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Higher intake of cryptoxanthin is related to low body mass index and body fat in Japanese middle-aged women

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ABSTRACT

Objectives: The prevalence of cardiovascular diseases increases with age, especially in postmenopausal women. In this study, we investigated the dietary patterns associated with body mass and body fat in Japanese middle-aged women.
Study design: Cross-sectional.
Main outcome measures: This study used baseline data collected in a previous study in 88 women aged 40–60 years. Participants were assessed for age, menopausal status, lifestyle factors, body composition, and dietary habits using a brief-type self-administered diet history questionnaire, which provides information on the amounts of nearly 100 nutritional factors consumed during the previous month. Classifying body mass index (BMI) as low ($\leq$22 kg/m^2) or high (>22 kg/m^2) and percentage body fat as low ($\leq$25%) or high (>25%), we sought to identify the nutritional factors associated with BMI and percentage body fat.
Results: Consumption differences between high/low BMI and high/low body fat percentage groups were not significant for any nutritional factors except cryptoxanthin. Multiple logistic regression analysis adjusting for age, menopausal status, working, exercise, and smoking revealed that higher cryptoxanthin intake was associated with low BMI (adjusted odds ratio, 1.22 per 100 μg/day increase of cryptoxanthin intake; 95% confidence interval, 1.01–1.52) and low body fat percentage (adjusted odds ratio, 1.36 per 100 μg/day increase of cryptoxanthin intake; 95% confidence interval, 1.13–1.70).
Conclusions: Higher intake of cryptoxanthin was shown to be related to low body mass and body fat in Japanese middle-aged women.

1. Introduction

The prevalence of cardiovascular diseases increases with age, especially after menopause in women [1–4]. The postmenopausal increase in cardiovascular risk factors, such as central obesity, hypertension, dyslipidemia, and diabetes is not only caused by unhealthy diets, physical inactivity, smoking, and harmful use of alcohol, but also partly explained by estrogen withdrawal [5]. Menopausal transition is thought to be associated with weight gain [6], as exemplified by a study revealing that middle-aged women gained an average of 2.25 ± 4.19 kg during a 3-year menopausal period [7]. The types of nutrients as well as total calories consumed may affect body composition, including body mass and body fat. A number of dietary habits, such as high-fat [8], low-carbohydrate [9], and high-sugar foods [10] and low intake of calcium [11], vitamins [11,12], and minerals [12] have been suggested to associate with high body mass and body fat in previous studies. However, the precise nutritional factors that directly affect body composition remain to be elucidated.

The aim of this study was to investigate nutritional factors that are independently associated with body composition, especially body mass index (BMI) and body fat percentage, in Japanese middle-aged women.

Abbreviations: ABC, ATP-binding cassette transporter; BDHQ, brief-type self-administered diet history questionnaire; BMI, body mass index; PPAR, peroxisome proliferator-activated receptor; RAR, retinoic acid receptor; RXR, retinoid X receptor.

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2. Methods

2.1. Study population

In the present study, we performed a cross-sectional analysis using the baseline data of a previous study conducted at the Menopause Clinic of the Tokyo Medical and Dental University that examined the effects of a dietary supplement on a variety of health parameters in 88 Japanese women [13]. The inclusion criteria were those who aged between 40 and 60 and having at least one menopausal symptom on the Menopausal Health-Related Quality of Life (MHR-QOL) Questionnaire (score >1). The exclusion criteria were those who were receiving menopausal hormone therapy, herbal medicine, or psychotropic drugs. The participants were recruited through advertisements posted in our hospital and in the patients' social network. Collected information included: age; menopausal status; lifestyle factors such as working, exercise, and smoking; body composition; and detailed dietary habits. The study protocol was reviewed and approved by the Tokyo Medical and Dental University Review Board, and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

Participants' menopausal status was classified as follows: premenopausal (regular menstrual cycles in the past 3 months), perimenopausal (a menstrual period within the past 12 months but a missed period or irregular cycles in the past 3 months), postmenopausal (no menstrual period in the past 12 months), or surgically induced menopause (hysterectomy).

2.2. Measures

2.2.1. Body composition and cardiovascular parameters

Participants' body composition, including height, weight, BMI, fat mass, and muscle mass, was assessed using a body composition analyzer (MC190-EM; Tanita, Tokyo, Japan).

