The Association Between Adherence to The Dietary Approaches to Stop Hypertension (DASH) Diet and Neuro-Psychological Function in Young Women

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**Abstract**

**Background:** The beneficial impact of adherence to a DASH diet may have a bidirectional relationship with mental wellbeing. The aim of the present study was to evaluate the relationship between the DASH diet and neuro-psychological function in young women.

**Methods:** In this cross-sectional study, a total of 181 adolescent girls aged between 18-25 years were recruited. The dietary intakes of study participants were collected using a valid and reliable food frequency questionnaire (FFQ) containing 65 food items. Neuropsychological function of participants was evaluated using standard questionnaires.

**Results:** As may be expected, individuals in the highest tertile of adherence to DASH diet (high adherence) consumed more folate, fruits, vegetables, low fat dairy, nuts, legume, and seed, and less sweetened beverage and sodium, compared to the participants in the lowest tertile (lower adherence). There was a significant negative relationship between cognitive function and consumption of red and processed meat ($r=-0.168$; $p<0.05$), quality of life score with dietary sodium ($r=-0.151$; $p<0.01$) and depression score with vegetables ($r=-0.174$; $p<0.05$). In multivariate multinomial logistic regression analyses adjusted for age, BMI and energy intake, adherence to a DASH style-pattern was protective against stress score (OR=0.32; 95%CI: 0.14-0.71) and difficulty with sleep initiating (OR=0.46; 95%CI: 0.21-1.00).

**Conclusion:** Adherence to a DASH diet may be a protective against a high stress score and difficulty with sleep initiating.

**1. Introduction**

There is increasing evidence that mental health disorders are significant contributors to the burden of disease, accounting for 7.4% of disease burden globally (1, 2). Mental health disorders include mood disturbance, depression and anxiety (3). These mental health problems may also affect the quality of life (QoL) (4). Strategies for preventing these mental health conditions would be of significant importance (5).

Life style factors, including diet may have an important role in the development and treatment of these psychological disorders (6). Several studies have evaluated the relationship between some dietary factors and mental dysfunction (7, 8). It has been reported that a diet rich in fish, polyunsaturated fatty acids (PUFAs), folate, and, B vitamin groups can mitigate the features of depression (8). A positive association was found between the dietary glycemic index (GI) and mental diseases, depressive disorder, and psychological function (7). A meta-analysis has reported that a healthy lifestyle characterized by a high intake of vegetables, whole seeds, fruits and fish, is associated with a reduced risk of depression in adolescents (9), whilst a positive association was reported between “junk foods” (high energy and low nutritional content foods) use and risk for psychiatry and mental distress and aggressive behaviors in Iranian children and adolescents (10). Turagabeci et al. have reported that a healthy lifestyle comprising a good diet, hygienic behaviors and high levels of physical activity, is associated with a lower risk of aggressive behavior (11). A high consumption of sweets, high energy beverages and high dietary carbohydrates was associated with a poor sleep quality, but a high use of fish and vegetable was associated with a high sleep quality (12).
Nutritional epidemiologists have emphasized the importance of assessing an overall diet pattern, rather than single nutrients or foods, to consider diet-related disease correlations (13, 14). The Dietary Approaches to Stop Hypertension (DASH) type diet is considered to be a healthy diet that includes high intakes of whole seeds, fruits, vegetables, leguminous plants and nuts, and only small amounts of low fat dairy, red or processed meats, desserts, and sweet and sugar-containing beverages; it was essentially created to reduce blood pressure (6). Beneficial effects of the DASH diet has been reported for other conditions (15), including cardiovascular disease (16), stroke in women (17) and renal disease (18), however there are little data on the effects of the DASH diet on mental health in children and youngsters (5). A clinical trial showed that in postmenopausal women, a low sodium DASH diet, improved mood and depressive symptoms (19). We have designed a cross sectional study to evaluate the relationship between adherence to a DASH diet and neuro-psychological function in apparent healthy young women.

2. Materials And Methods

2-1. Study design

In this cross-sectional study, 181 single women aged 18-25 years, were recruited from 5 different universities in Birjand, South Khorasan, Iran in January 2020. We excluded women with any acute or chronic disease. The Ethics Committee of Birjand University of Medical Sciences approved the study. All participants provided written informed consent,

2-2. Dietary assessment

A valid and reliable 65 item semi-quantitative food frequency questionnaire was used to assess the food intake of subjects over the previous year (20, 21). Experienced dietitians, asked participants to describe their consumption frequency for each food item during the previous year on a daily, weekly, monthly, rarely or never basis. Food analysis was done using Diet Plan 6 software (forest field Software Ltd., Horsham West Sussex, UK). The DASH dietary pattern scoring was determined according to the method of Fung et al (17). The DASH score, focusing on 8 components: high intake of vegetables, fruits, legumes and nuts, whole grains and low intake of sodium, low-fat dairy products, red and processed meats, and sweetened beverages. For the composition of DASH score, values of 1 or 5 were assigned to each nutritional component using the quintiles as cut-off values. For vegetables, fruits, legumes and nuts, whole grains and low-fat dairy products the lowest quintile was scored 1 point and the highest quintile was scored 5 points. For red and processed meats, salt and sweetened beverages the scoring was inverted. Finally, the score of each group was integrated and with a value of 8 (minimal adherence) to 40 (maximal adherence).

