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Original article

Adherence index to the American Heart Association Diet and Lifestyle Recommendation is associated with the metabolic syndrome in Japanese male workers

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ABSTRACT

Background: As Japanese societies rapidly undergo Westernization, the prevalence of metabolic syndrome is increasing. We investigated the association between dietary habits and the prevalence of metabolic syndrome using a new adherence index to optimal dietary habits based on the American Heart Association Diet and Lifestyle Recommendation (AHA-DLR).

Methods: We conducted a cross-sectional study of 503 male workers who completed a brief food frequency questionnaire. Adherence to the AHA-DLR was assessed using a 10-component adherence index (AI-84; a total possible score of 84 points). Metabolic syndrome was defined according to the most recently published harmonized criteria by the International Diabetes Federation in conjunction with the National Heart, Lung, and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society, and International Association for the Study of Obesity.

Results: The prevalence of metabolic syndrome was 26.6% and the AI-84 score ranged from 5 to 56 points. Subjects with metabolic syndrome had a significantly lower AI-84 score compared with those without (27.1 ± 9.1 vs. 28.9 ± 9.2, $p = 0.042$). After adjusting for age, energy intake, smoking habit and physical activity, a higher AI-84 score was associated with a significantly lower prevalence of metabolic syndrome, with an odds ratio of 0.778 (95% CI 0.614–0.986, $p = 0.038$) for each 10-point score increment.

Conclusions: A lower AI-84 score was associated with increased prevalence of metabolic syndrome. Our findings support a potential beneficial impact of nutritional assessment using adherence to the AHA-DLR for prevention of metabolic syndrome.

1. Introduction

Cardiovascular disease is a major cause of death in Japan, and metabolic syndrome is an important risk factor for cardiovascular disease [1]. The prevalence of metabolic syndrome has increased over the last decade among the Japanese population, and in 2008, it was estimated that 27% of men aged 40 to 74 years met the criteria for this disorder (Ministry of Health, Labour and Welfare of Japan 2010). Dietary habits play an important role in the development of metabolic syndrome, and over the past few decades, the Japanese diet has become more Westernized. The dominant approach of nutritional epidemiology in the past has been to investigate the association between single nutrients or foods and the risk of disease; however, this approach is fraught with problems [2]. Recently, comprehensive approaches, such as the analysis of dietary pattern, have been used to investigate the association between diet and disease. Several studies have tried to identify the relation between dietary pattern analysis and the presence of metabolic syndrome [3–6], but the findings are not consistent. An assessment of dietary patterns can evaluate potential synergistic effects and the balance between protective and harmful components in the diet, but there are limitations in dietary pattern analyses in a single ethnic group with respect to extrapolation of findings to other ethnic populations.

The development of dietary scores determined by established dietary recommendations may have certain advantages over dietary pattern approaches, and some adherence indexes have been proposed, including the healthy eating index [7], adherence to Mediterranean diet [8], the alternative healthy index [9], and adherence to Dietary Guidelines for Americans [10]. Although a large number of indices have been developed, several methodological issues concerning index composition remained unresolved [11]. Recently, the American Heart Association designed specific goals of an overall healthy diet, that is, the AHA Diet and Lifestyle Recommendation (AHA-DLR) [12], and an adherence index based on the AHA-DLR was developed by a study group of Tufts University [13]. The adherence index is aimed at examining the association between dietary behaviors and cardiovascular disease risk. To the

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best of our knowledge, no study has assessed the utility of the adherence index to the AHA-DLR for the risk of metabolic syndrome. The aim of this study was to determine whether adherence to the AHA-DLR is associated with metabolic syndrome in male Japanese workers.

2. Patients and methods

2.1. Subjects

We conducted a cross-sectional study of 516 male workers at an electronic products factory in Nara Prefecture, Japan, aged 25 to 62 years, who underwent annual health examinations between July 2010 and December 2011. For the current analysis, we excluded participants with insufficient answers to the dietary questionnaire (n = 9), who had implausibly low or high estimated caloric intake (n = 2, <600 or >4500 kcal per day), or who had missing information for factors needed for statistical adjustment (n = 2). We thus analyzed data from 503 participants. Study protocols were approved by the Institutional Review Board of Kio University and written informed consent was received from each participant.

2.2. Definition of metabolic syndrome

All participants were subjected to a physical examination assessing height, weight, waist circumference, and blood pressure. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Waist circumference was measured midway between the lower rib margin and iliac crest. Venous samples were collected from each subject after overnight fasting, and serum levels of triglycerides, high-density lipoprotein (HDL) cholesterol, and plasma levels of glucose were measured. The metabolic syndrome was defined according to the most recently published harmonized criteria by the International Diabetes Federation in conjunction with the National Heart, Lung, and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society, and International Association for the Study of Obesity [14]. Based on this definition, subjects were defined as having metabolic syndrome if they had three or more of the 5 components: waist circumferences ≥ 85 cm [15]; high blood pressure (≥130 mm Hg systolic or ≥85 mm Hg diastolic or current use of antihypertensive medicine); a high serum level of triglycerides (≥150 mg/dl or specific treatment for this lipid abnormality); low HDL cholesterol (<40 mg/dl); and high fasting glucose level (≥100 mg/dl).

