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Association between 24-hour ambulatory blood pressure and erythrocyte n-3 polyunsaturated fatty acids in Korean subjects with hypertension

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Abstract

N-3 polyunsaturated fatty acids (PUFAs) are known to have antihypertensive properties, but the association between 24-hour ambulatory blood pressure and the tissue content of n-3 PUFA remains controversial. The purpose of the present study was to investigate the hypothesis that the level of erythrocyte n-3 PUFA is inversely related with 24-hour ambulatory blood pressure after adjustment for relevant confounders. Fifty-one male and 49 female Korean patients were included in this study. Twenty-seven of the patients were defined as having hypertension. There were significant differences in age, body mass index, sex, marital status, and family history of hyperlipidemia between hypertensive and nonhypertensive subjects, and these factors were therefore considered to be confounding factors. Multivariate-adjusted regression analysis showed that erythrocyte fatty acids were not significantly associated with the risk of hypertension after adjusting for confounders. However, Pearson correlation analysis showed that 24-hour ambulatory systolic blood pressure (SBP) was significantly and negatively correlated with n-3 PUFA ($r = -0.228$, $P = .027$) and eicosapentaenoic acid ($r = -0.270$, $P = .008$), but not with docosahexaenoic acid ($r = -0.156$, $P = .131$). Multivariate-adjusted regression analysis also showed that intake of protein, vitamin B_2, vitamin E, and cholesterol increased the risk of hypertension after adjusting for confounders. In addition, Pearson correlation analysis showed that fat and cholesterol consumption was positively correlated with SBP, but carbohydrate intake was negatively correlated with SBP. In conclusion, erythrocyte n-3 PUFA did not reduce the risk of hypertension but were negatively correlated with 24-hour ambulatory SBP in the Korean population.

Keywords: N-3 polyunsaturated fatty acids; Erythrocyte; 24-Hour ambulatory blood pressure; Hypertension; Diet; Human
Abbreviations: BMI, body mass index; DHA, docosahexaenoic acid; DPA, docosapentaenoic acid; EPA, eicosapentaenoic acid; FFQ, food frequency questionnaire; PUFA, polyunsaturated fatty acid; SBP, systolic blood pressure.

1. Introduction

Hypertension is positively and linearly associated with cardiovascular morbidity and mortality, as well as all-cause mortality [1]. Diet has been implicated as one of the factors that can influence blood pressure, although the relationship between dietary nutrients and blood pressure remains controversial [2]. The Dietary Approaches to Stop Hypertension trial demonstrated that a diet emphasizing fruits, vegetables, and low-fat dairy products and includes whole grains, poultry, nuts, and fish lowers blood pressure [3]. Fish is the major dietary source of n-3 polyunsaturated fatty acids (PUFA), eicosapentaenoic acid (EPA; 20:5n3), and docosahexaenoic acid (DHA; 22:6n3). N-3 PUFA are known to have antihypertensive properties by stimulating prostaglandins, which increase vasodilatation by suppressing the vasoconstrictor thromboxane, regulate rennin release, and decrease the response to antidiuretic hormones [4].

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Results of epidemiologic studies [5,6] and clinical trials [7-9] suggest an inverse association between n-3 PUFA and blood pressure. However, some studies reported conflicting results regarding the effects of n-3 PUFA supplementation on blood pressure [10-13]. Ciocca et al [14] observed no association between erythrocyte n-3 PUFA content and blood pressure. In addition, Nogi et al [6] reported that plasma n-3 PUFA content was significantly related with blood pressure in Korean individuals but not in Japanese or Mongolian individuals, suggesting that the differences between populations may be due to ethnicity and/or diet.

