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Original article

Do patterns of nutrient intake predict self-reported anxiety, depression and psychological distress in adults? SEPAHAN study

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SUMMARY

Background & aims: Despite the growing evidence about dietary patterns, this study aimed at the association between patterns of nutrients intake and psychological disorders.
Methods: In this cross-sectional study, diet and psychological factors including anxiety, depression, and general health (GHQ) were assessed through self-administered questionnaires in 3846 Iranian adults. Daily intakes of 57 nutrients and bioactive compounds were calculated. Nutrient patterns (NPs) were derived using factor analysis.
Results: Three NPs were identified: 1) high in individual amino acids, cobalamin, zinc, phosphorus, saturated fatty acids, cholesterol and pantothenic acid named as “omnivore”; 2) high in thiamin, folate, selenium, iron, starch, maltose, betaine, calcium, riboflavin, and niacin; named as “grains and dairy”. Mono-unsaturated fats, vitamin E and polyunsaturated fats were inversely associated with this pattern; 3) “fruits and vegetables” NP high in copper, vitamin C, glucose, fructose, potassium, dietary fiber, sucrose, vitamin A, magnesium and vitamin K. After adjustment for confounders, men in the top tertile of the omnivore NP had lower anxiety score than those in the bottom tertile ($P = 0.04$). Men in the highest tertile of the first NP were less likely to be depressed (OR = 0.50, 95%CI: 0.26–0.96; P-trend = 0.04). Women in the highest tertile of this pattern had lower GHQ scores than those in the bottom tertile ($P = 0.01$) and had lower odds of psychological distress (OR = 0.75, 95%CI: 0.57–0.99, P-trend = 0.0.04).
Conclusions: An “omnivore” like diet high in amino acids, cobalamin, zinc, phosphorus, saturated fat, cholesterol and pantothenic acid is associated with reduced psychological disorders. Prospective studies are recommended to confirm our results.

1. Introduction

Mental disorders including depression, anxiety and psychological distress are affecting a large number of individuals worldwide. Based on WHO reports, about 350 million people of all ages suffer

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from depression [1], and about 7.3% of people are affected by anxiety globally [2]. Depression is regarded as the most important cause for disability that contributes to the global burden of disease; if not treated it might even lead to suicide [1]. Anxiety disorders also tend to become chronic, and can be as disabling as somatic disorders [3]. Both mental disorders impose a great cost to the health care system [1,3]. Mental disorders have dramatically increased from 27.7% to 34.2% since 1998 to 2007 among Iranian adults [4], showing the high priority of these problems for research and action.

Several hereditary and environmental are proposed to be associated with the risk of both depression and anxiety. Diet has long been suggested as a contributing factor to these common conditions. Earlier studies on the association between diet and psychological disorders have mostly targeted individual nutrients or food groups. For example, dietary intakes of iron [5], vitamin B6 [6], omega-3 fatty acids [7], folate, vitamin B_{12}, selenium and zinc [8] have been related to anxiety and depression. However, some studies have reported the association between patterns of dietary food intake and these conditions. In summary, healthy dietary pattern has been protectively associated, while adherence to the western dietary pattern is proposed to increase the risk of developing these disorders [9,10]. Although dietary patterns provide a more general understanding about diet-disease connections [11] and might better predict chronic disease risk than individual foods [12], the interpretability of the underlying mechanisms is hard using this method. Instead, nutrient patterns (NPs) might provide more realistic data for explaining the probable mechanisms. Furthermore, compared to foods, nutrients functionally cannot be exchanged and there are not non-consumers for nutrients [13]. On the other hand, dietary behaviors and cultures may completely affect foods and the way they are processed, while this may not be the case for nutrients. Despite the logics behind, few studies have examined NPs in association with chronic diseases like osteoporosis, cancer and obesity [14–16]. To our knowledge, no study has assessed the association between NPs and psychological disorders. This method might provide novel insights into the possible interactions between nutrients in the etiology of these conditions. Therefore, this study aimed to investigate the association between major patterns of nutrients intake and anxiety, depression and psychological distress among a large sample of Iranian adults.

2. Methods

2.1. Study population

The present study was done in the context of a large-scale cross-sectional study named as the “Study on the Epidemiology of Psychological Alimentary Health and Nutrition (SEPAHAN)”, which was conducted among the employees of Isfahan University of Medical Sciences working across 50 health care centers. The employees were aged 18–55 years. The study design, participants recruitment and data collection methods are fully described elsewhere [17]. Required information in SEPAHAN study was collected in two phases. A questionnaire that contained information on demographic and dietary data was sent to 10,087 participants and 8691 subjects returned the completed questionnaire (response rate of 86.16%), in the first step. At the second phase, information on psychological health was recruited and 6239 returned the completed questionnaires. After linking the completed questionnaires of first and second phases, 4633 participants had the complete information on diet and psychological factors. In this study, we excluded participants dietary under and over-reporting (energy intake outside the range of 800–4200 kcal/day). These exclusions left 3846 adults (1712 males and 2134 females) for the current analysis. Signed written informed consent forms were taken from all participants. The SEPAHAN project was approved by the ethics committee of Isfahan University of Medical Sciences.

