hospital in Tehran: Possible Roles For Vitamin D?

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ABSTRACT

Background and Objectives: Overweight/obesity can be consequences or causative factors of depression. Vitamin D has been suggested as a contributing factor in depression and excessive body weight; however, the existing evidence is still unclear. The objective of this study was to assess statuses of overweight and obesity in patients with depression, considering possible roles of vitamin D.

Materials and Methods: A cross-sectional study was carried out on 56 18–60 year-old patients with mild to moderate depression. Demographic data were collected, serum 25(OH)D and anthropometric indices were assessed. Statuses of weight and abdominal obesity were assessed based on the body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR), respectively. Data analyses were carried out using SPSS Software v.21.

Results: The mean weight of the patients was 75.44 ± 14.52 kg. Moreover, 42.86 and 39.25% were overweight and obese indices, respectively. Most of the participants included abdominal obesity (96.43 and 60.71% based on WC and WHR, respectively). The mean of serum 25(OH)D was 80.37 ± 30.78 nmol l^{-1} . Results of multiple regression revealed that age was significantly linked to depression; however, this relationship was not statistically significant for anthropometric variables.

Conclusions: Overweight and obesity were prevalent in patients with mild to moderate depression. Appropriate preventive policy-making to carry out nutritional interventions with increasing physical activity (PA) seem necessary to decrease treatment costs in these patients.

Keywords: Depression, Obesity, Overweight, Vitamin D, Tehran

Introduction

Nowadays, depression is one of the most important global health problems (1), which seems to be intensified under the quarantine conditions caused by Covid-19 pandemic (2). This psychiatric disorder is ranked second in burden of diseases according to World Health Organization (WHO) (3). Recent studies have shown that major depressive disorder (MDD) with a 12.9% global prevalence is further prevalent in Asian developing countries (29.2%) (3). Undesirable consequences of depression not only affect mental health but also lead to several physiologic problems such as obesity and cardiovascular disease (CVD) (4, 5) as well as high economic burdens (1, 4). Co-occurrence of obesity and depression (6) suggests that increasing in body weight and depression may include bi-directional relationships (7). Sedentary lifestyle and isolation, as characteristics of depression (8), may result in overweight, obesity and CVD (6, 9). It is suggested that progression of depression further occurs in obese people (7). In other words, each of these parameters increases risk of the other one (10). However, a high prevalence of depression has been reported in underweight individuals (11, 12). In spite of suggested mechanisms such as dysregulation of metabolism, immuno-inflammation and hypothalamic-pituitary-adrenal (HPA)-axis (13), these relationship is still unknown (14).

In terms of MDD, Iran ranks first in the region and obesity is prevalent in Iranian adults (> 20%) (15). Results of recent studies have shown that vitamin D status may be associated with depression (16, 17); however, associations have not been established (18). Vitamin D is suggested as one of the factors that may affect body weight and composition (19-21). Hence, it is important to investigate if

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vitamin D includes roles in relationship with depression and obesity. Mechanisms are suggested for the regulatory effects of vitamin D, including HPA axis (13), inflammation (22) and neurotransmitters (16, 23); however, the exact mechanisms are still unclear. To design and use further practical preventive and therapeutic strategies, knowledge of the status of overweight and obesity in patients with depression, especially in initial stages of disease with regards to vitamin D levels, is important (24). Use of anthropometry, as an accurate practical and low-cost method for assessing patient body weight status, is helpful (25). It has been shown that BMI is a reliable anthropometric index for assessing body weight status (26). Assessing abdominal obesity, as one of the factors most associated with the development of CVD in patients with depression, is important as well (27). Hence, assessment of WC and WHR statuses can be useful (28). To the best of the authors' knowledge, no comprehensive study has been carried out to assess statuses of body weight in patients with mild to moderate depression in Iran, considering vitamin D statuses. Accordingly, the aim of this study was to assess statuses of overweight and general/abdominal obesity and investigating possible roles of vitamin D in patients with depression, Tehran, Iran.

