The Relationship between Double Burden of Malnutrition and Mental Health among Adult Females

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Abstract

Background: The coexistence of overweight or obesity with concurrent deficiency of one or more nutrients, referred to as double burden of malnutrition (DBM). A number of mental health impairments have been associated with a wide variety of nutrient deficiencies. In the current environment, the co-occurrence of obesity, overweight and mental health impairments have emerged as a significant global health concern. Although DBM is relevant for a number of health outcomes, the ubiquitous involvement of vitamin D across multiple systems and tissues suggests D insufficiency as a viable target for nutritional modification.

Purpose: This study aimed to evaluate the contribution of DBM to mental health among adult females.

Methods: Study participants included 231 females ages 18-59 years who presented to one of the 25 health centers in Tehran. Women were overweight or people with obesity and BMI ranging from 25 to 40 Kg/m². The 147-item food frequency questionnaire (FFQ) was used to estimate their dietary intake. Body composition was measured by bioelectric impedance assay, anthropometrics including waist circumference (WC) hip circumference were determined and BMI was calculated. Mental health status was assessed using the depression, anxiety, and stress scales-21 (DASS-21). Venipuncture was performed to assess plasma vitamin D level and lipid profile. Results were analyzed by SPSS software.

Results: The mean $\pm$ standard deviation (SD) age, weight, and BMI of the participants were 36.49 ± 8.38 , 80.89 ± 12.45 kg and 31.04 ± 4.31 Kg/m², respectively.

DBM was significantly associated with stress after adjusting for potential confounders including age, energy and marital status in the model 1 (OR;1.28, 95% confidence interval (CI)=1.00-1.65 P=0.04) in comparison to crude model (OR=1.22; 95% CI=0.96-1.55 P=0.09). No significant relationship was seen among DBM and DASS-21 outcomes were observed.

Conclusions: In this cohort, stress and DBM were significantly associated. However, the directionality of the relationship is unclear. Vitamin D insufficiency is associated with mental health and obesity in opposing directions. Whether vitamin D supplementation can decrease mental health impairments requires further evaluation.

Registered number; IR.TUMS.VCR.REC.1398.819

We intake register number in May of 2020

Introduction

The continued rise in overweight and obesity remain a global health concern. In particular, the increases and consequent adverse health effects widely recognized among developing countries are introducing a tremendous health challenge (1). In particular, the emergence of double burden of malnutrition (DBM), the co-existence of caloric overconsumption with essential nutrient insufficiency has been reported as

more prevalent in developing countries in comparison to developed countries (2, 3). While the contributors include egregiously increasing urbanization, alteration dietary pattern and lifestyle (4), some nutrients are more likely to be implicated in adverse health effects.

The physiologic effects of DBM are well- recognized. However, a comprehensive understanding of modifiable health outcomes requires an understanding of the psychological effects of DBM, as well. A link between obesity and a number of mental health impairments across the life course have been reported (5, 6).

Since, poor mental health afflicts more than 300 million people all ages, the additive effect of the obesity epidemic and mental health impairments could have profound effect on mortality in the ensuing decade. Indeed, a bidirectional link between obesity and mental health has been suggested, (7), with obesity increasing the risk of depression incidence, and a suggested mechanistic role (8) of inadequate amount of essential nutrient intake as a moderator (9, 10). Suboptimal nutrient including cobalamin, folic acid, niacin and ascorbic acid, zinc, iron and selenium have been associated to depression (11). However, the ubiquitous involvement of vitamin D in neurocognition and obesity-related disorders offer a viable area of investigation as a modifiable intervention (12, 13).

In this cross-sectional study we consider to assessing association between DBM and mental health including depression, anxiety and stress within Iranian people with obesity and overweight females focusing on vitamin D as a potential moderator.