2.2. Dietary assessment

The dietary assessment was done through a self-administered multiple choice 106-item semi-quantitative food frequency questionnaire (FFQ) which was designed and validated for Iranian adults [16]. Daily intakes of 57 nutrients (including individual amino acids, starch, dietary fiber, simple sugars, different fatty acids, vitamins, minerals, and bioactive substances) were calculated for each participant using the US Department of Agriculture's nutrient databank [18] and used in factor analysis to derive NPs. The nutrients are listed in Supplementary Table 1.

2.3. Assessment of the psychological profile

The Hospital-Anxiety- and Depression Scale (HADS) validated for Iranians was used to assess the anxiety and depression [19]. The scale had fourteen items [20], seven for anxiety (HADS-A), and seven for depression (HADS-D). Each item is scored on a four-point scale from zero (not present) to three (considerable) while the scoring method for questions 7 and 10 are reverse. The item scores are summed, to provide scores which may range between zero to 21 for each condition. Participants with the scores of 0–7 were considered as “healthy”, 8–10 as “borderline” and individuals with scores of ≥11 were considered to be a “severe” case for given psychological disorder.

The validated General Health Questionnaire (GHQ) with 12-items was also used to assess psychological distress [21]. GHQ-12 is a brief and simple questionnaire for assessing the current and primary mental health that asks the respondents about their experience in a recent particular symptom of psychological distress or change in behavior. Each item has four possible answers (less than usual, no more than usual, rather more than usual, or much more than usual). The bimodal scoring style (0-0-1-1) was incorporated for the current analysis. This gives scores ranging from 0 to 12. Higher scores indicate a greater degree of psychological distress [21]. In the current study psychological distress was defined as having the GHQ score of ≥4.

2.4. Assessment of other variables

Information about age, gender, education (high school diploma or lower/above high school diploma), marital status (single/married), family size (≤4/>4 people), smoking status (non-smoker, former smoker and current smoker), and breakfast consumption, was gathered using a self-administered questionnaire. Subjects who ate breakfast <4 times/wk were defined as skippers. Physical activity was examined using the General Practice Physical Activity Questionnaire (GPPAQ) [22]. We categorized participants as having <1 h/wk or ≥1 h/wk of exercise for this study. Data on antidepressants use, and history of chronic diseases (hyperlipidemia, hypertension, diabetes or insulin resistance syndrome, heart attack, stroke, heart failure and cancer, asthma, colitis, cholelithiasis and gastrointestinal bleeding) were also collected using a self-administered questionnaire. Height and weight were collected using a self-reported questionnaire. Body mass index (BMI) was computed as weight in kilogram divided by height in meters squared.

2.5. Statistical analysis

Energy adjusted nutrients intake were calculated using the residual method [23]. Nutrient intakes are provided based on their actual units; however the scales were harmonized using log transformation (natural logarithm) before running the factor analysis. The log transformation was used to make variances and covariances independent of scale. Factor analysis with varimax rotation was applied to derive NPs. Factors retained for further analysis based on their natural interpretation, eigen values (>3), and visual inspection of scree plots [24]. Intakes of nutrients weighted by their factor loadings were summed to calculate the factor score for each NP [24]. Subjects received a factor score for each NP. Subjects were categorized based on tertiles of NPs' scores.

Analysis of variance and chi-square test were used to compare continuous and categorical variables across tertiles of NPs' scores, respectively. We compared age-, and energy-adjusted intakes of food groups and some nutrients across categories of NPs' scores using analysis of covariance (ANCOVA) with Bonferroni correction. ANCOVA was also applied to compare anxiety, depression and GHQ-12 scores across tertiles of NPs in two different models that was firstly adjusted for age and energy intake (kcal), and then in the multivariable model was further controlled for antidepressant use, marital status, education, family size, smoking status, physical activity, breakfast skipping, having a chronic disease and BMI. To determine the association between NPs, anxiety and depression, we also used binary logistic regression, in crude and multi-variable adjusted models. The statistical analyses were conducted using the Statistical Package for Social Sciences (version 16.0 for Windows, 2006, SPSS, Inc, Chicago, IL). P value less than 0.05 was regarded as statistically significant.

3. Results

Male and female participants were aged 38.3 ± 8.5 and 35.1 ± 7.4 years, respectively. The prevalence of anxiety cases among men and women was 4.3% and 6.7%, respectively. Depression was prevalent in 6.8% of men and 13.3% of women. Psychological distress was prevalent in 17.6% and 26.0% of men and women, respectively.

Three major NPs were identified in both genders: the first pattern was mainly loaded by individual amino acids, cobalamin, zinc, phosphorus, saturated fatty acids, cholesterol and pantothenic acid for both genders. Pyridoxine was highly loaded in the first NP in men, only. The second pattern was high in thiamin, folate, selenium, iron, starch, maltose, betaine, calcium, riboflavin and niacin. Dietary intake of MUFAs, vitamin E and PUFAs was inversely associated with this pattern in either gender. The third pattern was characterized by high intakes of copper, vitamin C, glucose, fructose, potassium, dietary fiber, sucrose, vitamin A, magnesium and vitamin K. Identified NPs explained 60% of the total variance of nutrient intakes in either gender (Supplementary Table 1).

