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Original article

Mediterranean diet, Dietary Approaches to Stop Hypertension (DASH) style diet, and metabolic health in U.S. adults

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SUMMARY

Background & aims: There is sparse evidence on the relationship between the Mediterranean diet, Dietary Approaches to Stop Hypertension (DASH) style diet, and metabolic health, especially comparing cardiometabolic phenotypes among in normal weight and obese populations. We aimed to investigate the association of the Mediterranean diet score (MDS) and DASH index with metabolically healthy obese (MHO) and metabolically obese normal weight (MONW) phenotypes in a representative U.S. population.
Methods: MDS and DASH index were calculated using dietary data from 2767 adults aged 20–90 years without any prior diagnosis of cancer or cardiovascular disease from the National Health and Nutrition Examination Survey III, 1988–1994. MHO and MONW individuals were identified using fasting glucose, insulin resistance, blood pressure, triglycerides, C-reactive protein, and high-density lipoprotein-cholesterol.
Results: Higher MDS was associated with higher odds of MHO phenotype (odds ratio $(OR)_{T3\ vs\ T1}$, 2.57 [95% confidence interval (CI), 1.04–6.35]; P trend = 0.04), and higher DASH index was associated with lower odds of MONW phenotype ($OR_{T3\ vs\ T1}$, 0.59 [95% CI, 0.38–0.93]; P trend = 0.03) only in the younger age group (<45 years for men or premenopausal women). No significant associations of MDS and DASH index with MHO and MONW phenotypes were observed in the older age group (≥45 years for men or postmenopausal women).
Conclusions: Adherence to Mediterranean diet or DASH style diet was favorably associated with MHO and MONW phenotypes only in the younger age group, suggesting that potential dietary intervention to prevent cardiometabolic disease differ by age group.

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1. Introduction

Obesity is associated with an increased risk of type 2 diabetes and cardiovascular disease (CVD) [1], but not all obese individuals are equally susceptible to cardiometabolic risk. Within the same category of body mass index (BMI), a subgroup of obese individuals who have normal metabolic characteristics has been identified as metabolically healthy obese (MHO) phenotype, compared with metabolically unhealthy obese (MUO) phenotype [2–4]. In addition, a subgroup of normal weight individuals who are susceptible to metabolic abnormalities has been referred to as metabolically obese normal weight (MONW) phenotype [5–7].

It is well known that the Mediterranean diet and the Dietary Approaches to Stop Hypertension (DASH) style diets are associated

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with lower risk of cardiometabolic disease [8]. Both dietary patterns are hypothesis-driven diets characterized by key components: the Mediterranean diet relies on the dietary habits adopted by population living in the Mediterranean area and is characterized by high content of fruit, vegetables, legumes, fish, nuts, and unsaturated fatty acids from vegetable sources including a large amount from olive oil [9,10]; the DASH diet takes into account macro- and micro-nutrients demonstrated to be effective in reducing risk of hypertension [11]. Underlying mechanisms for cardiovascular health benefits of Mediterranean diet and DASH style diet are complex, but can be explained by the improvement of cardiometabolic profiles including insulin resistance, lipid profiles, blood pressure, and inflammatory markers [12]. Therefore, it is plausible that adherence to Mediterranean diet and DASH style diets might be positively associated with a metabolically healthy phenotype.

Several studies have explored associations between dietary factors and metabolic phenotypes. However, these reports have been limited to MHO phenotype [13], especially without considering dietary pattern [14], or with specific age groups [15]. A few studies have reported associations in MONW phenotype in non-US population [16], but with limited generalizability [17]. Several studies demonstrated that dietary factors are related to metabolic phenotype in both obese and normal weight population [18], but only focused on women [19], or single foods such as olive oil [20]. However, limited data exist on the relationship of Mediterranean diet and DASH diet with metabolic phenotypes, especially for a potential differential association by age groups with substantially different cardiovascular risk.

It has been suggested that the risk of developing coronary heart disease significantly increases after 45 years in men [21] and in postmenopausal women [22]. In addition, it is reported that the association between Mediterranean diet and atherothrombotic biomarkers is largely different between men <45 years and men ≥45 years as well as premenopausal and postmenopausal women [23]. Another study showed that the Healthy Eating Index score was associated with MHO phenotype only in younger age group [13].

Therefore, we aimed to identify the association of Mediterranean diet and DASH style diet with MHO and MONW phenotypes in a nationally representative U.S. population, with a priori hypothesis that this association should be different according to the two age groups exhibiting a substantial difference in cardiovascular risk; less than or greater than 45 years in men; before or after menopause in women.