2-3. Demographic and anthropometric analysis

General demographic and anthropometric data such as age, height, weight, waist circumference, hip circumference, systolic blood pressure (SBP) and, diastolic blood pressure (DBP) were collected in all contributors by employing standardized protocols (22). Body mass index (BMI) was computed as weight in kilograms divided with height in meters squared (5). Blood samples were collected of all participants since nightly fasting. A complete blood count (CBC) was operated as segment of the evaluation of hematological parameters using the SysmexK-800.
2-4: Neuropsychological analysis

2-4-1. Cognitive Ability Assessment (CAA):

The Cognitive Abilities Questionnaire (CAQ) is a valid and reliable tool which estimate 7 distinctive abilities including: memory, inhibitory control and selective attention, decision making, planning, sustained attention, social cognition and cognitive flexibility (23). This instrument is comprised of 30 items, each rated on 1-5 to yield a total score ranging from 30 to 150. Higher scores reflected better cognitive performance (24).

2-4-2. Depression Anxiety Stress Scales (DASS):

Depression Anxiety and Stress Scale (DASS-21) is a valid and reliable tool to measure status of negative well-beings (25). This questionnaire consists of 21 items with 3 subscales (each consist of 7 questions) in which each items is rated on a 4-point Likert scale 0-3 measuring severity of depression, anxiety and stress. Because DAS-21 is the brief version of DAS-42; the total score of each sub-class must be doubled. Higher score correlated with severe negative emotional. The validity and reliability of the DASS-21 has been previously validated in an Iranian population (26).

2-4-3. Quality of Life (QoL)

The Short Form health survey (SF-12) derivative from the SF-36 is a widely reliable tool for measuring of physical and mental components of QoL. Validity and, reliability from this tool has been established in Iranian population (27). The SF-12 consists of 12 questions covering 8 health domains with higher scores indicating a better health dependent QoL (28).

2-4-4. Insomnia Severity Index (ISI)

This tool is a 7 item itself-detail instrument measuring the nature, intensity and, effect from insomnia. The areas assessed are: severity of sleep initiation, sleep maintenance, and timely morning awakening complications, degree of sleep satisfaction and interfering of sleep difficulties with daytime activities. A 5-level Likert score is applied to level ever part (0 = no problem; 4 = many problem) efficiency all scales ranging of 0 to 28. The Persian version of this tool with good reliability and validity for Iranian population was established in current study (29, 30).

2-4-5. Epworth Sleepiness Scale (ESS)

The Epworth Sleepiness Scale (ESS) is an 8-item reliable questionnaire for assessing the individual's daytime sleepiness propensity. Each item rated on 4-point Likert scale (0 to 3) which measures the intensity of sleepiness in daily life conditions. Total scores range from 0 to 24 and higher scores correlated to intensive sleepiness (31, 32).

2-4-6. Short sleep duration and difficult sleep initiating

Sleep signs were evaluated based on 2 asks reporting to sleep during the past month: (1) “Do you have difficulty falling asleep at night?” (2) “How many times have you woken up early and, have trouble getting back to sleep?” Short sleep duration was determined if a subject slept for fewer than 5 h/day, once or more a week
Difficult sleep initiating was determined as had problems falling asleep in half an hour one time or rather a week (35-38).

### 2-5. Statistical analysis

All statistical analyses were conducted by using SPSS, version 16 software packages. Data were evaluated for normality by applying the Kolmogorov-Smirnov test. One-way ANOVA test was used for comparison of continues variables with normal distribution across tertiles of DASH-style diet score. Depression, anxiety, stress, insomnia and sleepiness scores were divided into two categories (No/Minimal state and some degree of disorder) regarding to scores. Acquiring a score below median cut of QoL score was considered as low QoL. The correlation between component of the DASH diet score and neuro-psychological test scores was evaluated using Pearson correlation analysis. Multinomial logistic regression was used to evaluate the association between adherence to DASH diet and neuropsychological difficulties and we adjusted all variables for age, BMI and energy intake. P-value <0.05 was set as significant level.