Participants' characteristics across tertiles of NPs' scores are demonstrated in Table 1. There was no difference in general characteristics across tertiles of the first NP's scores in either gender. Women in the top tertile of the second NP score were more likely to be younger than those in the bottom tertile. Compared with men in the lowest tertile of the third NP score those in the highest tertile were more likely to be married and of greater family size.

Age and energy adjusted intakes of selected food groups and nutrients across categories of major NPs' scores are provided in Table 2. Compared with those in the lowest tertile, men and women in the highest tertile of the first NP had higher intakes of vegetables, dairy, red and processed meat, white meat, legumes and nuts, dietary fats, proteins, PUFAs and pyridoxine and lower intakes of grains, carbohydrates, dietary fiber, thiamin, folate and caffeine for both genders. Energy intake was positively associated with the first NP among men and inversely among women. Therefore, the authors named the first NP as “omnivore”. Higher adherence to the second NP was related to higher intakes of grains, dairy, protein, carbohydrate, dietary fiber, thiamin and folate and lower intakes of meats, legumes and nuts, total energy, fats, PUFAs, pyridoxine and caffeine in either gender and lower intakes of fruits and vegetables only in women. Based on the nutrients loaded in this pattern and the food groups associated, the NP was named as “grains and dairy pattern”. The third NP was associated with greater intakes of fruits, vegetables, legumes and nuts, carbohydrates, dietary fiber, and pyridoxine and lower intakes of processed and white meats, grains, total energy, fats, PUFAs and thiamin in either gender and was named as “fruits and vegetables pattern”. This NP was also associated with higher intakes of dairy, red meat, folate and caffeine and lower intakes of grains in men, only. Women in the highest tertile of this NP had higher intakes of grains and lower intakes of red meat and folate compared with those in the lowest tertile.

Multivariable-adjusted means of anxiety, depression and GHQ scores across tertiles of NPs' scores are indicated in Table 3. After controlling for potential confounders, men in the top tertile of the omnivore pattern had lower anxiety score than those in the bottom tertile (2.60 ± 0.16 vs. 3.14 ± 0.16 respectively, P = 0.04). Women in the highest tertile of this pattern had lower GHQ scores than those in the bottom tertile (2.08 ± 0.13 vs. 2.52 ± 0.12 kg, P = 0.01). Comparing extreme tertiles of the other NPs, we found no significant difference in mean anxiety, depression, and GHQ scores across the tertiles of NP scores for either gender.

Male subjects in the highest tertile of the omnivore NP were 39% less likely to be depressed (Odds ratio (OR): 0.61, 95% confidence interval (CI): 0.38–0.98; P for trend = 0.04) (Table 4). In the fully adjusted model the association was even strengthened (OR: 0.50, 95%CI: 0.26–0.96; P for trend = 0.04). No association was seen between NPs and anxiety or psychological distress among men (Table 4).

Although no association was seen between the omnivore NP and psychological distress among women in the crude model (OR:1.12, 95%CI:0.88–1.42, P for trend = 0.24), we found a protective association (OR:0.75, 95%CI:0.57–0.99, P for trend = 0.04) when all confounders were taken into account (Table 5). No other significant association was observed between NPs and anxiety or depression among women.

4. Discussion

The present cross-sectional study among a large group of Iranian adults, found a significant protective association between adherence to omnivore like NP and odds of depression in men and psychological distress in women. Anxiety scores were significantly lower in the top tertile of this NP compared with the bottom tertile in either gender. The GHQ score was also significantly lower in the highest tertile of omnivore NP compared with the lowest among females. To our knowledge, this is the first study trying to examine relationship between patterns of nutrient intake and psychological problems.

Although NPs has recently received attention for their effect on risk of chronic diseases, few data are still available. Since nutrients are consumed together and not separately, they might affect each other through their interactive or synergistic effects. Therefore, examining patterns of nutrient intake would be superior to assessing the effects of individual nutrients. Previous studies on NPs have reported the associations with different types of cancer [13,14,25] and osteoporosis [15]. Nutrients included in PCA in previous studies ranged from 19 to 30 nutrients and were different based on the outcome variable of interest. In the current analysis,

Table 1
General characteristics of study participants across tertiles of major nutrient patterns' score.