Materials and Methods

Study design

This cross-sectional study, as the first part of a double-blind randomized clinical trial (RCT), was carried out on patients with mild to moderate depression with no other psychiatric disorders referred to Outpatient Clinics of Baharloo Hospital in Tehran, Iran, May 2018 to June 2019. The inclusion criteria were (1) age 18–60 years old, and (2) having mild to moderate depression with no other psychiatric disorders. The non-inclusion criteria were (1) having a history of heart infarction, angina pectoris, stroke, kidney stones, high blood pressure, liver disease and hyperparathyroidism, (2) pregnancy and lactation, (3) being reproductive-aged women (< 50 years old) who were not receiving adequate contraception, (4) consuming nutritional supplements with vitamin D since two months prior to the enrolling in the study. The exclusion criteria were (1) not willing to continue the study, and (2) failure to follow the program. First-diagnosed cases were participated in this study; however, patients with pre-existing depression were enrolled as well. After study registration, diagnostic assays were carried out on eligible volunteers by psychiatrists. Written informed consents were collected from the participants after explaining protocols and objectives of the study. General socio-demographic information were completed for each participant during a face-to-face interview. Data of the questionnaire included sex, age, educational level, marital status, drug usage, alcohol consumption, PA, history of illness, medication, exposure to sunlight and sunscreen usage. the PA level was assessed using modified questionnaire of "Intensity and Effects of Various Activities on Physical Activity level in Adults" (29). Anthropometric and blood pressure assessments were carried out for all the participants. Blood sampling and serum 25(OH)D concentration assessment were carried out as well.

Ethics

Ethical approval was received from the Ethics Committee of National Nutrition and Food Technology Research Institute (NNFTRI) (approval no. IR.SBMU.NNFTRI.REC.1396.185). Since the current study was first part of an RCT, the clinical trial registration code was received from the Iranian Registry of Clinical Trials (IRCTID) (reg. code: IRCT20170926036425N1) and ClinicalTrials.gov (reg. code: NCT03766074) as well.

Assessment of depression

Assessment of depression status was carried out by psychiatrists through structural clinical diagnostic interviews based on Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM–IV) criteria and Beck Depression Inventory-II (BDI-II) scores (30). The BDI-II-Persian included a high internal consistency (Cronbach's alpha = 0.87) and acceptable test-retest reliability (r = 0.74) (31). A score of 13–29 from BDI-II questionnaires was considered as mild to moderate depression and depression severity status was classified based on BDI-II score as mild (< 20) and moderate (20 to < 29) (30).

Anthropometric measures

First, anthropometric assessments, including weight, height, WC and hip circumference (HC), were carried out as follows: weight was measured with no shoes and with light clothing to the nearest of 0.1 kg using calibrated digital scale (Seca 808; Seca, Hamburg, Germany). Height was measured to the nearest of 0.1 cm in standing position with no shoes using standard stadiometer. The WC was measured to the nearest of 0.1 cm at the midpoint between the lower rib and iliac crest at the end of expiration and HC was measured to the nearest of 0.1 cm at the maximum extension of the buttock and horizontal to the floor, using measuring tape (32). Then, BMI and WHR were calculated as follows: BMI [kg $(m^2)^{-1}$] was calculated by dividing weight (kg) by height^2 (m^2) and WHR by dividing WC to HC.

Classification of body weight and abdominal obesity statuses

Body weight status was categorized based on BMI as underweight (< 18.5), normal weight (18.5–24.9), overweight (25–29.9) and obesity (≥ 30) (33). For assessing statuses of abdominal obesity, participants were further subdivided into normal (< 94.0 cm for males and <

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80.0 cm for females) and abdominal obesity (≥ 94.0 cm for males and ≥ 80.0 cm for females) based on the values of WC and also based on the WHR values into normal (< 1 for male and < 0.85 for female) and abdominal obesity (≥ 1 for male and ≥ 0.85 for female) (34). Moreover, WC was categorized as abdominal obesity in the two sexes based on Iranian cut-offs of 90 cm (35).

Blood pressure

Systolic and diastolic blood pressures (SBP and DBP) were measured in sitting position after 10 min resting using digital sphygmomanometer (BC 08; Beurer, Ulm, Germany).

Laboratory investigations

Briefly, a 10-ml venous blood sample was collected from each participants and stored on ice in cold boxes for transportation to the Nutrition Laboratory of NNFTRI. Sera were separated from the clot samples by centrifugation at room temperature and then aliquoted in fresh microtubes and stored at -80 °C until use. In this study, enzyme immunoassay (EIA) method (Euroimmun EIA, Lubeck, Germany) was used for assessing serum 25(OH)D. Details of laboratory methods were described previously (36).

Classification of vitamin D status

Vitamin D status was classified based on circulating concentration of 25(OH)D as deficiency (< 50 nmol l^{-1}), insufficiency (50–75 nmol l^{-1}) and normal status (> 75 nmol l^{-1}) (37).