Method

Study design

A cohort of 231 people with obesity and overweight Iranian females aged 18-59 years participated in this study. Women were randomly selected from those presenting to 25 health centers in Tehran. All participants signed a written consent form. Inclusion criteria were age 18-59 years; no current weight loss program; no use of weight loss supplements. Participants with a history of type 2 diabetic (T2D), cardiovascular disease (CVDs), polycystic ovary syndrome (PCO), stroke, non-alcoholic fatty liver disease (NAFLD), inflammatory disease, hypertension, cancer, thyroid diseases, or who were currently pregnant were excluded because of possible changes in diet. In addition, the women reporting intake energy lower or higher than 800-4200 K/Cal excluded. The study procedure was approved by the ethics committee of Tehran University of Medical Science (IR.TUMS.VCR.REC.1398.819).

Anthropometric assessments

The individuals wore light clothing and without shoes for measuring weight and height. All the measurements were assessed by A trained technician. The waist circumference (WC) measured by a none elastic tape to the nearest 0.1 cm the narrowest area at the end of a normal exhalation. In addition, hip circumference determines at the largest part of the hip over light clothing. Body mass index (BMI) was

calculated based on Quetelet's index (14) According to WHO guidelines (15), the individuals were classified as underweight ($\text{BMI} < 18.50 \text{ kg/m}^2$), normal weight ($18.50\text{--}24.99 \text{ kg/m}^2$), overweight ($25.0\text{--}29.9 \text{ kg/m}^2$) and people with obesity ($\geq 30.0 \text{ kg/m}^2$).

Complete body composition analysis

The body composition of all participants analyzed by body analyzer devices (model BC-418, MA-Tanita, product by the UK) followed body analyzer recommendation. This instrument measured the body composition including; Body fat mass (BFM), Fat-free mass (FFM), Visceral fat area (VFA) by data from bioelectrical impedance analysis (16). According to the manufacturer's instructions, after shoes, coats, and sweaters had been removed, subjects were required to stand on the balance scale in bare feet and hold the handles of the machine. The measurements took approximately 20 s, and the output was printed.

Dietary intake assessment

The individual diet intake was assessed by a 147-item food-frequency questionnaire (FFQ) that was validated before (17). The data documented in household measures and serving size and changed to gram and millimeter. The nutritionist IV (First Data Bank, San Bruno, CA) food analyzer used for analyzing dietary intake. Moreover, through analysis of residuals, the energies were calculated for each category and adjusted that means.

Blood sampling and biochemical parameters

At first 10-milligram blood after 8-12 hours fasting obtained and The serum was centrifuged then, it isolated and stored at 80°C . All data evaluated by the Endocrinology & Metabolism Research Institute (EMRI) Bionanotechnology laboratory of Tehran University of Medical Science. Serum fasting glucose assessment by glucose oxidase–phenol 4-amino antipyrine peroxidase (GOD-PAP) that is a colorimetric method, triglyceride (TG), total cholesterol (TC) cholesterol (CH), measured by glycerol-3-phosphate oxidase–phenol 4-amino antipyrine peroxidase (GPOPAP), enzymatic endpoint, respectively. Also low-density-lipoprotein (LDL) and high-density lipoprotein (HDL) cholesterol measured by direct enzymatic clearance assay. This laboratory assessment performed by Seven Randox Laboratories kits (Random Laboratories Ltd., Ardmore, UK).

The level of vitamin D in individuals assessed by immunoassay immunodiagnostic system (IDS) kits. finally, we considered the level of Serum Vitamin D concentration between 20-30 ng/L, and, less than 20 ng/ml called insufficiency and deficiency, respectively (18).

Calculation of the double burden malnutrition and mental disorders

Double burden malnutrition (DBM) assessed by calculating Body mass index (BMI) was calculated based on Quetelet's index (14) from participants with measuring weight and height. The participants BMI were

greater than 25 kg/m² along with plasma concentration of vitamin D lower than 20ng/ml (25OHD<20ng/ml) considered DBM.

DASS Questionnaire

Mental health status was calculated by the Depression, Anxiety, and Stress Scales (DASS) is a 42-items self-report for measuring symptoms of depression, anxiety, and stress over the past week which generates three scale score. Also, the participant responded to three scales of which consist of 14-items of 0-3 scale. where responded 0=did not apply to me at all and 3=applied to me very much, or most of the time (possible scale range for each scale is 0-42). When score take 42 scales that means increase depression, anxiety and stress (19, 20).