Variables	Males						Females					
	Omnivore pattern score		Grains and dairy pattern score		Fruits and vegetables pattern score		Omnivore pattern score		Grains and dairy pattern score		Fruits and vegetables pattern score	
	T1	T3	T1	T3	T1	T3	T1	T3	T1	T3	T1	T3
Age (year)	38.5±8.8[a]	38 ± 8.3	38.6 ± 8.5	38.6 ± 8.6	37.6 ± 8.5	38.9 ± 8.5	34.6 ± 7.4	35.6 ± 7.4	34.9 ± 7.3	34.6 ± 7.5[b]	34.9 ± 7.4	35.2 ± 7.4
Married (%)	88.1	89.6	89.2	88.2	86	90.9[b]	72.5	77.2	75.2	74.7	73.4	75.2
Education (higher than high school diploma) (%)	45.8	43.7	46.2	43.5	43.2	47.6	68.1	64.1	69.2	64.1	65.7	66.6
Family size (>4 people) (%)	11.7	12.8	12.7	11	13.1	10.4[b]	11	10	12	10.1	10.6	9.8
Physically active (≥1 h/wk) (%)	44.5	46.2	43.6	44.3	48	43	25.1	25.8	24.6	26	56.5	27.6
Breakfast skippers (<4 times/wk) (%)	17.7	19.9	18.8	17.7	20.3	18.7	24.2	24.2	26.1	23.7	24.5	24
Antidepressant use (%)	6.3	8.2	7	6.7	6.8	6.8	9.6	13.8	10.7	11.3	11.3	11.4
Chronic diseases (%)[c]	18.6	17.9	17.4	19.6	16	19.6	13.5	14.9	12.5	14.3	13.8	13.6
Non-smokers (%)	75.8	73.9	76	73.4	75.8	75.7	85.8	85.7	83.8	86.8	84.5	87.8

[a] Mean ± standard deviation (SD).
[b] P value < 0.05, Obtained from ANOVA or chi-square test, where appropriate.
[c] Chronic disease included: hyperlipidemia, hypertension, diabetes or insulin resistance syndrome, heart attack, stroke, heart failure and cancer, asthma, colitis, cholelithiasis and gastrointestinal bleeding.

we tried to include the maximum number of nutrients and active compounds (57 nutrients) related to psychological conditions. Previous studies did not include individual amino acids at the analysis. However, since there is a large body of evidence about the association of individual amino acids with psychological problems [26], we included these nutrients in the analysis.

This study found a significant protective association between a pattern of nutrient intake that was greatly loaded by individual amino acids, vitamin B_{12} (cobalamin), zinc, phosphorus, cobalamin, saturated fatty acids, cholesterol, pantothenic acid and vitamin B_6 (pyridoxine) and odds of major depression and psychological distress in women and anxiety score in either gender. We named this pattern omnivore like diet because the nutrients loaded in this pattern are highly found in animal food sources. In fact, animal foods are rich sources of the nutrients loaded in this NP. In line with our results, a recent investigation showed that men with vegetarian diet had higher odds for developing depressive symptoms compared to non-vegetarians [27]. Several mechanisms might explain such associations. Dietary protein intake and also individual amino acids' status have been linked to psychological status in previously published studies. For instance methionine in the form of S-adenosyl-L-methionine [28], tryptophan [29] and serine [30] were inversely associated to depression. Lysine, argenine [31], beta-alanine [32], tryptophan [29] and tyrosine [33] have been shown to have anxiolytic effects. As amino acids are important precursors for neurotransmitters; they might affect psychological condition. Important neurotransmitters like dopamine and serotonin are made from amino acids tyrosine and tryptophan, respectively [29,33]. Vitamin B_6 as an important cofactor in serotonin-tryptophan pathway was also highly loaded in the first NP [34]. The protective effects of this NP can also be attributed to its high content of vitamin B12 and zinc. Earlier studies have also indicated an inverse association between zinc and vitamin B_{12} status and depression [35]. Zinc is an antagonist of the glutamate/N-methyl-D-aspartate (NMDA) receptor, and has antidepressant-like activities such as up-regulation of the expression of brain derived neurotrophic factor (BDNF) gene and amplification of its level of synaptic pool in the hippocampus [36]. It must be kept in mind that cholesterol was highly loaded in the first NP. While the nature of this association is unclear, a substantial body of evidence has shown that low serum total cholesterol may increase the risk of depression and suicide attempts [37]. It is hypothesized that low cholesterol intake might cause a depressed central serotonergic activity which in turn leads to depression [38].

Several limitations need to be considered in interpreting our findings. Due to the cross-sectional design of SEPAHAN project, causality cannot be inferred and prospective observational like cohort or nested case–control studies are highly needed to confirm our findings. Furthermore, it is possible that individuals' diet may have changed because of the change in psychological features. Although these changes would confound the association between NPs and psychological disorders, such residual confounding effects would tend to decrease the risk estimates and the true results may be even stronger than what we have reached. In addition, although we have tried to control for several confounding variables in our analyses, residual confounding from unknown or unmeasured factors is inevitable. Although we used a validated FFQ for dietary assessment, some degree of measurement error and misclassification must be noted. Due to the lack of a complete Iranian food composition table, we used USDA nutrient databank to identify daily intake of 57 nutrients or active compounds. Although this might result in some sort of misclassification, it does not seem to affect participants' ranking based on nutrient intakes. The subjective or arbitrary decisions in the use of

Table 2
Age- and energy-adjusted food and nutrient intakes across tertiles of nutrient patterns' scores.[a]

