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Research Article

High dietary intake of aromatic amino acids increases risk of hypertension

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Abstract

Recent studies investigated the relation between amino acids and blood pressure. Our aim was to examine the association between intake of aromatic amino acids (AAAs) and risk of hypertension. A total of 4288 individuals, aged 20–70 years, participants of the Tehran Lipid and Glucose Study, who were free of hypertension at baseline (2008–2011), were followed for 3 years (2011–2014). Average intakes of AAAs including phenylalanine, tyrosine, and tryptophan were collected using a valid and reliable food frequency questionnaire at baseline. Adjusted logistic regression models were used to report odds ratio (OR) of hypertension across quartiles of AAAs. At the end of follow-up, 429 (10%) hypertension cases were ascertained. The adjusted OR of hypertension for percentage of AAAs from total protein intakes was 1.63 (95% confidence interval, 1.06–2.50; *P* for trend: .03) when comparing the highest quartile to the lowest. Furthermore, in the adjusted analyses, a statistically significant positive relationship was observed between the highest versus the lowest quartile intake of phenylalanine (OR = 1.66; 95% confidence interval, 1.14–2.47; *P* for trend: .03). However, there was no significant association of tyrosine and tryptophan intakes with hypertension risk. Our data suggest that AAAs may increase the risk of incident hypertension. J Am Soc Hypertens 2018;12(1):25–33.

Keywords: Hypertension; phenylalanine; tyrosine; tryptophan.

Introduction

Hypertension is the most common cause of cardiovascular disease and one of the main risk factors of mortality worldwide[1]; its prevalence was 26.4% in 2000 and predicted to be increased by 30% in 2025, with higher rates in developing countries than developed ones.[2]

Genetics, aging, obesity, tobacco use, low physical activity, unhealthy diet, and high salt consumption are some of the main risk factors of hypertension.[3] Among dietary factors, protein intake has been more focused on, with some studies indicating that higher dietary protein is related to lower blood pressure (BP).[4–6] Plant protein had inverse relation with BP,[6–8] although findings on animal protein are inconsistent, indicating that animal protein intake is directly related to BP.[7–9] Despite these findings, it is unclear that how protein intake can affect BP; it has been hypothesized that the vasoactive properties of dietary proteins are due to amino acid content and protein sources,[10] which is why recent studies are investigating the relation between different dietary amino acids and BP. Aromatic amino acids (AAAs), phenylalanine, tryptophan, and tyrosine are the annular amino acids that contribute to

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structures of proteins, precursor of neurotransmitters and hormones, and many other actions in body. Phenylalanine and tryptophan are essential amino acids synthesized by plants obtained from foods; tyrosine is the semiessential amino acid that can be synthesized by humans but only from phenylalanine.[11] AAAs biophysically have similar metabolism; phenylalanine is mostly converted to tyrosine and higher tyrosine intake can decrease phenylalanine requirement by 78%, also tyrosine and tryptophan similarly contribute to protein and neurotransmitter synthesize,[12] and it also indicated that amino acid transporter systems of T and L transport AAAs from cellular membranes.[13] Although the association of some amino acids such as arginine, cysteine, and glutamic acid with BP and stroke has been investigated in cross-sectional studies,[4,10,14,15] there is limited data on the association of phenylalanine, tryptophan, and tyrosine with BP. In a cross-sectional analysis, higher intakes of tyrosine in the Rotterdam Study were significantly related to lower systolic BP (SBP) but were not associated with incidence of hypertension after 6 years of follow-up.[16] Tuttle et al[17] indicated that for every quartile increase of phenylalanine intakes, the risk of diastolic BP (DBP) increased by 14% and increase not seen for SBP.

To the best of our knowledge, no previous study has investigated the association between AAAs and incidence of hypertension in adults; therefore, we conducted this study to assess the relation between dietary AAAs intake with incident hypertension in the framework of the Tehran Lipid and Glucose Study (TLGS).

Material and Methods

Subjects

The TLGS is a population-based prospective study being conducted to determine the risk factors for noncommunicable diseases among a representative urban population of Tehran, including 15,005 subjects aged ≥3 years.[18] The first phase of the TLGS began in March 1999, and data collection, at 3-year intervals, is ongoing; the baseline survey was a cross-sectional study conducted from 1999 to 2001, and surveys 2 (2002–2005), 3 (2006–2008), 4 (2009–2011), and 5 (2012–2014) were prospective follow-up surveys. In the fourth survey of the TLGS (2009–2011), from 12,823 participants, 7956 randomly selected, agreed to complete the dietary assessment.

For the current study, a total of 6493 individuals, aged 20 to 70 years, with complete data in the fourth survey of TLGS, as a baseline examination, were enrolled and followed through the fifth survey as an outcome examination (median follow-up: 3.1 years). Subjects with underreported or overreported dietary intakes (less than 800 kcal/d or more than 4500 kcal/d, respectively) or on specific diets (n = 317); those with history of myocardial infraction, cerebral vascular accident, and cancers (n = 43); those with hypertension (n = 1057); and lactating and pregnant women (n = 106) were excluded. Some individuals fell into more than one exclusion category. Of 5004 subjects with normal BP at baseline, after a 3.1-year follow-up, 4288 participants remained for final analysis (follow-up rate: 86.2%).

The study protocol was approved by the ethics committee of the Research Institute for Endocrine Sciences, affiliated to Shahid Beheshti University of Medical Sciences, Tehran, Iran. Written informed consent was obtained from all subjects.

Dietary Intake Assessment

A valid and reliable semiquantitative food frequency questionnaire was used to assess food intakes of subjects over the previous year.[19] Trained dieticians, with at least 5 years of experience in the TLGS survey, asked participants to designate their consumption frequency for each food item during the previous year on a daily, weekly, or monthly basis. Portion sizes of consumed foods, reported in household measures, were then converted to grams. Dietary intakes at fourth survey of TLGS were considered as dietary intake exposure at baseline.

Amino acid intake was calculated using the United States Department of Agriculture (USDA National Nutrient Database for Standard Reference, Release 28, 2015) food composition table (available on http://www.ars.usda.gov/ba/bhnrc/ndl), which was based on chemical analysis of amino acid composition.[20] To analyze the food source of AAAs, six food groups including "dairy," "white meat (poultry, fish) and egg," "red and processed meat and viscera," "grains, legumes, and nuts," "fruits and vegetables," and "snacks" were determined.

Physical Activity Assessment

The Modifiable Activity Questionnaire, used for assessing physical activity levels in participants, modified and validated among Iranians, previously[21]; individuals were asked to report and identify the frequency and time spent during the past 12 months on activities of light, moderate, hard, and very hard intensity, according to a list of common activities of daily life; physical activity levels are expressed as metabolic equivalent hours per week.

Clinical and Biological Measurements

For obtaining past medical history and smoking habits, participants interviewed by trained physicians and completed the questionnaire.[18] Weight was measured and recorded, while the subjects were minimally clothed, without shoes or socks, using digital scales with an accuracy of up to 100. Height was measured in a standing position, without shoes, using a stadiometer with a