### 3. Results

#### 3-1. Demographic, anthropometric characteristics of the participants according to the DASH pattern scores tertiles

The mean age of the participants was 20.7±2.2 y. The DASH diet scores were categorized into tertiles, T1 as lowest tertile (least adherence; n=56), T2 (n=63), and T3 as highest tertile (highest adherence; n=30). There was no significant correlation among the demographic and anthropometric variables from the participants containing: age, waist-to-hip ratio (WHR), systolic blood pressure, diastolic blood pressure, hemoglobin and hematocrit (P>0.05; Table 1). But significant differences in BMI for participants in the 1st tertile compared to 3rd tertile of adherence to the DASH dietary (P<0.05).

#### 3-2. Dietary intakes of participants in different tertiles of the adherence to the DASH dietary pattern scores

Correlation among dietary intakes of participants in different tertiles of the adherence to the DASH dietary pattern scores are shown in Table 2. The amount of folate, fruits, vegetables, nuts, legume, seed and low fat dairy, were higher among individuals in the highest tertile of adherence to DASH diet than others in the lowest tertile and the value of sweetened beverage and sodium were higher among subjects in the first tertile of adherence to DASH diet compared to the participants in the third tertile.

#### 3-3. Correlation coefficient between neuropsychological tests and components of DASH score

There was a significant negative correlation between total cognitive abilities score with red and processed meat (r=-0.168; P<0.05), quality of life score with sodium (r=-0.151; P<0.01) and depression score with vegetables (r=-0.174; P<0.05). There was a significant positive correlation among quality of life by nuts, legume, seed (r=0.183; P<0.05), insomnia with sweetened beverage consumption (r=0.205; P<0.01) and sleep duration with whole grain (r=0.179; P<0.05) (P<0.05).

#### 3-4. Multivariate adjusted odds ratios (95% CIs) for neuropsychological disorders across tertiles of DASH-style diet scores
In multivariate multinomial logistic regression analyses adjusted for age, BMI and energy intake, adherence to DASH style-pattern was a protective factor against the degree of stress (OR=0.32; 95%CI: 0.14-0.71; 2nd tertile with 1st DASH tertile) and difficulty in sleep initiating (OR=0.46; 95%CI: 0.21-1.00; third tertile versus first DASH tertile) (Table 4).

4. Discussion

Our findings show that a high adherence to a DASH diet is associated with a reduced stress score and sleep disturbance in young women. A DASH diet is characterized by higher intakes of fruits, vegetables, low-fat dairy products, fish and nuts, and lower intake of refined grains, red and processed meat, sugar-sweetened beverages and sweets (39). Stress is a modern complaint and excessive and, persistent stress may affect the QoL (40). Due to the importance of stress on QoL, it is necessary to note the factors that can be effective in managing stress disorders. In one study conducted on university students stress was reported to be significantly related to a lower QoL and higher insomnia and burnout levels (41). Cartwright et al showed that greater levels of stress were associated with a higher intake of fatty foods and snacks and less fruits and vegetables, as well as lower daily breakfast use (42). Several risk factors are also associated with higher stress levels are higher use of sweets, chocolate, and food composition (e.g. high fat/energy) (43, 44).

We found that depression score was negatively related to vegetables intake. A prospective cohort study reported that more frequent use of vegetables protects against depressive signs in the elderly (45). In several cross-sectional surveys, use of vegetables or fruits has been demonstrated to be connected with lower risks of depression (46, 47). The mechanism by which vegetables or ‘healthy diet patterns’ decreases the risk of depression is unclear (45). But, some nutrients including B-vitamins (especially B6, B12 and folate), n-3 fatty acids and, antioxidants have been implicated in this (48). Lucas et al reported that high a linolenic acid and lower linoleic acid (an n-6 fatty acid) recessives decrease depression risk in a 10-year prospective study (49).

In this study, we have found an inverse relationship between cognitive ability score and amount of dietary red and processed meat intake. In adolescents, a Western pattern that contained higher intakes of processed foods, sweet and red meat was found to be related to greater levels of behavior problems (50). Nutrition plays an important role in cognitive abilities in the fast growth period during childhood as it supplies the making components for nerve formation and, brain development (51).