	Males						Females					
	Omnivore pattern score		Grains and dairy pattern score		Fruits and vegetables pattern score		Omnivore pattern score		Grains and dairy pattern score		Fruits and vegetables pattern score	
	T1	T3	T1	T3	T1	T3	T1	T3	T1	T3	T1	T3
Food groups (g/day)												
Fruits	300 ± 10.4	270 ± 10.2	296 ± 10.2	258 ± 10.2[c]	125 ± 7.8	474 ± 7.7[c]	318 ± 9.2	276 ± 9.2[c]	288 ± 9.4	293 ± 9.1	125 ± 6.8	506 ± 6.8[c]
Vegetables	138 ± 3.4	173 ± 3.4[c]	159 ± 3.4	148 ± 3.4[c]	121 ± 3.1	200 ± 3.1[c]	140 ± 3.1	177±3.1[c]	159 ± 3.2	160 ± 3.1	116 ± 2.7	213 ± 2.7[c]
Dairy	218 ± 11.7	537 ± 11.5[c]	273 ± 12.7	448 ± 12.7[c]	309 ± 13	406 ± 12.8[c]	221 ± 9.5	525 ± 9.6[c]	288 ± 10.7	421 ± 10.5[c]	292 ± 10.6	399.7 ± 10.6
Red meat	64.1 ± 1.7	73.9 ± 1.7[c]	87.1 ± 1.6	53.3 ± 1.6[c]	74 ± 1.7	68.6 ± 1.7[c]	69.3 ± 1.5	79.9 ± 1.7[c]	93.3 ± 1.5	56.6 ± 1.4[c]	76.4 ± 1.6	73.3 ± 1.6[c]
Processed meat	4.3 ± 0.5	6.9 ± 0.5[c]	9.1 ± 0.5	3.7 ± 0.5[c]	8.9 ± 0.5	4.1 ± 0.5[c]	5.1 ± 0.5	7.9 ± 0.5[c]	10.5 ± 0.5	3.2 ± 0.5[c]	10.1 ± 0.5	4.1 ± 0.5[c]
White meat	38.5 ± 1.9	95.8 ± 1.9[c]	73.5 ± 2.2	55.6 ± 2.2[c]	73.6 ± 2.2	58.8 ± 2.1[c]	37.6 ± 1.6	95.4 ± 1.6[c]	71.5 ± 1.9	55.6 ± 1.8[c]	69.9 ± 1.9	60.3 ± 1.9[c]
Legumes and nuts	48.4 ± 1.7	62 ± 1.7[c]	60 ± 1.7	51.2 ± 1.7[c]	51.1 ± 1.7	60.5 ± 1.7[c]	47.6 ± 1.5	67.5 ± 1.5[c]	61.6 ± 1.5	52.8 ± 1.5[c]	52.4 ± 1.5	62.6 ± 1.5[c]
Grains	439 ± 6.9	305 ± 6.8[c]	294 ± 6.6	452 ± 6.6[c]	424 ± 7	315 ± 6.9[c]	455 ± 6.1	321 ± 6.1[c]	298 ± 5.9	464 ± 5.8[c]	447 ± 6.1	619 ± 6.1[c]
Nutrients												
Energy (kcal/day)[b]	2504 ± 38.6	2793 ± 37.7[c]	2643 ± 35.9	2488.9 ± 36[c]	2460 ± 38.8	2443 ± 38.2[c]	2562 ± 31.8	2535 ± 32[c]	2697 ± 30.7	2518 ± 30.7[c]	2546 ± 32.2	2471 ± 32.3[c]
Fats (g/day)	89.3 ± 0.8	105.7 ± 0.8[c]	111.7 ± 0.7	84.6 ± 0.7[c]	102.3 ± 0.9	93.4 ± 0.8[c]	91.5 ± 0.7	107.2 ± 0.7[c]	114.8 ± 0.6	85.2 ± 0.6[c]	102.4 ± 0.7	96.1 ± 0.7[c]
Protein (g/day)	76.6 ± 0.5	100.2 ± 0.5[c]	85.2 ± 0.7	90.4 ± 0.7[c]	90.1 ± 0.7	86 ± 0.7[c]	78.3 ± 0.4	103 ± 0.4[c]	87.3 ± 0.6	91.9 ± 0.6[c]	91.4 ± 0.6	88 ± 0.6[c]
Carbohydrate (g/day)	322 ± 2	263 ± 2[c]	265 ± 2.1	318 ± 2.1[c]	275 ± 2.2	310 ± .2.2[c]	330 ± 1.7	271±1.7[c]	270 ± 1.8	330 ± 1.7[c]	288 ± 1.9	317 ± 1.9[c]
Dietary fiber (g/day)	22.8 ± 0.3	21.9 ± 0.26[c]	20.8 ± 0.2	23.8 ± 0.25[c]	18.4 ± 0.2	26.8 ± 0.2[c]	23.3 ± 0.2	22.8 ± 0.2	20.83 ± 0.22	25.3 ± 0.2[c]	19.1 ± 0.2	27.6 ± 0.2[c]
PUFAs (g/day)	27.9 ± 0.3	29.1 ± 0.3[c]	33.2 ± 0.3	24.4 ± 0.3[c]	30 ± 0.3	27.1 ± 0.3[c]	28.3 ± 0.3	30±0.3[c]	33.9 ± 0.2	24.9 ± 0.2[c]	30.2 ± 0.3	28.2 ± 0.3[c]
Thiamin (μg/day)	2 ± 0.02	1.6 ± 0.02[c]	1.4 ± 0.02	2.3 ± 0.03[c]	1.9 ± 0.03	1.08 ± 0.02[c]	2.1 ± 0.2	1.7±0.02[c]	1.4 ± 0.02	2.4 ± 0.02[c]	2 ± 0.02	1.8 ± 0.02[c]
Pyridoxine (μg/day)	1.8 ± 0.02	2.1 ± 0.2[c]	2.05 ± 0.02	1.9±0.02[c]	1.8 ± 0.02	2.16 ± 0.02[c]	1.8 ± 0.01	2.2±0.02[c]	2.1 ± 0.02	1.9 ± 0.02[c]	1.8 ± 0.01	2.3 ± 0.1[c]
Folate (μg/day)	600 ± 5.7	529 ± 5.54[c]	471 ± 4.5	657 ± 4.5[c]	556 ± 5.7	573 ± 5.7	609 ± 4.7	553 ± 4.8[c]	480 ± 3.7	679 ± 3.6[c]	586 ± 4.8	578 ± 4.8
Caffeine (mg/day)	113.3 ± 4.1	84.4 ± 4[c]	116.5 ± 4.1	84.5 ± 4.1[c]	87.1 ± 4.1	105.7 ± 4[c]	119.6 ± 3.4	82.9 ± 3.5[c]	118.1 ± 3.5	87.6 ± 3.4[c]	98.6 ± 3.5	98.4 ± 3.5

