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Amino acid profiles of young adults differ by sex, body mass index and insulin resistance

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KEYWORDS
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Abstract *Background and aims:* An increase in plasma branched-chain amino acids is associated with a higher risk of developing type 2 diabetes and cardiovascular diseases. However, little is known about the basal plasma amino acid concentrations in young adults. Our aim was to determine the plasma amino acid profiles of young adults and to evaluate how these profiles were modified by sex, body mass index (BMI) and insulin resistance (IR).
Methods and results: We performed a transversal study with 608 Mexican young adults aged 19.9 ± 2.4 years who were applicants to the Universidad Autónoma de San Luis Potosí. The subjects underwent a physical examination and provided a clinical history and a blood sample for biochemical, hormonal and amino acid analyses. The women had higher levels of arginine, aspartate and serine and lower levels of α-aminoadipic acid, cysteine, isoleucine, leucine, methionine, proline, tryptophan, tyrosine, urea and valine than the men. The obese subjects had higher levels of alanine, aspartate, cysteine, ornithine, phenylalanine, proline and tyrosine and lower levels of glycine, ornithine and serine than the normal weight subjects. Subjects with IR (defined as HOMA > 2.5) had higher levels of arginine, alanine, aspartate, isoleucine, leucine, phenylalanine, proline, tyrosine, taurine and valine than the subjects without IR. Furthermore, we identified two main groups in the subjects with obesity and/or IR; one group was composed of amino acids that positively correlated with the clinical, biochemical and hormonal parameters, whereas the second group exhibited negative correlations.
Conclusion: This study demonstrates that young adults with obesity or IR have altered amino acid profiles characterized by an increase in alanine, aspartate, proline and tyrosine and a decrease in glycine.

Abbreviations: BMI, body mass index; IR, insulin resistance; HOMA, homeostatic model assessment; BCAA, branched-chain amino acids; SBP, systolic blood pressure; DBP, diastolic blood pressure; TC, total cholesterol; TG, triglycerides; OR, odds ratio; CI, confidence intervals.

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Introduction

Alterations in the plasma amino acid profile during obesity and insulin resistance (IR) have been recognized for a long time [1–3]. Recently, the plasma amino acid profile acquired a predictive potential associated with diabetes, since people with an increase in the branched-chain amino acids (BCAAs) leucine, isoleucine and valine and the aromatic amino acids phenylalanine and tyrosine were shown to have a 5-fold higher risk of developing diabetes [4]. Thus, determining the plasma amino acid profiles of the general population could help identify subjects with a major risk of developing type 2 diabetes.

In Mexico, several studies have assessed plasma amino acid profiles as a result of the types of diet in people from urban or rural areas [5–7]. The data from these studies have revealed that the neutral and basic amino acid concentrations in the plasma are stable during the day despite the consumption of a diet with 55–70% carbohydrates [5], indicating that the carbohydrate content in the diet poorly affects the plasma amino acid concentration. Conversely, the type of protein consumed has a major effect. For instance, we recently showed that in women from a Mexican rural area, ingesting a Mexican urban diet, which is characterized by a higher animal protein content, induced a higher increase in leucine, isoleucine, valine, phenylalanine, tyrosine and proline than ingesting a Mexican rural diet, which is composed mainly of vegetable proteins [6]. These data may suggest that the consumption of an urban Mexican diet could make people more prone to a higher risk of developing diabetes, especially in subjects with low amino acid/BCAA intake, such as women from rural areas [8]. This evidence is supported by a recent study showing that vegans have decreased insulin sensitivity when they increase their consumption of BCAAs [9]. However, little information is available regarding the basal plasma amino acid concentrations in the general population, especially in young adults.

Thus, the basal amino acid profiles of the young adult population should be determined to establish the values in healthy subjects; these values will provide the normal ranges of the basal plasma amino acid concentrations and allow the identification of people with altered amino acid profiles and a potential risk of developing type 2 diabetes. Therefore, the aims of our study were 1) to establish the plasma amino acid values in young subjects; 2) to determine whether the amino acid profiles were dependent on sex, body mass index (BMI), or the homeostatic model assessment (HOMA) index; and 3) to evaluate whether alterations in amino acid plasma concentrations were associated with the presence of obesity and/or IR.

Methods

Study design and population

This is a cross-sectional study. Subjects were recruited in July 2012 at the Universidad Autónoma de San Luis Potosí (UASLP), which is located in San Luis Potosí, Mexico. Subjects who were completing the entrance procedures for the UASLP received detailed information on the research project during their visit to the university health center. The subjects were Mexican mestizos aged >18 years with a BMI >20 and < 40 kg/m^2. The exclusion criteria included a serum glucose level >126 mg/dL, a history of cardiovascular events, cancer, AIDS, kidney or liver disease, pregnancy or substance abuse. The subjects underwent a health screening at the university health center that consisted of a) anthropometric measurements, b) a medical interview and a physical examination performed by a physician, and c) the collection of a blood sample to assess biochemical and hormonal parameters and the amino acid profile. Age, height, weight, BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP) and HOMA index were considered clinical parameters; glucose, creatinine, total cholesterol (TC) and triglycerides (TG) were considered biochemical parameters; and insulin and leptin were considered hormonal parameters. This study was approved by the Ethics Committee of the Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán. The study was designed according to the Declaration of Helsinki and the ethical treatment of human subjects. The details of the study were explained, and written informed consent was obtained from all subjects before any study procedures were performed.

Anthropometric measurements

A complete physical examination was performed for each patient. The anthropometric evaluation included measurements of the body weight and height in the morning after a 12-h fast [10]. The nutritional status of the subjects was evaluated by BMI classification according to the World Health Organization [11].

Biochemical analysis

Blood samples were collected after a 12-h fasting period on the same day. Plasma glucose, TC, and TG were measured enzymatically using the BS-300 chemistry analyzer (Mindray Medical International Limited, Shenzhen, China). Insulin and leptin were measured by radioimmunoassay (RIA, Millipore, Billerica, MA, USA). The amino acid analysis was performed as previously described [6]. Briefly, 50 mg

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