One of the noticeable finding of our study, was that adherence to DASH diet was a protective factor against difficult sleep initiating. The sleep–wake cycle, one of our biologic rhythms, is driven with a 24-hour timing system that is influenced with certain factors included physiological function and work program (52). Sleepiness can have a significant negative influence on overall health and quality of life (53). Results of one study among school-aged children showed that sleep variables have significant correlations with cognitive and behavioral scores (54). Interestingly, people with a normal sleep pattern showed higher protein intake compared to people by insomnia (55). Tanaka et al demonstrated that a lower protein intake was correlated with difficulty initiating sleep (DIS) and, poor quality of sleep (PQS), while lower carbohydrate intake was associated with difficulty maintaining sleep (DMS) (56). The mechanism of the effect of protein on sleep can be dependent on tryptophan (TRP), which is a precursor to serotonin and melatonin, and can control the sleep cycle (57). A high carbohydrate diet that is lower in protein has been reported to raise brain TRP levels comparative to higher-protein diets in animal models (58) Also, the use of carbohydrates with high GI including white rice can cause
the secretion of insulin and, raising TRP influx into the brain and regulating serotonin production (59). The findings indicate that individuals with a greater adherence to a DASH diet consume lower sweetened beverages and fat, and experienced better sleep quality (60). In an animal study, it has been showed that long-term sugar intake had negative effect on brain serotonin 5-hydroxytryptophan (5-HT1A) receptor sensitivity (61). Another study in Wistar rats showed that a week following a higher fat, lower carbohydrate diet there was a decrease in serotonin release in the hypothalamus (62). Therefore, it seems that a diet with low levels of sweetened beverages and fat can be efficient in decreasing sleep disturbances.

In this study, we have showed an inverse correlation between quality of life status and sweetened beverage. Due to important result of sleep health on quality of life, it is essential to notice main factors, that can be effective on managing or treating of sleep disorders (60). Kanyinga et al reported that a high Sweetened beverages intake plays an important role in the short sleep duration (63). Sweetened beverages include stimulants, of which caffeine is the main active component (64). A high consumption of caffeinated sweetened beverages may lead to seizures, difficulty sleeping and even death (65).

To the best of our knowledge, this is the first study, which has examined the correlation between adherence to DASH diet and, neuropsychological function. However, there are several limitations in our study that must be evaluated. Firstly, using a cross-sectional study design, cannot demonstrate causality. Secondly, we applied the FFQ for measuring diets; improper classication is another limitation in this study, like any epidemiologic study. Thirdly, difficult sleep initiating was evaluated with self-reported questionnaires which likely to be predisposed to abuse.

5. Conclusion

We found a significant relationship between adherence to a DASH diet and lower stress scores and difficult sleep initiating among young women. It seems that following a healthy diet pattern can have a good effect on decrease stress and increase quality of sleep. Further studies, especially longitudinal studies are necessary to confirm these results with larger population.

Abbreviations

Dietary Approaches to Stop Hypertension (DASH), food frequency questionnaire (FFQ), quality of life (QoL), poly unsaturated fatty acids (PUFAs), glycemic index (GI), systolic blood pressure (SBP), diastolic blood pressure (DBP), Body mass index (BMI), complete blood count (CBC), Cognitive Ability Assessment (CAA), Cognitive Abilities Questionnaire (CAQ), Depression Anxiety Stress Scales (DASS), Form health survey (SF-12), Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), difficulty initiating sleep (DIS), poor quality of sleep (PQS), difficulty maintaining sleep (DMS), tryptophan (TRP), serotonin 5-hydroxytryptophan (5-HT1A).

Declarations

Disclosure: The authors have no conflict of interest to disclose

Author's Contribution:
AB contributed to research planning, examination, writing and statistical analysis. MA contributed to planning, supervision and correction. MA and MS and contributed to research planning, case examination, writing and editing the manuscript. MS and MN contributed to statistical analysis, correction. GAF contributed to planning and correction. SK contributed to examination, supervision and edition.

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Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval Ethical approval was obtained from the Birjand University of Medical Sciences.

Informed consent Informed consent was obtained from all individual participants included in the study.

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References

1. Whiteford HA, Degenhardt L, Rehm J, Baxter AJ, Ferrari AJ, Erskine HE, et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. The lancet. 2013;382(9904):1575-86.
2. Desa U. World population prospects: the 2010 revision, highlights and advance tables. Working Paper No ES/P/WP. 220. New York: United Nations, Department of ..., 2011.

3. Steel Z, Marnane C, Iranpour C, Chey T, Jackson JW, Patel V, et al. The global prevalence of common mental disorders: a systematic review and meta-analysis 1980–2013. International journal of epidemiology. 2014;43(2):476-93.

4. Owens J, Group ASW. Insufficient sleep in adolescents and young adults: an update on causes and consequences. Pediatrics. 2014;134(3):e921-e32.

5. Khayyatzadeh SS, Mehramiz M, Mirmousavi SJ, Mazidi M, Ziaee A, Kazemi-Bajestani SMR, et al. Adherence to a Dash-style diet in relation to depression and aggression in adolescent girls. Psychiatry research. 2018;259:104-9.

6. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. New England journal of medicine. 2001;344(1):3-10.

7. Haghighatdoost F, Azadbakht L, Keshteli AH, Feinle-Bisset C, Daghaghzadeh H, Afshar H, et al. Glycemic index, glycemic load, and common psychological disorders. The American journal of clinical nutrition. 2016;103(1):201-9.