[a] Data are means ± standard error (SE).
[b] Only adjusted for age.
[c] $P < 0.05$ compared with the lowest tertile, Obtained from ANCOVA.

Table 3
Gender-stratified multivariable-adjusted means for anxiety, depression and GHQ score measures across tertiles of nutrient patterns' scores.[a]

	Omnivore pattern score				Grains and dairy pattern score				Fruits and vegetables pattern score			
	T1 (n = 698)	T2 (n = 704)	T3 (n = 698)	P[b]	T1 (n = 699)	T2 (n = 703)	T3 (n = 698)	P	T1 (n = 697)	T2 (n = 706)	T3 (n = 697)	P
Males												
Anxiety score												
Age and energy adjusted	3.18 ± 0.16	2.81 ± 0.16	2.70 ± **0.16**	0.08	3.04 ± 0.16	2.79 ± 0.16	2.85 ± 0.16	0.53	2.93 ± 0.16	2.81 ± 0.16	2.94 ± 0.16	0.81
Multivariable adjusted[c]	3.14 ± 0.16	2.73 ± 0.16	2.60 ± 0.16	0.04	3.04 ± 0.17	2.64 ± 0.18	2.86 ± 0.17	0.29	2.82 ± 0.17	2.67 ± 0.17	3.06 ± 0.17	0.27
Depression score												
Age and energy adjusted	5.61 ± 0.15	5.44 ± 0.15	5.35 ± 0.15	0.47	5.56 ± 0.15	5.40 ± 0.16	5.43 ± 0.15	0.72	5.41 ± 0.15	5.47 ± 0.15	5.51 ± 0.15	0.91
Multivariable adjusted	5.52 ± 0.16	5.46 ± 0.16	5.3 ± 0.16	0.64	5.51 ± 0.16	5.37 ± 0.17	5.4 ± 0.16	0.82	5.28 ± 0.16	5.39 ± 0.16	5.62 ± 0.16	0.30
GHQ score												
Age and energy adjusted	1.71 ± 0.12	1.56 ± 0.12	1.79 ± 0.12	0.36	1.69 ± 0.12	1.74 ± 0.12	1.62 ± 0.12	0.77	1.68 ± 0.12	1.61 ± 0.12	1.77 ± 0.12	0.62
Multivariable adjusted	1.62 ± 0.12	1.59 ± 0.12	1.68 ± 0.12	0.87	1.64 ± 0.12	1.62 ± 0.13	1.62 ± 0.12	0.98	1.61 ± 0.12	1.50 ± 0.12	1.78 ± 0.12	0.26
Females												
Anxiety score												
Age and energy adjusted	4.19 ± 0.15	4.0 ± 0.16	3.85 ± 0.15	0.29	3.99 ± 0.16	3.97 ± 0.16	4.08 ± 0.15	0.86	3.91 ± 0.15	4.03 ± 0.15	4.10 ± 0.15	0.70
Multivariable adjusted	4.23 ± 0.15	3.92 ± 0.16	3.73 ± 0.15	0.07	4.05 ± 0.17	3.99 ± 0.18	3.96 ± 0.17	0.94	3.94 ± 0.15	3.93 ± 0.17	4.15 ± 0.17	0.59
Depression score												
Age and energy adjusted	6.70 ± 0.13	6.72 ± 0.14	6.47 ± 0.14	0.35	6.66 ± 0.14	6.56 ± 0.14	6.67 ± 0.13	0.85	6.73 ± 0.14	6.56 ± 0.14	6.60 ± 0.14	0.67
Multivariable adjusted	6.69 ± 0.15	6.71 ± 0.16	6.4 ± 0.15	0.28	6.64 ± 0.15	6.60 ± 0.16	6.56 ± 0.15	0.92	6.74 ± 0.15	6.40 ± 0.15	6.68 ± 0.15	0.24
GHQ score												
Age and energy adjusted	2.51 ± 0.11	2.47 ± 0.12	2.15 ± 0.11	0.05	2.38 ± 0.12	2.36 ± 0.12	2.38 ± 0.11	0.99	2.28 ± 0.12	2.42 ± 0.11	2.42 ± 0.11	0.62
Multivariable adjusted	2.52 ± 0.12	2.55 ± 0.13	2.08 ± 0.13	0.01	2.40 ± 0.12	2.40 ± 0.13	2.34 ± 0.13	0.92	2.34 ± 0.13	2.32 ± 0.13	2.50 ± 0.13	0.53