Outcomes

The major outcome included assessment of the overweight and general/abdominal obesity statuses of the participants. Secondary outcomes included significant associations between depression and variables such as vitamin D.

Sample size and statistical analyses

Considering effect size of 0.75 and power of 80%, a sample size of 56 patients was calculated based on previous study (38). To describe quantitative data, mean ±SD (standard deviation) was expressed and for qualitative data, absolute or relative frequencies were used. Shapiro-Wilk's test was used to assess the normality of data distribution. To assess possible associations between each general and anthropometric variable with depression as well as possible links between various variables and depression, single and multiple regression tests were used, respectively. Independent sample *t*-test or Mann-Whitney test (based on normality distribution of data) was used to compare between-group differences. In the current study, the significance level was $p < 0.05$. Data were analyzed using SPSS Software v.21 (SPSS, Chicago, IL, USA). Further details were previously described (23).

Results

Out of 719 registered volunteers, 69 volunteers (56 incident and 13 old cases) were enrolled in the study. However, 13 volunteers were excluded as they had exclusion criteria (Figure 1). Thus, a total of 56 participants [50 women (89.29%) and 6 men (10.71 %)] aged 43.0 ±8.15 yrs completed the study. General characteristics of the participants are shown in Table 1.

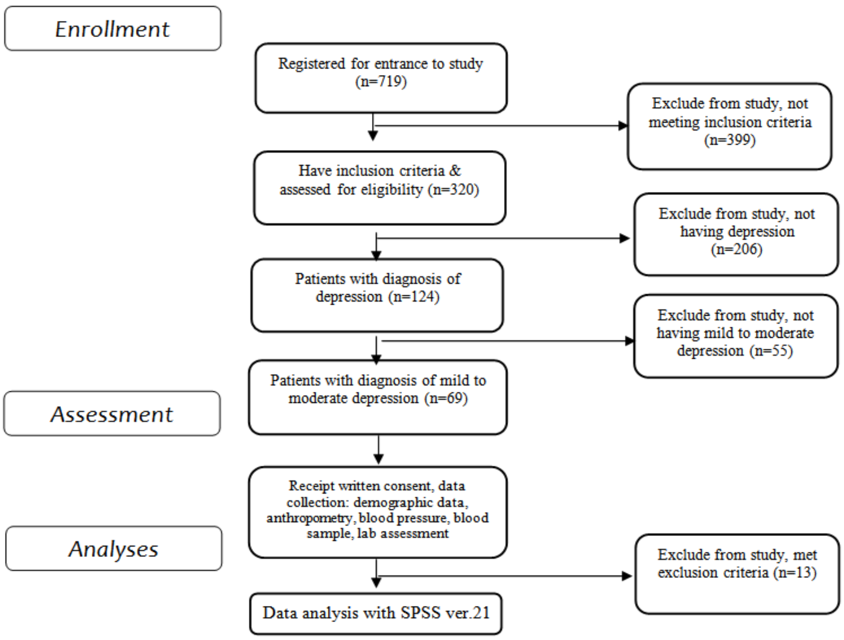

Figure 1. Summary of the study design

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Table 1. General characteristics of the participants

Variable		Total (n=56)
Sex †	Female	50 (89.3)
	Male	6 (10.7)
Age (year)‡		43 (8.15)
Educational level†	Illiterate & elementary	10 (17.9)
	Guidance & high school	12 (21.4)
	Diploma	14 (25.0)
	University	20 (35.7)
marital situation†	Single	5 (8.9)
	Married	50 (89.3)
	Divorced	1 (1.8)
Drug usage†	Never	46 (82.1)
	Very low	6 (10.7)
	Low	2 (3.6)
	Moderate	1 (1.8)
	High	1 (1.8)
Alcohol consumption†	Never	47 (83.9)
	Very low	7 (12.5)
	Low	2 (3.6)
Sunlight exposure a day†	No exposure	13 (23.2)
	10-60 min	40 (71.4)
	>60 min	3 (5.4)
Time of sunlight exposure†	10 AM	30 (53.6)
	15 PM	26 (46.4)
	Other times	-
duration of sunlight exposure (min) ‡		25.30 (21.18)
sunlight exposure (part of body) †	Face	11 (19.6)
	Feet	1 (1.8)
	Hand from wrist	2 (3.6)
	Hand from arm	2 (3.6)
	Combination of above	40 (71.4)
sunscreen usage	Never	26 (46.4)
	Occasionally	13 (23.2)
	Often	4 (7.1)
	Always	13 (23.2)
PA level†	Very low	32 (57.1)
	Low	17 (30.4)
	Moderate	5 (8.9)
	High	1 (1.8)
	Very high	1 (1.8)
SBP (mm Hg) ‡		121.21 (13.51)
DBP (mm Hg) ‡		78.77 (10.50)
BDI-II score ‡		22.82 (5.66)
Depression severity†	Mild	19 (33.9)
	Moderate	37 (66.1)
25(OH)D (nmol ml^{-1})‡		80.37 (30.78)
vitamin D status†	Deficiency	8 (14.3)
	Insufficiency	18 (32.1)
	Sufficiency	30 (53.6)