8. Murakami K, Sasaki S. Dietary intake and depressive symptoms: a systematic review of observational studies. Molecular nutrition & food research. 2010;54(4):471-88.

9. Lai JS, Hiles S, Bisquera A, Hure AJ, McEvoy M, Attia J. A systematic review and meta-analysis of dietary patterns and depression in community-dwelling adults. The American journal of clinical nutrition. 2014;99(1):181-97.

10. Zahedi H, Kelishadi R, Heshmat R, Motlagh ME, Ranjbar SH, Ardalan G, et al. Association between junk food consumption and mental health in a national sample of Iranian children and adolescents: the CASPIAN-IV study. Nutrition. 2014;30(11-12):1391-7.

11. Turagabeci AR, Nakamura K, Takano T. Healthy lifestyle behaviour decreasing risks of being bullied, violence and injury. PloS one. 2008;3(2).

12. Tan X, Alén M, Cheng SM, Mikkola TM, Tenhunen J, Lyytikäinen A, et al. Associations of disordered sleep with body fat distribution, physical activity and diet among overweight middle-aged men. Journal of sleep research. 2015;24(4):414-24.

13. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. Current opinion in lipidology. 2002;13(1):3-9.

14. Michels KB, Schulze MB. Can dietary patterns help us detect diet–disease associations? Nutrition research reviews. 2005;18(2):241-8.

15. Azadbakht L, Fard NRP, Karimi M, Baghaei MH, Surkan PJ, Rahimi M, et al. Effects of the Dietary Approaches to Stop Hypertension (DASH) eating plan on cardiovascular risks among type 2 diabetic patients: a randomized crossover clinical trial. Diabetes care. 2011;34(1):55-7.

16. Salehi-Abargouei A, Maghsoudi Z, Shirani F, Azadbakht L. Effects of Dietary Approaches to Stop Hypertension (DASH)-style diet on fatal or nonfatal cardiovascular diseases—incidence: a systematic review and meta-analysis on observational prospective studies. Nutrition. 2013;29(4):611-8.
17. Fung TT, Chiuve SE, McCullough ML, Rexrode KM, Logroscino G, Hu FB. Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women. Archives of internal medicine. 2008;168(7):713-20.

18. Rebholz CM, Crews DC, Grams ME, Steffen LM, Levey AS, Miller III ER, et al. DASH (Dietary Approaches to Stop Hypertension) diet and risk of subsequent kidney disease. American Journal of Kidney Diseases. 2016;68(6):853-61.

19. Torres SJ, Nowson CA. A moderate-sodium DASH-type diet improves mood in postmenopausal women. Nutrition. 2012;28(9):896-900.

20. Ahmadnezhad M, Asadi Z, Miri HH, Ferns GA, Ghayour-Mobarhan M, Ebrahimi-Mamaghani M. Validation of a Short Semi-Quantitative Food Frequency Questionnaire for Adults: a Pilot study. Journal of Nutritional Sciences and Dietetics. 2017.

21. Asadi Z, Yaghootti-Khorasani M, Ghazizadeh H, Sadabadi F, Mosa-Farkhany E, Darroudi S, et al. Association between dietary inflammatory index and risk of cardiovascular disease in the Mashhad stroke and heart atherosclerotic disorder study population. IUBMB life. 2019.

22. Bushman BA. Understanding and Using the Dietary Guidelines for Americans. ACSM's Health & Fitness Journal. 2017;21(1):4-8.

23. Nejati V. Cognitive abilities questionnaire: development and evaluation of psychometric properties. Advances in Cognitive Science. 2013;15(2):11-9.

24. Bahrami A, Bahrami-Taghanaki H, Khorasanchi Z, Tayefi M, Ferns GA, Sadeghnia HR, et al. The Association Between Neuropsychological Function with Serum Vitamins A, D, and E and hs-CRP Concentrations. Journal of Molecular Neuroscience. 2019;68(2):243-50.

25. Henry JD, Crawford JR. The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. British journal of clinical psychology. 2005;44(2):227-39.

26. Sahebi A, Asghari MJ, Salari R. Validation of depression anxiety and stress scale (DASS-21) for an Iranian population. 2005.

27. Montazeri A, Vahdaninia M, Mousavi SJ, Omidvari S. The Iranian version of 12-item Short Form Health Survey (SF-12): factor structure, internal consistency and construct validity. BMC public health. 2009;9(1):341.

28. Juniper E, O’ byrne P, Guyatt G, Ferrie P, King D. Development and validation of a questionnaire to measure asthma control. European respiratory journal. 1999;14(4):902-7.

29. Morin CM, Belleville G, Bélanger L, Ivers H. The Insomnia Severity Index: psychometric indicators to detect insomnia cases and evaluate treatment response. Sleep. 2011;34(5):601-8.