Statistical analysis

Normality distribution was tested by applying Kolmogorov-Smirnov's test; data that were not normally distributed and could not be transformed appropriately for normal distribution were used for z-scores. Data on quantitative characteristics were reported as the mean $\pm$ SD and data on qualitative characteristics were expressed as a percentage. chi-square analysis performed for detection confounders and recognize mental health disorders. one whey ANOVA and TUKEY POC HOC used for in comparison variables. The logistic regression performed for the relationship between vitamin D deficiency in overweight and people with obesity by mental disorders. An initial model (0) was created and included only vitamin D deficiency (using 20 as a cut point) and secondary model (1) with included vitamin D deficiency and mental health status are predictor variables controlling for age, energy, marital status. SPSS software was used (version 23; SPSS Inc, Chicago IL) for all statistical analyses.

Result

Descriptive statistics are represented in Table 1. Based on table 1 the mean age and BMI of people were 36.49 $\pm$ 8.38 and 31.04 $\pm$ 4.3, respectively.

The number of people in each category and their characteristics differences shown in table 2. Based on table 2, 305 individuals participate in this study. Then, after excluding the people without eligible criteria, 231 individuals remained for analysis. The table 2 no significant differences in variables between groups.

Table 3 illustrates the mean $\pm$ SD of characteristics of variables in four categories. The table shows that there are significant body composition differences including weight, BMI, waist circumference (WC), Fat-free mass (FFM), visceral fat area (VFA), triglycerides (TG) with p-value: (<0.0001) and CHOL (p-value 0.05) and diastolic blood pressure (P=0.02) between four categories.

Table 4 shows the evaluation relationship between mental health and DBM. Regard this table there is no observed significant correlation between anxiety and depression after adjusting potential confounders

including age, energy and marital status in model 1 (0.26,0.74) in compare to crude (0.35, 0.75), respectively. However, there is demonstrated a significant relationship between stress and DBM after adjusting age, energy and marital status in model 1(0.04) in comparison to crude (0.09).

Discussion

This is a novel investigation aiming to identify vitamin D as a moderator in the association between DBM and mental health was the first conducted in Iranian women. We observed at this study a significant relationship between DBM and stress.

Today's obesity and overweight are the main problems as well as they associated with inflammatory status. They play important roles in depression conditions (21–24). Moreover, obesity caused to a mutation in the leptin/melanocortin pathway in the central nervous system. It appears the leptin/melanocortin pathway regulates body energy hemostasis. Moreover, obesity-related to many brain disorders and psychopathology conditions including eating and mood disorders (25–27). Furthermore, the high BMI modestly associated with mood disorders (OR 1.23) and major depression (OR 1.27). In addition, evidence showed a significant relationship between high BMI and anxiety disorders such as post-traumatic stress disorders (OR 2.64) (28). Rebecca E. S et al performed a systematic review and meta-analysis in 2013 on one case-control, three cohorts and ten cross-sectional studies. The showed significantly relationship between vitamin D deficiency and depression (10).

In similar our finding, Aya Mousa et al performed a study on 63 overweight participant and people with obesity (39 mal/24 female) in 2017 at first, they performed a cross-sectional analysis on individuals with mean age = 31.3 ± 8.5 along with vitamin D deficiency (25(OH) D nmol/l) and BMI 25 kg/m^2 without clinical depression. Also, the participants consume a bolus oral dosage of 100000IU and followed 4000IU daily cholecalciferol for 16 weeks. After 16 weeks they observed an increasing concentration of vitamin D in plasma. Finally, they reported that vitamin D deficiency no has a correlation with depression, also vitamin D supplementation has not warranted for reducing depression symptoms (29).

In contrast with our finding, Kelly A. Schaad et al preformed a study in 2019 on 18–67 years old in both gender for assessing correlation between vitamin D deficiency and depression. They finally found significant relationship among participant with vitamin D deficiency and depression. But the number of male (n = 9799) is more than the female(1121) (30). Similarly, John C. Umhau reported the significant correlation between suicide and vitamin D deficiency in 2013 among active duty military. the number of male(n = 467) are more than female(n = 19) at this studies (31). It seems the correlation between depression and vitamin D deficiency in male are more than female.