PA, physical activity; SBP, systolic blood pressure; DBP, diastolic blood pressure; BDI-II, Beck Depression Inventory-II.
† Number (%)
‡ Mean (±SD)

More than 80% of the participants were married and never had smoking, drug abuse and alcohol consumption habits. Most of the participants (87.5%) included under-moderate PA levels. Based on the BDI-II scores, severity of depression in approximately two third of the participants was classified as moderate. No significant differences were seen between the mean BDI-II scores of overweight and obese participants, compared to normal weight participants (21.79 ±6.04 vs. 22.40 ±5.82, p = 0.79; and 24.14 ±5.13 vs. 22.40 ±5.82, p = 0.40, respectively). Overweight and obese participants included no statistically significant BDI-II score difference (p = 0.17). This was also observed in abdominal obesity based on the two categories (WC and WHR) (p > 0.05). Vitamin D status of the participants revealed that more than half of them were in sufficient situation and no significant differences were reported between the serum 25(OH)D concentrations of overweight and obese participants (85.05 ±33.22 vs. 85.30 ±26.00 nmol l^{-1}, p = 0.98).

Table 2 shows anthropometric values of the participants, including weight, height, BMI, WC, HC and WHR.

Table 2. Anthropometric characteristics of the participants†

Variable	Participants		
	Male (n=6)	Female (n=50)	Total (n=56)
Weight (kg)	91.45 (15.68)	73.52 (13.28)	75.44 (14.52)
Height (m)	1.72 (0.04)	1.59 (0.06)	1.60 (0.07)
BMI (kg m^{-2})	30.66 (4.23)	29.12 (5.10)	29.26 (5.00)
WC (cm)	106.67 (13.34)	97.41 (10.78)	98.40 (11.32)
HC (cm)	114.00 (11.03)	112.78 (10.01)	112.91 (10.03)
WHR	0.93 (0.06)	0.86 (0.07)	0.87 (0.07)

† All values are means ±SD. BMI, body mass index; WC, waist circumference; HC, hip circumference; WHR, waist to hip ratio.

Based on the BMI classification, a high proportion of the participants included overweight or general obesity (82.14 %), none of them was underweight (Table 3). In abdominal obesity, most of the participants included abdominal obesity, based on the international WC category (Table 4). Similar results were reported based on the Iranian cut-offs [total, 41 (73.2%), women, 35 (70%); men, 6 (100 %)]. Based on the WHR category, half of the participants included normal statuses (Table 4). Results of single regression test showed no statistically significant relationships between the BDI-II scores and anthropometric variables as well as other variables (p > 0.05). After carrying out multiple regression test by entering all possible variables involved in depression, statistically significant relationships were seen between the BDI-II scores and variables, including sunlight exposure in day (p = 0.004), and sunscreen usage (p = 0.016). After adjusting variables (age, sex, serum 25(OH)D concentration, BMI, duration of sun exposure and physical activity) in Model 1, only the relationship between the BDI-II score and age was statistically significant (Table 5). After classifying the BDI-II scores into mild and moderate, severity of depression was significantly in negative relationship with PA (p = 0.025).

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Table 3. Weight statuses of the participants based on BMI value†

Variable Sex	Weight status Underweight n (%)	Normal n (%)	Overweight n (%)	Obesity n (%)
Male (n=6)	-	-	4 (66.70)	2 (33.30)
Female (n=50)	-	10 (20.0)	20 (40.0)	20 (40.0)
Total (n=56)	-	10 (17.86)	24 (42.86)	22 (39.28)

† BMI, body mass index; Weight status was defined as: underweight (<18.5), normal (18.5-24.9), overweight (25-29.9) and obesity (≥ 30).