30. Yazdi Z, Sadeghniiat-Haghighi K, Zohal MA, Elmizadeh K. Validity and reliability of the Iranian version of the insomnia severity index. The Malaysian journal of medical sciences: MJMS. 2012;19(4):31.

31. Chung K-F, Kan KK-K, Yeung W-F. Assessing insomnia in adolescents: comparison of insomnia severity index, Athens insomnia scale and sleep quality index. Sleep medicine. 2011;12(5):463-70.

32. Castronovo V, Galbiati A, Marelli S, Brombin C, Cugnata F, Giarolli L, et al. Validation study of the Italian version of the Insomnia Severity Index (ISI). Neurological Sciences. 2016;37(9):1517-24.

33. Cappuccio FP, Taggart FM, Kandala N-B, Currie A, Peile E, Stranges S, et al. Meta-analysis of short sleep duration and obesity in children and adults. Sleep. 2008;31(5):619-26.
34. Kurotani K, Kochi T, Nanri A, Eguchi M, Kuwahara K, Tsuruoka H, et al. Dietary patterns and sleep symptoms in Japanese workers: the Furukawa Nutrition and Health Study. Sleep medicine. 2015;16(2):298-304.
35. Furihata R, Uchiyama M, Takahashi S, Suzuki M, Konno C, Osaki K, et al. The association between sleep problems and perceived health status: a Japanese nationwide general population survey. Sleep medicine. 2012;13(7):831-7.
36. Association AP. American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, (p. 81). Arlington: American Psychiatric Association. 2013.
37. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry res. 1989;28(2):193-213.
38. Doi Y, Minowa M, Uchiyama M, Okawa M, Kim K, Shibui K, et al. Psychometric assessment of subjective sleep quality using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J) in psychiatric disordered and control subjects. Psychiatry research. 2000;97(2-3):165-72.
39. Lutsey PL, Steffen LM, Stevens J. Dietary intake and the development of the metabolic syndrome. Circulation. 2008;117(6):754-61.
40. Ribeiro IJ, Pereira R, Freire IV, de Oliveira BG, Casotti CA, Boery EN. Stress and quality of life among university students: A systematic literature review. Health Professions Education. 2018;4(2):70-7.
41. Cho J-Y, Song J-C. Dietary behavior, health status, and perceived stress of university students. The Korean Journal of Food and Nutrition. 2007;20(4):476-86.
42. Cartwright M, Wardle J, Steggles N, Simon AE, Croker H, Jarvis MJ. Stress and dietary practices in adolescents. Health psychology. 2003;22(4):362.
43. Kandiah J, Yake M, Jones J, Meyer M. Stress influences appetite and comfort food preferences in college women. Nutrition Research. 2006;26(3):118-23.
44. Zellner DA, Loaiza S, Gonzalez Z, Pita J, Morales J, Pecora D, et al. Food selection changes under stress. Physiology & behavior. 2006;87(4):789-93.
45. Tsai AC, Chang T-L, Chi S-H. Frequent consumption of vegetables predicts lower risk of depression in older Taiwanese—results of a prospective population-based study. Public Health Nutrition. 2012;15(6):1087-92.
46. Woo J, Lynn H, Lau W, Leung J, Lau E, Wong S, et al. Nutrient intake and psychological health in an elderly Chinese population. International Journal of Geriatric Psychiatry: A journal of the psychiatry of late life and allied sciences. 2006;21(11):1036-43.
47. Avila-Funes JA, Garant M-P, Aguilar-Navarro S. Relationship between determining factors for depressive symptoms and for dietary habits in older adults in Mexico. Revista Panamericana de Salud Pública. 2006;19(5):321-30.
48. Kim J-M, Stewart R, Kim S-W, Yang S-J, Shin I-S, Yoon J-S. Predictive value of folate, vitamin B 12 and homocysteine levels in late-life depression. The British Journal of Psychiatry. 2008;192(4):268-74.
49. Lucas M, Mirzaei F, O'Reilly EJ, Pan A, Willett WC, Kawachi I, et al. Dietary intake of n-3 and n-6 fatty acids and the risk of clinical depression in women: a 10-y prospective follow-up study. The American journal of clinical nutrition. 2011;93(6):1337-43.
50. Oddy WH, Robinson M, Ambrosini GL, Therese A, de Klerk NH, Beilin LJ, et al. The association between dietary patterns and mental health in early adolescence. Preventive medicine. 2009;49(1):39-44.
51. Benton D. The influence of children's diet on their cognition and behavior. European journal of nutrition. 2008;47(3):25-37.
52. Lima P, Medeiros A, Araujo J. Sleep-wake pattern of medical students: early versus late class starting time. Brazilian Journal of Medical and Biological Research. 2002;35(11):1373-7.
53. Jewett ME, Dijk D-J, Kronauer RE, Ding D. Dose-response relationship between sleep duration and human psychomotor vigilance and subjective alertness. Sleep. 1999;22(2):171-9.
54. Rand S, Afek I, Suraiya S, Shahar E, Pillar G. Sleep disturbances are associated with reduced school achievements in first-grade pupils. Developmental neuropsychology. 2009;34(5):574-87.
55. Zadeh SS, Begum K. Comparison of nutrient intake by sleep status in selected adults in Mysore, India. Nutrition research and practice. 2011;5(3):230-5.
56. Tanaka E, Yatsuya H, Uemura M, Murata C, Otsuka R, Toyoshima H, et al. Associations of protein, fat, and carbohydrate intakes with insomnia symptoms among middle-aged Japanese workers. Journal of epidemiology. 2013;23(2):132-8.
57. Yu C, Shi Z, Lv J, Guo Y, Bian Z, Du H, et al. Dietary patterns and insomnia symptoms in Chinese adults: the China Kadoorie Biobank. Nutrients. 2017;9(3):232.
58. Fernstrom JD, Wurtman RJ. Brain serotonin content: physiological regulation by plasma neutral amino acids. Science. 1972;178(4059):414-6.
59. Lyons PM, Truswell AS. Serotonin precursor influence by type of carbohydrate meal in healthy adults. The American journal of clinical nutrition. 1988;47(3):433-9.
60. Pahlavani N, Khayyatzadeh SS, Banazadeh V, Bagheri M, Tawfei M, Eslami S, et al. Adherence to a Dietary Approach to Stop Hypertension (DASH)-Style in Relation to Daytime Sleepiness. Nature and Science of Sleep. 2020;12:325-32.
61. Inam Q, Haleem M, Haleem D. Effects of long term consumption of sugar as part of meal on serotonin 1-a receptor dependent responses. Pakistan journal of pharmaceutical sciences. 2006;19(2):94-8.
62. Banas SM, Rouch C, Kassiss N, Markaki EM, Gerozissis K. A dietary fat excess alters metabolic and neuroendocrine responses before the onset of metabolic diseases. Cellular and molecular neurobiology. 2009;29(2):157.
63. Sampasa-Kanyinga H, Hamilton HA, Chaput J-P. Sleep duration and consumption of sugar-sweetened beverages and energy drinks among adolescents. Nutrition. 2018;48:77-81.
64. Wolk BJ, Ganetsky M, Babu KM. Toxicity of energy drinks. Current opinion in pediatrics. 2012;24(2):243-51.
65. Trabulo D, Marques S, Pedroso E. Caffeinated energy drink intoxication. Emergency medicine journal. 2011;28(8):712-4.