Limitations of our study were no assessed normal weight participant with vitamin D deficiency for comparing together with DBM individuals. Moreover, the future studies should be design the studies in considering to both gender.

Conclusion

In this cohort study, we represented that stress and DBM were significantly associated. However, the directionality of the relationship is unclear. Vitamin D insufficiency is associated with mental health and obesity in opposing directions. Whether vitamin D supplementation can decrease mental health impairments requires further evaluation.

Abbreviations

DBM: Double burden of malnutrition

BMI: Body mass index

FFQ: Food frequency questionnaire

WC: waist circumference

T2D: Type 2 diabetic

CVDs: cardiovascular disease

PCOs: polycystic ovary syndrome

NAFLD: non-alcoholic fatty liver disease

FFM: Fat-free mass

VFA: visceral fat area

Declarations

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All participant has consent to participate at this study

Author contribution:

KH.M, MGH, LS and AM designed and constructed the research, wrote paper and had primary responsibility for the final content. MGH, LS and HY carried out the statistical analysis. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

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Conflict of interest:

The author declares no conflict of interest

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Tables

Table 1: bassline demographic and characterristic of participants by mean $\pm$ SD

Variables	Mean $\pm$ SD	Minimum	Maximum
Age (M $\pm$ SD)	36.49 $\pm$ 8.38	17.00	56.00
Weight (kg)	80.89 $\pm$ 12.45	59.50	136.60
BMI (Kg/m ²)	31.04 $\pm$ 4.31	24.20	49.60
Body composition			
Body fat mass	34.04 $\pm$ 8.69	19.40	74.20
FFM %	46.80 $\pm$ 5.64	35.30	67.70
WHR	1.23 $\pm$ 5.24	.81	92.00
WC (cm)	99.01 $\pm$ 10.05	80.10	136.00
Visceral.fat.area(cm ²)	168.30 $\pm$ 103.11	20.00	1817.00
Blood parameters and Blood pressure			
CHOL (g/dl)	185.30 $\pm$ 35.77	104.00	344.00
TG (g/dl)	122.10 $\pm$ 69.29	37.00	512.00
HDL (mg/dl)	46.58 $\pm$ 10.86	18.00	87.00
LDL (mg/dl)	95.30 $\pm$ 24.12	34.00	156.00
SBP (mm Hg)	111.70 $\pm$ 13.66	76.00	159.00
DBP (mm Hg)	77.84 $\pm$ 9.58	51.00	111.00

BMI; body mass index, FFM; fat free mass, WHR; waist hip ratio, WC; waist circumference, TG; triglyceride, HDL; high density lipoprotein, LDL; low density lipoprotein, SBP; systolic blood pressure, DBP; diastolic blood pressure.

Table2: the sample size and confounders.

Variables		Anxiety			Stress			Depression		
		cat1 (n)	cat2 (n)	P	cat1 (n)	Cat2 (n)	P	Cat1 (n)	Cat2 (n)	P
Education	Illiterate	1	2	0.57	1	2	0.34	1	2	0.48
	Primary education	3	10		5	8		3	10	
	intermediate Education	6	12		5	13		5	13	
	High school education	5	3		6	2		5	3	
	Diploma	33	51		44	40		44	40	
	12Postgraduate education	13	13		12	14		13	13	
	Bachelor's degree and higher	52	78		65	65		78	52	
Job	Housekeeper	70	101	0.51	86	85	0.39	83	88	0.19
	Labor	1	2		1	2		1	2	
	Management employee	21	25		8	28		25	21	
	Non-managerial employee	12	22		22	12		25	9	
	household jobs	2	4		2	4		2	4	
	University student	5	13		8	10		10	8	
Marriage	Married	89	130	0.29	106	113	0.04	113	106	0.14
	Single	23	31		30	24		34	20	
	Away from spouse more than 6 month	0	2		0	2		0	2	
	Dead spouse	1	1		2	0		1	1	
	Divorce	0	5		0	5		0	4	
Monthly salary	Low	0	5	0.26	2	3	0.69	2	3	0.49
	Medium	3	8		7	4		4	7	
	Good	36	51		41	46		42	45	
	Excellent	53	70		61	62		68	55	
housing status	Owner	74	97	0.17	92	79	0.11	92	79	0.64
	Tenant	38	63		43	58		51	50	
	Relatives' house	0	5		1	4		2	3	
	Organization house	0	1		0	1		0	1	
Economic status	Low	29	35	0.42	30	34	0.53	31	33	0.26
	Medium	49	88		61	71		66	66	
	Good	31	41		41	31		41	31	