2. Methods

2.1. Study population

We used data from the Third National Health and Nutrition Examination Survey (NHANES III), 1988–1994 for this analysis. A complex multi-stage stratified clustered probability sample design was used to achieve a nationally representative sample of the civilian, non-institutionalized US population. The survey included personal interviews, physical examinations, and laboratory measurements.

We included 3858 normal weight ($18.5 \leq$ BMI < 25 kg/m^2) and obese (BMI ≥ 30 kg/m^2) adults aged 20–90 years with complete data on food frequency questionnaire (FFQ) and 24-h dietary recall, as well as the variables for defining metabolic health including fasting glucose, insulin, blood pressure (BP), triglycerides, high-density lipoprotein cholesterol (HDL-C), and high-sensitivity C-reactive protein (hs-CRP) with at least 10 h' fasting. We applied these strict fasting criteria to minimize misclassification of metabolic health status. Because dietary habits might change due to chronic disease, we excluded those who reported a history of myocardial infarction, stroke, congestive heart failure, or any prior diagnosis of cancer (n = 463). To minimize reverse causation, we also excluded the participants who reported changing their dietary patterns due to any medical reason during the previous 12 months (n = 489). Furthermore, we excluded those who reported implausible extreme energy intakes (<1st and >99th percentiles of energy intake/d in adults), those with hs-CRP >10 mg/L, BMI > 60 kg/m^2, or pregnant or lactating women (n = 139). A total of 2767 individuals were included in the present analysis. We classified men under 45 years and premenopausal women as the younger group; while we considered men ≥45 years and postmenopausal women as the older group. Women were considered as premenopausal if they reported having had a menstrual period during the past 12 months; and postmenopausal if they did not or if they had a history of surgery with both ovaries removed [24].

2.2. Assessment of Mediterranean diet

An 81-item FFQ and 24-h dietary recall, determined by the Nutrition Methodology Working Group [25], were used to assess dietary intake. We evaluated adherence to Mediterranean diet using the scoring methods established by Panagiotakos et al. [26,27]. The FFQ used in NHANES III applied a one-month reference period without recording portion sizes. Thus, we calculated the MDS, assuming that the number of servings per week were equivalent to the number of times that a person consumed a food item per week. In brief, we assigned scores 0–5 for the weekly consumption of food items assumed to be contributing to a Mediterranean dietary pattern, whereas scores on the inverse ordinal scale were assigned for the consumption of food items assumed to be against the Mediterranean dietary pattern. For instance, the scores designated to the frequencies of legumes consumed weekly were as follows: never, less than 1 time, 1–2 times, 3–4 times, 5–6 times, and >6 times, corresponding to scores of 0, 1, 2, 3, 4 and 5, respectively. We assigned the scores for the food items of whole grains, fruits, vegetables, fish, and olive oil in a similar way; and for the food items of dairy products, poultry, and red meat and products in a reverse way. For the alcohol consumption, a score of 5 was assigned for consumption of less than 300 ml (36 g) of alcohol per day, 0 for no consumption or for consumption of >700 ml (84 g) per day. It has been shown that Mediterranean Diet Scores (MDS) are highly Q2 associated with prevalent cardio-metabolic diseases, 10-year CVD risk, and inflammation and coagulation markers, as well as capturing inherent characteristics of Mediterranean dietary pattern [23,26,27].

We excluded potatoes in our MDS assessment, because the way potatoes are prepared in U.S. is quite different from European countries [28]. The amount of alcohol consumed daily was assessed using the following assumption: 12.8 g for 12-oz beer, 11 g for 4-oz glass of wine, and 14 g for an ounce of liquor. Additionally, gender-specific cut-offs were applied: a score of 5 was assigned for consumption of less than 28 g and 14 g of alcohol per day, score 0 for no consumption or for consumption of greater than 70 g and 28 g per day in men and women, respectively, and the cutoffs for subcategories between 0 and 5 were reassigned with even intervals [29]. Since consumption of olive oil was not ascertained in the NHANES III FFQ, we used the ratio of total monounsaturated fatty acid to total saturated fatty acids using the 24-h dietary recall, then dividing it into the six even intervals as a proxy for olive oil consumption. Finally, the possible MDS score ranged from 0 to 50, with higher values of this MDS score indicating greater adherence to Mediterranean diet (Supplemental Table S1) [30].

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