**Tables**

**Table 1.** Demographic, anthropometric and clinical characteristics of the participants according to the DASH dietary pattern score tertiles
| Variables       | T1       | T2       | T3       | P value<sup>a</sup> |
|-----------------|----------|----------|----------|--------------------|
| Age (y)         | 20.8±1.9 | 20.6±1.5 | 20.9±1.8 | 0.67               |
| BMI (Kg/m2)     | 20.2±2.3 | 20.4±2.6 | 21.9±3.4 | **0.006**          |
| WHR             | 0.73±0.04| 0.73±0.03| 0.74±0.04| 0.23               |
| SBP (mmHg)      | 10.5±0.9 | 10.8±1.0 | 10.5±0.9 | 0.29               |
| DBP (mmHg)      | 7.1±0.7  | 7.1±0.8  | 6.9±0.8  | 0.61               |
| Hb(g/dl)        | 13.7±1.3 | 14.2±1.7 | 13.8±1.1 | 0.20               |
| Hct (%)         | 41.1±2.8 | 42.4±4.5 | 41.1±2.6 | 0.10               |

Abbreviations: Body mass index (BMI); Waist-to-hip ratio (WHR); Systolic blood pressure (SBP); Diastolic blood pressure (DBP); Hemoglobin (Hb); Hematocrit (Hct).

Data presented as Mean±SD.

<sup>a</sup> p-value from analysis of the variance (ANOVA) for groups comparison.