Accurate measurement of blood pressure in clinical practice is dependent on the individual, the equipment used, and the observer. Ambulatory blood pressure measurements are used to determine blood pressure behavior during a 24-hour period during usual daily activities, rather than when an individual is sitting in the artificial environment of a clinic or office. Ambulatory blood pressure measurements provide a blood pressure profile and can be used to detect a number of patterns of blood pressure behavior that may be relevant to clinical management, such as white-coat hypertension, isolated systolic enhanced hypertension, masked hypertension, and large blood pressure variability [15]. Thus, we used 24-hour ambulatory blood pressure measurements to investigate the relationship between blood pressure and fatty acid composition in this study. Specifically, we investigated the hypothesis that erythrocyte n-3 PUFA levels are inversely related with 24-hour ambulatory blood pressure in Korean adults after adjusting for relevant confounders. The association between 24-hour ambulatory blood pressure and intake of nutrients was also assessed.

2. Methods and materials

2.1. Subjects

One hundred subjects aged 18 to 65 years were recruited from the general population between May 2008 and September 2009. Fifty-one subjects were men and 27 subjects had hypertension (cases). Hypertension was defined as a 24-hour ambulatory systolic blood pressure at least 130 mm Hg or a 24-hour ambulatory diastolic blood pressure at least 80 mm Hg [16]. We excluded subjects with stage 2 hypertension (blood pressure, ≥160/100 mm Hg), as well as subjects with secondary hypertension, angina pectoris, myocardial infarction, congestive cardiac failure, stroke, diabetes mellitus, and chronic kidney disease (estimated glomerular filtration rate by modification of diet in renal disease equation, <60 mL/min) or those taking any medications that affect blood pressure that could not be discontinued. Pregnant or lactating subjects or those who reported heavy alcohol consumption were also excluded. The institutional review board of Dongguk University approved the study protocol, and informed consent was obtained from all participants.

Height and body weight were measured using a digital scale, with the subjects wearing a light gown, and body mass index (BMI) was calculated as weight (in kilograms)/height (in meters squared). Socioeconomic data and medical history were obtained by interview.

2.2. Blood pressure measurements

Twenty-four hour ambulatory blood pressure was measured by a trained member of staff during the 2 days of hospitalization using an automated, noninvasive oscillometric device (P6 Pressurometer; Del Mar Reynolds Inc, Irvine, Calif), which was attached to the left upper arm [17]. All systolic and diastolic blood pressure measurements were averaged.

2.3. Dietary intake

Usual dietary intake was assessed by a semiquantitative food frequency questionnaire containing 91 food items designed to measure the “typical Korean” diet that was published by the Korea Health and Nutrition Examination

Table 1
Characteristics of subjects with (cases) and without (controls) hypertension[a]

	Cases (n = 27)	Controls (n = 73)	*P*
Age (y)[b]	52.7 ± 2.4	44.0 ± 2.02	.008
Female, n (%)	11 (40.7)	38 (52.1)	.315
BMI (kg/m^2)	25.6 ± 0.7	23.4 ± 0.3	.005
24-h ambulatory SBP (mm Hg)	129.2 ± 1.2	111.3 ± 1.0	<.001
24-h ambulatory DBP (mm Hg)	85.8 ± 1.0	69.5 ± 0.7	<.001
Alcohol, n (%)	17 (63.0)	49 (67.1)	.697
Smoking, n (%)	10 (37.0)	20 (27.4)	.350
Education level, n (%)			.581
≤High school	15 (55.6)	45 (61.6)	
>High school	12 (44.4)	28 (38.4)	
Married, n (%)	4 (14.8)	32 (43.8)	.025
Exercise, n (%)	18 (66.7)	44 (60.3)	.559
Family history of hypertension, n (%)	12 (44.4)	20 (27.4)	.267
Family history of hyperlipidemia, n (%)	12 (44.4)	9 (12.3)	.002

[a] Cases were defined as individuals with a 24-hour ambulatory SBP at least 130 mm Hg or a 24-hour ambulatory DBP at least 80 mm Hg.
[b] Values for continuous variables are means ± SEM or the number of subjects (percentage distribution), as appropriate.