Table 4. Abdominal obesity statuses of the participants based on WC† and WHR‡ values

Variable Sex	Abdominal obesity status Based on WC values Normal n (%)	 Abdominal obesity n (%)	Abdominal obesity status Based on WHR values Normal n (%)	 Abdominal obesity n (%)
Male (n=6)	-	6 (100.0)	6 (100.0)	-
Female (n=50)	2 (4.00)	48 (96.0)	22 (44.0)	28 (56.0)
Total (n=56)	2 (3.57)	54 (96.43)	28 (50.0)	28 (50.0)

† WC, waist circumference; Abdominal obesity status was defined as: normal (<94.0 cm for males and <80.0 cm for females) and abdominal obesity (≥94.0 cm for males and ≥80.0 cm for females).
‡ WHR, waist to hip ratio; Abdominal obesity status was defined as: (< 1 for male and < 0.85 for female) and abdominal obesity (≥ 1 for male and ≥ 0.85 for female).

Table 5. Associations of the variables with BDI-II scores

Participants Variable	Total (n=56) coefficients B	 SE	 95% CI	 P value*
25(OH)D				
Crude	0.041	0.024	0.003, 0.108	0.097
Model 1	0.045	0.026	-0.007-0.098	**0.089**
Age				
Crude	-0.110	0.089	-0.287, 0.068	0.222
Model 1	-0.216	0.096	-0.409, -0.023	**0.029***
BMI				
Crude	0.131	0.153	-0.176, 0.438	0.395
Model 1	0.172	0.156	-0.142, 0.48	0.276
Duration of sunlight				
Crude	0.040	0.036	-0.032, 0.112	0.27
Model 1	0.040	0.037	-0.033, 0.113	0.277

†mild to moderate depression defined as BDI-II score 13-29
*P < 0.05 denotes significant association between variable and depression
Model 1: adjusted for age, sex, serum 25(OH)D, BMI, duration of sun exposure and physical activity

Discussion

This study is the first cross-sectional study to assess statuses of overweight and general and abdominal obesities in patients with mild to moderate depression, regarding possible roles of vitamin D in Tehran, Iran. The current results revealed that a significant proportion of patients included overweight or general obesity based on BMI values. Based on the WC category, almost all of the patients included abdominal obesity and this issue was significant based on the WHR category. No significant associations were seen between the BDI-II scores and anthropometric variables, including BMI, as well as other supposed variables, individually. After adjusting variables [age, sex, serum 25(OH)D concentration, BMI, duration of sun exposure and physical activity], age was significantly linked to depression during the suggested model. The PA was in significant negative relationships with the severity of depression, as well. The results of previous studies on weight statuses of the patients with depression are inconsistent. Similarly, studies demonstrated that overweight or obesity were prevalent in depressed patients (7, 25, 39). In contrast, high prevalence of depression was reported in underweight people (11, 12, 40, 41). One possible explanation for this controversy could be due to the role of socioeconomic factors (40, 42). For example, social problems, including unemployment (43), not only can result in low food intakes, but also can double burden

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of mood disorders, especially depression (44). Economic situation with nutrition literacy (45) can affect food habits, resulting in body weight changes (25, 46). Cultural factors and social values such as thinness and fatness as beauty symbols can also affect eating behaviors (25, 47). This is while body weight as a health concern can cause stress and increase negative emotional disorders such as depression (48, 49). Furthermore, perception of weight affected by cultural and ethnic factors should be considered as other possible factor (50).