Thyroid	Healthy	57	73	0.13	62	68	0.10	71	59	0.37
	Hypothyroidism	47	73		65	55		65	55	
	Hyperthyroidism	5	18		7	16		9	14	
Smoking	Yes	7	9	0.78	9	7	0.54	7	9	0.47
	No	107	159		129	137		141	125	

Anova test for recognize confounder s in to categories. Cat 1: healthy mental cat 2: unhealthy mental

Table 3: characteristics of variable in four categories

Variable	CAT1	CAT2	CAT3	CAT4	P-value
	Mean±SD (77)	Mean±SD (31)	Mean±SD (82)	Mean±SD (41)	
Age (years)	35.48±8.02	33.70±8.15	37.60±8.92	37.04±7.98	0.11
Weight (Kg)	71.85±5.32	74.37±8.19	89.22±11.31	87.05±11.35	<0.0001
BMI (Kg/m ²)	27.51±1.47	27.79±1.44	34.28±3.85	33.76±3.64	<0.0001
Body composition analysis					
Body fat mass	27.38±3.38	28.58±4.40	40.17±8.26	39.29±7.19	<0.0001
FFM %	44.39±4.13	45.46± 5.65	49.17±5.59	48.43±5.44	<0.0001
WHR	0.90±0.04	0.91±0.04	2.05±9.99	0.96±0.04	0.59
WC (cm)	91.46±5.05	93.34±6.72	105.74±8.29	105.66±8.63	<0.0001
VFA (cm ²)	133.71±22.37	141.54±28.48	206.72±182.70	189.08±26.73	<0.0001
Blood parameters					
Cholesterol (g/dl)	175.98±29.07	184.34±33.00	192.87±41.93	188.48±37.46	0.05
TG (g/dl)	99.64±46.63	103.10±42.22	145.46±92.03	124.60±74.41	<0.0001
LDL (mg/dl)	91.60±19.98	93.06±26.43	95.68±25.03	95.11±26.00	0.77
HDL (mg/dl)	47.42±10.11	47.20±11.16	44.69±11.23	47.00±12.82	0.51
SBP (mm Hg)	110.20±11.74	108.62±13.85	113.42±15.47	114.92±13.50	0.12
DBP (mm Hg)	77.23±8.59	74.40±8.46	78.60±9.97	81.07±11.41	0.02

BMI; body fat mass, VFA; Visceral fat area FFM; fat free mass, WHR; waist hip ratio, WC; waist circumference, TG; triglyceride, HDL; high density lipoprotein, LDL; low density lipoprotein, SBP; systolic blood pressure, DBP; diastolic blood pressure. CAT1; Overweight without D deficiency, CAT2; Overweight with D deficiency, CAT3; people with obesity without D deficiency and CAT4; people with obesity D deficiency.

Table 4: unadjusted and adjusted odds ratio quartiles in variables.

Variables	Q1	Q2	Q3	Q4	P-trend
Anxiety					
Model 0	1	1.12(0.48-2.58)	1.97(1.00-3.86)	1.01(0.46-2.21)	0.35
Model 1	1	1.32(0.55-3.19)	1.87(0.93-3.76)	1.21(0.54-2.73)	0.26
Stress					
Model 0	1	1.45(0.63-3.34)	1.54(0.80-2.95)	1.84(0.83-4.05)	0.09
Model 1	1	1.38(0.58-3.29)	1.53(0.78-3.02)	2.29(1.00-5.22)	0.04
Depression					
Model 0	1	0.79(0.34-1.84)	1.05(0.55-2.01)	1.08(0.49-2.35)	0.75
Model 1	1	0.72(0.30-1.74)	0.98(0.50-1.93)	1.13(0.50-2.54)	0.74

Model 0: crude model

Model 1: adjusted for age, energy, marriage status