2.3. Dietary assessment

Habitual food consumption and nutrient intake were assessed using a brief self-administered diet history questionnaire (BDHQ) [16]. The questionnaire asks about the consumption frequency of 56 food and beverage items and requires that participant recall his dietary habits over a 1-month period. Participants were asked to choose seven possible answers to indicate how often they had consumed various specified foods during the past month (never, <1 times per week, once a week, 2 to 3 times per week, 4 to 6 times per week, once-daily, and more than 2 times per day). Combined with standard serving sizes, the intake frequencies were converted into the average daily intake for each food item. Estimates of nutrients and energy were calculated using an adhoc computer algorithm for the BDHQ that was based on the Standard Tables of Food composition in Japan (Japan Science and Technology Agency, 2010).

2.4. Adherence index to the AHA-DLR

We proposed an adherence index to the AHA-DLR modified from the original index developed by Bhupathiraju et al. [13]. The original index is constructed by summing scores based on adherence to 13 individual components of the AHA-DLR. The modified adherence index we used includes 10 components of the original index: (1) consuming a diet rich in fruit and vegetables, (2) choosing a variety of fruit and vegetables, (3) choosing whole-grain products, (4) consuming oily fish, (5) consuming an appropriate range of total fat, (6) limiting intake of saturated fat, (7) reducing dietary cholesterol, (8) minimizing intake of beverages and foods with added sugars, (9) consuming low- or no-salt foods, and (10) consuming alcohol in moderation. Our adherence index was modified through the exclusion of 3 components (maintained a healthy body weight, taking part in moderate and vigorous physical activity, and limiting trans fat intake to <1% of energy). Trans fat intake was excluded from the analysis because precise evaluation of trans fat intake is difficult using a brief semi-quantitative food-frequency questionnaire.

In addition, we used simpler scoring system (Table 1). Participants who reported adhering to recommended levels received the maximum points (4, 5, 6, or 10 points for each component) and those not adhering to recommended levels were assigned 0 points or intermediate points (2, 3, or 5 points for each component). The serving size was determined as approximately 100 g for fruits and approximately 70 g for vegetables [17]. Fruit and vegetables consumption were analyzed separately, and consumption of 2 or more servings of fruits and 5 or more servings of vegetables (about >350 g per day) were considered as standard (each 5 points). The index includes one item for consuming a variety of fruit and vegetables: individuals who ate ≥15 of 17 varieties of fruit and vegetables at least once per week scored 10 points, those who ate 10 to 14 varieties scored 5 points, and those who ate <10 varieties scored 0 points. There was also one item to assess total daily grain intake: >50% of total intake from whole grains is considered to be in line with healthy recommendations. With respect to added sugars, total intakes of added sugars were calculated from major sources of sugars in food categories of sugars, cakes, soft drinks, and other sugar-sweetened beverages. A recent statement by the AHA indicated that a prudent upper limit of intake for men is no more than 150 kcal per day from added sugars [18]. Therefore, we assigned 0 points if a participant's intake of added sugar was >150 kcal per day. Subjects were divided into 3 subgroups according to alcohol consumption: non-drinker, light drinker (>0 and <2 drinks per day), and heavy drinkers (≥2 drinks per day). Finally, the adherence index (namely AI-84) was calculated as the sum of these 10 components with a possible score of 0 to 84. A higher score on the AI-84 indicates better adherence to the recommendations.

2.5. Other variables

A self-reported questionnaire was used to assess current smoking status (yes, no) and physical activity (active, sedentary). According to the National Health and Nutrition Survey in Japan, the questions asking

Table 1
Scoring system for adherence to the American Heart Association Diet and Lifestyle Recommendations.

Recommendation	Nonadherence	Intermediate	Good adherence
1. Consume a diet rich in			
1) Fruits	<1 SV/d (0)	1–1.9 (3)	≥2 SV/d (5)
2) Vegetables	<3 SV/d (0)	3–4.9 (3)	≥5 SV/d (5)
2. Variety in fruits and vegetable intake	<10 (0)	10–14 (5)	≥15 (10)
3. Choose whole-grain	None (0)	10% (2), 25% (5)	≥50% (10)
4. Consume oily fish	Never (0)	Once a week (3)	≥2 times/w (10)
5. Total fat intake	>35% (0)	<25% (2)	25–35% (4)
6. Saturated fat intake	>7.0% (0)	3.5–7.0% (3)	<3.5% (6)
7. Dietary cholesterol	>300 mg/d (0)	150–300 (2)	<150 mg/d (4)
8. Added sugars	≥150 kcal/d (0)	100–149(2), 50–99(5)	<50 kcal/d (10)
9. Little or no salt foods	>9 g/d (0)	6–9 g/d (5)	<6 g/d (10)
10. Consume alcohol	≥2 drinks/d (0)	Nondrinker (5)	Adequate[a] (10)

Each point of score in parenthesis. SV, servings.
[a] Adequate alcohol intakes: >0 and <2 drinks.