[a] Data are means ± standard error (SE).
[b] Obtained from ANCOVA.
[c] Adjusted for antidepressant use, marital status, education, family size, smoking status, physical activity, breakfast skipping, BMI and having a chronic disease.

Table 4
Odds Ratio (95% CI) for anxiety, depression and psychological distress according to tertiles (T) of nutrient patterns, in male participants.[a]

	Omnivore pattern score				Grains and dairy pattern score				Fruits and vegetables pattern score			
	T1	T2	T3	P[b]	T1	T2	T3	P	T1	T2	T3	P
Anxiety (n)	31	17	26		30	22	22		30	20	24	
Crude	1	0.53 (0.29–0.97)	0.83 (0.48–1.41)	0.46	1	0.72 (0.41–1.26)	0.73 (0.42–1.29)	0.26	1	0.65 (0.37–1.16)	0.79 (0.46–1.37)	0.38
Model I[c]	1	0.56 (0.28–1.12)	0.72 (0.38–1.38)	0.30	1	0.63 (0.31–1.29)	0.73 (0.38–1.42)	0.35	1	0.86 (0.44–1.69)	0.88 (0.45–1.72)	0.71
Model II[d]	1	0.61 (0.30–1.30)	0.7 (0.34–1.42)	0.31	1	0.46 (0.21–1.03)	0.69 (0.34–1.40)	0.31	1	0.78 (0.34–1.66)	1.06 (0.52–2.17)	0.88
Model III[e]	1	0.60 (0.28–1.30)	0.57 (0.26–1.25)	0.15	1	0.57 (0.25–1.29)	0.70 (0.33–1.49)	0.34	1	0.76 (0.35–1.68)	1.03 (0.49–2.19)	0.95
Depression (n)	46	41	29		43	35	38		44	36	36	
Crude	1	0.88 (0.57–1.36)	0.61 (0.38–0.98)	0.04	1	0.79 (0.50–1.26)	0.88 (0.56–1.39)	0.57	1	0.80 (0.51–1.26)	0.81 (0.51–1.27)	0.34
Model I	1	0.90 (0.54–1.50)	0.54 (0.30–0.95)	0.04	1	0.77 (0.44–1.36)	0.73 (0.43–1.24)	0.24	1	0.82 (0.48–1.41)	0.82 (0.48–1.39)	0.45
Model II	1	0.96 (0.55–1.7)	0.51 (0.27–0.95)	0.04	1	0.62 (0.33–1.17)	0.71 (0.40–1.26)	0.23	1	0.85 (0.47–1.55)	096 (0.53–1.71)	0.87
Model III	1	0.98 (0.55–1.74)	0.50 (0.26–0.96)	0.04	1	0.69 (0.37–1.31)	0.74 (0.41–1.33)	0.31	1	0.84 (0.46–1.56)	1.04 (0.58–1.88)	0.90
Psychological distress (n)	106	90	106		113	88	101		109	92	101	
Crude	1	0.99 (0.74–1.34)	0.80 (0.59–1.10)	0.97	1	0.73 (0.53–0.99)	0.88 (0.65–1.19)	0.39	1	0.81 (0.59–1.10)	0.92 (0.68–1.25)	0.60
Model I	1	0.88 (0.62–1.26)	1.10 (0.79–1.54)	0.56	1	0.78 (0.55–1.12)	0.81 (0.78–1.13)	0.21	1	0.95 (0.67–1.34)	1.02 (0.73–1.43)	0.89
Model II	1	0.95 (0.65–1.39)	1.08 (0.75–1.56)	0.65	1	0.73 (0.49–1.08)	0.82 (0.57–1.18)	0.28	1	0.93 (0.63–1.35)	1.13 (0.78–1.62)	0.51
Model III	1	0.94 (0.64–1.39)	1.04 (0.71–1.51)	0.84	1	0.76 (0.51–1.13)	0.84 (0.58–1.21)	0.34	1	0.89 (0.60–1.31)	1.10 (0.76–1.60)	0.60

[a] Data are odds ratio (95% CI).
[b] P for trend.
[c] Model I: adjusted for age and energy intake.
[d] Model II: adjusted for variables in model I plus antidepressant use, marital status, education, family size, smoking status, physical activity, breakfast skipping and having a chronic disease.
[e] Model III: additionally adjusted for BMI.