**Table 2.** Dietary intakes of participants in different tertiles of the adherence to the DASH dietary pattern scores
| Variables                        | DASH diet adherence |       |       |       |       |
|---------------------------------|---------------------|-------|-------|-------|-------|
|                                 |                     | **T1**| **T2**| **T3**| **P value** |
| Dietary nutrient intake         |                     |       |       |       |       |
| Total energy (kcal)             | 2170±840            | 2166±658| 2177±816| 0.99 |
| Carbohydrate (g/1000Kcal)      | 64.8±39.5           | 57.5±28.1| 63.6±31.2| 0.54 |
| Protein (g/1000Kcal)            | 35.3±14.4           | 29.9±14.9| 31.9±14.1| 0.207 |
| Fat (g/1000Kcal)                | 13.9±12.8           | 16.5±11.2| 15.3±11.2| 0.54 |
| Dietary fiber (g/1000Kcal)      | 5.9±3.2             | 6.4±3.1 | 8.0±3.7 | 0.006 |
| Zinc (mg/1000Kcal)              | 2.59±1.39           | 2.23±1.20| 2.51±1.10| 0.28 |
| Folate(μg/1000Kcal)             | 74.3±38.2           | 81.7±34.7| 107.4±40.9| <0.001 |
| Components of DASH-diet style (g/1000 Kcal) | | | | | |
| Fruits                          | 68.2±57.7           | 89.7±69.3| 131.7±112.5| 0.001 |
| Vegetables                      | 31.5±24.8           | 49.2±28.4| 93.3±71.4| <0.001 |
| Nuts, legume, seed              | 12.1±11.7           | 20.0±15.1| 28.6±15.9| <0.001 |
| Low fat dairy                   | 7.3±16.7            | 18.3±23.3| 38.7±42.6| <0.001 |
| Whole grain                     | 10.2±23.0           | 15.3±17.8| 19.2±22.4| 0.092 |
| Red and processed meat          | 29.4±43.8           | 20.5±15.7| 19.9±12.3| 0.138 |
| Sweetened beverage             | 57.0±86.3           | 23.9±26.7| 14.4±31.2| <0.001 |
| Sodium(mg/1000Kcal)             | 1727±640            | 1512±900.9| 1272±812| 0.018 |

Data presented as Mean±SD and adjusted for energy intake.
†obtained from ANOVA test.

**Table 3.** Correlation coefficient between neuropsychological tests and components of DASH score.
Table 4. Multivariate adjusted odds ratios (95% CIs) for neuropsychological disorders across tertiles of DASH-style diet scores.

| Food groups                | Cognitive abilities | Depression  | Anxiety | Stress | Quality of life | Insomnia | Daytime sleepiness | Sleep duration |
|----------------------------|---------------------|-------------|---------|--------|-----------------|----------|-------------------|----------------|
| Fruits                     | 0.031               | -0.087      | 0.003   | 0.093  | -0.105          | -0.011   | 0.085             | 0.033          |
| Vegetables                 | 0.096               | -0.174*     | -0.146  | -0.096 | 0.12            | 0.034    | 0.071             | 0.054          |
| Nuts, legume, seed         | 0.028               | -0.92       | 0.027   | -0.060 | *0.183*         | -0.063   | -0.003            | 0.005          |
| Low fat dairy              | 0.005               | -0.025      | -0.070  | -0.054 | 0.062           | -0.012   | 0.004             | -0.054         |
| Whole grain                | 0.019               | 0.055       | -0.19   | 0.012  | 0.081           | -0.097   | -0.052            | 0.179*         |
| Red and processed meat     | -0.168*             | 0.027       | 0.112   | 0.084  | -0.077          | 0.118    | 0.031             | -0.021         |
| Sweetened beverage        | 0.046               | -0.017      | -0.002  | 0.059  | -0.127          | 0.205**  | 0.117             | -0.071         |
| Sodium                     | 0.013               | 0.148       | 0.021   | -0.064 | -0.151**        | -0.093   | 0.42              | -0.003         |

*p<0.05

**p<0.01

***p<0.001
| Variables                | Tertiles of DASH score |
|-------------------------|------------------------|
|                         | T1         | T2         | T3         |
| Cognitive impairments   | Ref.       | 1.07(0.52-2.22) | 0.62(0.30-1.28) |
| Depressive mood         | Ref.       | 0.90(0.44-1.86) | 1.6(0.78-3.42)  |
| Anxiety behavior        | Ref.       | 0.53(0.26-1.12) | 1.54(0.74-3.21) |
| Stress                  | Ref.       | 0.32(0.14-0.71)** | 0.70(0.34-1.47) |
| Lower quality of life   | Ref.       | 1.02(0.42-2.44) | 1.32(0.56-3.02) |
| Insomnia                | Ref.       | 0.81(0.39-1.67) | 0.89(0.43-1.84) |
| Daytime sleepiness      | Ref.       | 0.92(0.43-1.99) | 0.79(0.37-1.73) |
| Short sleep duration    | Ref.       | 0.51(0.12-2.32) | 0.70(0.18-2.76) |
| Difficult sleep initiating | Ref.   | 0.67(0.32-1.40) | 0.46(0.21-1.00)* |

Tertile 1 was considered as reference group.
Adjusted for age, BMI and energy intake.

*p<0.05
**p<0.01
***p<0.001