2.2.2. Dietary habits

Dietary habits were assessed using a brief-type self-administered diet history questionnaire (BDHQ), a short version of a self-administered diet history questionnaire that was developed in Japan [14]. The BDHQ asks about the consumption frequency of selected food and beverage items commonly consumed in Japan, mainly from the food list used in the National Health and Nutrition Survey of Japan [15,16]. Based on the information provided responses to the BDHQ, an ad hoc computer algorithm estimated the amounts of 98 nutritional factors consumed during the previous month [15,17]. Table 1 shows the major nutritional factors listed on the BDHQ.

2.3. Statistical analyses

We classified body mass index (BMI) level as low (≤22 kg/m2) and high (>22 kg/m2) according to the Japan Society for the Study of Obesity, and body fat percentage level as low (≤25%) and high (>25%) according to the Ministry of Health, Labour and Welfare. First, all nutrients were compared between the low and high BMI/body fat percentage groups using univariate analyses (unpaired *t*-test) in order to determine the association between body composition and the dietary intake of each nutritional factor. Variables emerging with possible prognostic value for low BMI and body fat percentage ($P < 0.05$) were then entered into a multiple logistic regression analysis (Model 1). We examined the association adjusting for age and menopausal status (Model 2), and for age, menopausal status, working, exercise, and smoking (Model 3). The variables that remained significant ($P < 0.05$) were retained in the final multivariate model and considered to be associated with the level of BMI and body fat percentage in Japanese middle-aged women. Statistical analyses were performed using GraphPad Prism version 5.02 (GraphPad Software, San Diego, CA, USA) and JMP version 11.0.0 (SAS Institute Inc, Cary, NC, USA).

Table 1
Major nutritional factors assessed with BDHQ.

Energy	Copper	Cholesterol
Weight of foods	Manganese	Soluble dietary fiber
Water	Retinol	Insoluble dietary fiber
Protein	Vitamin D	Dietary fiber
Animal protein	α-Tocopherol	Salt equivalent
Vegetable protein	Vitamin K	Sucrose
Fat	Vitamin B1	Alcohol
Animal fat	Vitamin B2	Daidzein
Vegetable fat	Niacin	Genistein
Carbohydrate	Vitamin B6	n-3 fatty acid
Ash content	Vitamin B12	n-6 fatty acid
Sodium	Folic acid	α-Carotene
Potassium	Pantothenic acid	β-Carotene
Calcium	Vitamin C	Cryptoxanthin
Magnesium	Saturated fatty acid	β-Tocopherol
Phosphorus	Monounsaturated fatty acid	γ-Tocopherol
Iron	Polyunsaturated fatty acid	δ-Tocopherol
Zinc		

BDHQ, brief-type self-administered diet history questionnaire.

Table 2
Background characteristics of the participants (N = 88).

	Mean	SD	Number	%
Age, y	49.7	5.0		
Gravida	0.59	0.49		
Para	0.56	0.50		
Menopausal status, premenopausal			38	43.2
perimenopausal			17	19.3
postmenopausal			26	9.5
surgically induced			7	8.0
Height, cm	156.7	5.1		
Weight, kg	52.6	6.9		
Body mass index, kg/cm^2	21.4	2.7		
Body fat percentage, %	26.3	6.6		
Lean body mass, kg	38.4	2.8		
Muscle amount, kg	36.2	2.5		
Resting energy expenditure, kcal/day	1818.3	442.1		
Body temperature, °C	36.3	0.46		
Waist-to-hip ratio	0.85	0.07		
Working, (yes/no)			79/9	89.8/10.2
Regularly exercising, (yes/no)			40/48	45.5/54.5
Smoking, (yes/no)			10/78	11.4/88.6

3. Results

The characteristics of 88 middle-aged women enrolled in the study are shown in Table 2. The participants were divided into two groups according to the level of BMI and body fat percentage: 56 women were classified as having low BMI (≤22 kg/m^2) and 32 women as high BMI (>22 kg/m^2). Thirty-five women were classified as having low body fat percentage levels (≤25%), and 53 women as having high levels (>25%).

We first compared the estimated daily intake of each nutrient between the low and high BMI and body fat percentage groups using unpaired *t*-test. The women with low BMI level consumed significantly more cryptoxanthin (4.1 ± 2.9 vs. 2.9 ± 2.2 mg/day, mean ± SD, $P = 0.048$) (Table 3). Likewise, those with low body fat percentage consumed significantly more cryptoxanthin (4.8 ± 3.1 vs. 2.9 ± 2.1 mg/day, mean ± SD, $P = 0.001$) (Table 4). The other 97