Table 5
Odds Ratio (95% CI) for anxiety, depression and psychological distress according to tertiles (Q) of nutrient patterns, in female participants.[a]

	Omnivore pattern score				Grains and dairy pattern score				Fruits and vegetables pattern score			
	T1	T2	T3	P[b]	T1	T2	T3	P	T1	T2	T3	P
Anxiety (n)	48	45	49		44	44	54		44	47	51	
Crude	1	0.93 (0.61–1.41)	1.02 (0.67–1.54)	0.93	1	0.99 (0.64–1.53)	1.25 (0.82–1.88)	0.29	1	1.06 (0.69–1.63)	1.18 (0.78–1.79)	0.44
Model I[c]	1	1.03 (0.66–1.61)	1.06 (0.69–1.62)	0.80	1	1.41 (0.92–2.16)	1.16 (0.72–1.86)	0.11	1	1.16 (0.74–1.82)	1.33 (0.87–2.05)	0.19
Model II[d]	1	1.00 (0.61–1.63)	1.00 (0.62–1.57)	0.96	1	1.11 (0.65–1.89)	1.51 (0.95–2.39)	0.08	1	1.21 (0.74–1.97)	1.33 (0.83–2.14)	0.24
Model III[e]	1	0.96 (0.58–1.59)	0.99 (0.61–1.58)	0.96	1	1.11 (0.65–1.91)	1.47 (0.92–2.35)	0.10	1	1.28 (0.78–2.11)	1.31 (0.80–2.14)	0.29
Depression (n)	94	93	97		90	104	90		83	102	99	
Crude	1	0.98 (0.72–1.33)	1.04 (0.76–1.41)	0.81	1	1.17 (0.87–1.59)	1.00 (0.73–1.37)	0.99	1	1.25 (0.92–1.70)	1.22 (0.90–1.67)	0.21
Model I	1	0.88 (90.63–1.22)	0.90 (0.65–1.24)	0.52	1	1.15 (0.82–1.62)	1.01 (0.72–1.40)	0.99	1	1.21 (0.87–1.69)	1.24 (0.89–1.72)	0.20
Model II	1	0.87 (0.61–1.24)	0.86 (0.61–1.22)	0.39	1	1.20 (0.83–1.74)	0.99 (0.69–1.41)	0.90	1	1.23 (0.86–1.76)	1.28 (0.90–1.83)	0.18
Model III	1	0.84 (0.59–1.21)	0.86 (0.61–1.23)	0.41	1	1.25 (0.86–1.82)	1.01 (0.70–1.45)	0.99	1	1.21 (0.85–1.74)	1.24 (0.87–1.80)	0.22
Psychological distress (n)	193	188	174		189	180	186		174	192	189	
Crude	1	1.15 (0.91–1.47)	1.12 (0.88–1.42)	0.24	1	0.94 (0.74–1.19)	0.99 (0.78–1.25)	0.91	1	1.14 (0.89–1.44)	1.11 (0.87–1.41)	0.40
Model I	1	0.97 (0.75–1.24)	0.79 (0.62–1.02)	0.07	1	0.96 (0.74–1.25)	0.97 (0.75–1.24)	0.79	1	1.17 (0.91–1.51)	1.11 (0.89–1.43)	0.40
Model II	1	0.94 (0.72–1.24)	0.74 (0.56–0.97)	0.03	1	0.99 (0.74–1.32)	0.92 (0.70–1.21)	0.55	1	1.14 (0.89–1.51)	1.17 (0.89–1.54)	0.26
Model III	1	0.93 (0.70–1.23)	0.75 (0.57–0.99)	0.04	1	1.00 (0.74–1.34)	0.95 (0.72–1.25)	0.69	1	1.13 (0.86–1.50)	1.14 (0.86–1.50)	0.36

[a] Data are odds ratio (95% CI).
[b] P for trend.
[c] Model I: adjusted for age and energy intake.
[d] Model II: adjusted for variables in model I plus antidepressant use, marital status, education, family size, smoking status, physical activity, breakfast skipping and having a chronic disease.
[e] Model III: additionally adjusted for BMI.

factor analysis must also be taken into account [39]. It must also be kept in mind that SEPAHAN was a cross-sectional study done in a sample of general adults working in 50 different health centers across Isfahan province; therefore, generalizing our findings to the Iranian adults must be considered with caution.

In conclusion, we found evidence indicating that an omnivore like NP characterized by high consumption of individual amino acids, cobalamin, zinc, phosphorus, saturated fatty acids, cholesterol, pantothenic acid and pyridoxine was associated with reduced odds of major depression in men and lower chance of psychological distress in women. Individuals with the greatest adherence to this NP had lower anxiety scores. Future large-scale, prospective cohort or nested case–control studies are required to confirm these findings.

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Authors contribution

The authors' responsibilities were as follows— ASA, AE, LA, HA and PA conceived the study. ASA, AE and AF conducted the data analysis and interpretation. All authors contributed to the study conception, design and drafting of the manuscript.

Conflict of interest

Authors declared no personal or financial conflicts of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.clnu.2018.02.002.

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