Findings of the current study demonstrated high prevalence of abdominal obesity in patients with mild to moderate depression. Controversy in results of prevalence of abdominal obesity in depressed patients is based on various indices. Similar to the current findings with regards to WC, prevalence of abdominal obesity was high in several studies (25, 51, 52). Based on data from this study, WHR classification showed insignificant or less prevalence of abdominal obesity (25, 53). A possible reason might be that obesity as a social stigma by affecting self-confidence, body image and social life could create or exacerbate depression (47, 52). Although, the present results demonstrated that general and abdominal obesities were prevalent in the participants; however, none of the anthropometric variables was individually in significant relationships with BDI-II scores. Results of various studies on anthropometric factors in relationships with depression are controversial. Similar to the present study, previous studies did not report significant associations between depression and anthropometric indices (41, 53, 54). In contrast, other studies revealed that anthropometric indices were significantly linked to depression (10, 14, 25, 26, 55). Differences between the results of various studies can be due to different sample sizes, measuring methods (self-report/measurement) (56), indices of measuring anthropometry variables (57) and depression severities (41). Differences of study design, location, ethnicity, hormonal changes, lifestyle, negative life events and poor self-esteem can be considered as reasons of these dissimilarities (10). One explanation for the association between general/abdominal obesity and depression can include the up-regulation of pro-inflammatory cytokines produced by visceral adipose tissues that may play roles in promotion of depression (53). Mechanisms have been suggested for the effects of increased body weight on depression, including genetic factors, immune-inflammatory interactions, intestine microflora , fat content of diets (58), HPA dysregulations, neuroendocrine regulators of energy metabolism (41, 56, 59), biological rhythms (60) and insulin resistances (61). Recently, vitamin D has increasingly reported as an effective factor linked to body composition and weight management (19-21) as well as depression (17, 62). The present results showed that 25(OH)D concentration was not significantly associated with BDI-II scores individually, even after adjusting confounding variables during suggested model.

Results of previous studies on the relationships of vitamin D concentration and depression are equivocal (16) and causal relationships between vitamin D and depression have not been assessed (18). Furthermore, results of the effects of vitamin D supplementation on depression improvement have been controversial (5, 63). To explain possible mechanisms of the effects of vitamin D on depression based on the suggested causes of depression such as dysregulation of HPA axis, increased levels of inflammatory biomarkers and disorders of neurotransmitters (16), vitamin D possibly down regulates inflammatory mediators (16, 64). Based on the production of vitamin D receptors (VDRs) and its binding protein (DBP) in brain, especially in mood regulatory parts (65), vitamin D may show direct neuro-regulatory activities (16). Additionally, it has been suggested that vitamin D may play regulatory roles in synthesize and release of neurotransmitters (23, 62). Since subcutaneous synthesis of vitamin D via sunlight exposure is the major supplying source of body needs (29), isolation and inactive lifestyle as characteristics of depression (8) can prevent providing enough vitamin D and lead to vitamin D deficiency (29). The current results verified that sunlight exposure was significantly linked to depression.

It has been shown that vitamin D deficiency or insufficiency is prevalent in overweight and obese people (19-21); however, the current results did not confirm this fact. Moreover, results of previous studies on effects of vitamin D supplementation on body weight/composition, especially fat mass, are unclear and need further investigations (66). Current findings revealed that age was significantly associated to depression, even after adjusting other factors. Similar to the present study, age has been reported as a significant, effective demographic factor associated with depression by previous studies (25, 50, 67). It is noteworthy that paying attention to body weight as a beauty symbol in young people can act as a stressor and cause depression (25, 50). In elderly people, loneliness, mental or physical disabilities and socioeconomic problems can cause or exacerbate depression (25, 50). In this study, PA was significantly in negative associations with severity of depression. Similar to the present results, almost all previous studies have shown the effectiveness of PA on improvement of depression (68). Several mechanisms have been suggested for antidepressant effects of PA, including 1) induced secretion of serotonin, dopamine and norepinephrine; 2) decrease of depression symptoms and freedom from worries and negative thoughts by increasing release of β-endorphin after exercises; 3) increase of self-efficacy during regular exercises; and 4) induced secretion of anti-inflammatory cytokines (69). However, this study included limitations. It was difficult to establish links

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between depression and alleged causes due to the nature of the cross-sectional studies. In addition, small sample sizes might cover relationships of the suggested factors with depression. Due to the lack of same sex distribution of the participants, no comparisons between the males and females were possible. There are great needs to assess body weight statuses of depressed patients with special focus on vitamin D in wide-range samples in terms of age and sex.

Conclusion

In conclusion, overweight and general/abdominal obesity were prevalent in patients with mild to moderate depression. The BDI-II scores were significantly in relationships with age. The PA was significantly in negative relationships with depression severity. The current findings can contribute to the future appropriate policy-making to carry out nutritional interventions with increasing PA to prevent overweight and obesity and decrease treatment costs in depressed patients.

Submission declaration

This article has not been published previously and is not under consideration for publication elsewhere. All authors approved publication of the manuscript tacitly and explicitly by the responsible authorities, where the study was carried and if accepted it will not be published elsewhere in the same form in English or in any other language, including electronically without written consent of the copyright-holder.

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