Dietary antioxidant quality score (DAQs) is associated with bone mass assessed by calcaneal quantitative ultrasound in young women

El índice de calidad antioxidante de la dieta (DAQS) está asociado con la masa ósea evaluada mediante ultrasonido cuantitativo en el calcáneo en mujeres jóvenes

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Resumen

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Introducción: la evidencia sugiere que la ingesta de antioxidantes podría influir positivamente en la masa ósea mediante la prevención contra el estrés oxidativo del metabolismo óseo.

Objetivo: el objetivo fue investigar la posible influencia del consumo de antioxidantes y del índice de calidad antioxidante de la dieta (DAQs) en la masa ósea, evaluada mediante ultrasonido cuantitativo (QUS) en el calcáneo en una población de adultos jóvenes.

Métodos: un total de 605 adultos jóvenes españoles participaron en este estudio (mediana 20,38 ± 2,67 años). La masa ósea se evaluó mediante QUS en el calcáneo para determinar el parámetro de atenuación de ultrasonido de banda ancha (BUA, dB/MHz). La composición corporal se determinó mediante bioelectrical impedance analysis y la ingesta dietética se determinó a través del recordatorio de 72 horas. El DAQs se aplicó para calcular la ingesta de nutrientes antioxidantes. Se realizaron análisis de regresión lineal para investigar la posible influencia del DAQs en QUS en el calcáneo.

Resultados: la mayoría de los adultos jóvenes mostraron una ingesta de antioxidantes baja o de baja calidad (solo el 17.6% de mujeres y 20.3% de hombres presentaron una puntuación de 4 o 5 en DAQs). Se observó una correlación positiva entre el parámetro de atenuación de ultrasonido de banda ancha (BUA) y el índice de calidad antioxidante de la dieta (DAQs) en las mujeres (r = 0.117; p = 0.024). El análisis de regresión lineal reveló que el DAQs se asociaba significativamente con el parámetro de atenuación de ultrasonido de banda ancha (BUA, dB/MHz) después de ajustar por peso corporal, altura, ingesta de calcio y actividad física (p = 0.035). No se encontraron asociaciones significativas entre la ingesta de antioxidantes individuales y QUS en el calcáneo.

Conclusion: nuestros resultados sugieren que una ingesta de antioxidantes de alta calidad podría influir en la salud ósea en mujeres jóvenes. Futuros estudios deben profundizar en el papel protector de los nutrientes antioxidantes contra la osteoporosis.
INTRODUCTION

Osteoporosis is considered to be a public health problem characterized by low bone density and reduced bone quality through the deterioration of bone microarchitecture (1). As a consequence, sufferers have an increased susceptibility to osteoporotic fractures (2). Osteoporosis is a multifactorial and complex disease determined by both genetic and environmental factors (3).

Oxidative stress and low serum levels of antioxidants have been proposed to be contributors to osteoporosis. In vitro and animal studies have shown that oxidative stress could induce bone loss by modulating osteoclast activation and osteoblast suppression (4-7). In this line, a number of epidemiologic studies have reported positive associations between oxidative stress and bone mineral density (BMD) (8,9).

Evidence suggests that intake of antioxidants could positively influence bone mass by preventing bone metabolism against oxidative stress. Previous studies have investigated a relationship between antioxidants intake and BMD, fracture risk and osteoporosis reporting contradictory results (10-14). Most studies generally analyzed the association between single antioxidant intake and bone status. Little is yet known regarding diet quality indexes of antioxidant intakes and their potential relation with bone status.

However, people consume foods with complex combinations of antioxidant nutrients (15) and therefore, this traditional approach misses information regarding interactions between different antioxidant contained in food.

Quantitative ultrasound (QUS) has been proposed as an alternative method to assess bone mass and provides parameters of bone structure (microstructure, elasticity and connectivity) (16). The QUS has been valued for its high correlation with BMD measured by DXA (17). Its portability, non-invasiveness, radiation-free and low cost nature make it a useful method for assessing bone status (18). Until now, no studies have examined the relationship between antioxidant intakes and bone mass assessed by QUS. Therefore, the aim of the current study was to investigate the influence of single antioxidant intakes and dietary antioxidant quality score (DAQs) on calcaneal QUS in young adults. We hypothesized that a high-quality antioxidant intake would be associated with a greater calcaneal QUS parameter.

METHODS

SUBJECTS

Six hundred and five individuals aged 18 to 25 (69.3% females and 30.7% males) agreed to participate in this study and were recruited from different academic centers of Granada (Spain). All participants were evaluated by means of a detailed medical history. Subjects with any of the following criteria were excluded from the study: history of bone disease, metabolic or endocrine diseases, hormone-replacement therapy or current treatments that could affect bone mass. Written informed consent was obtained from each participant and the study was approved by local ethics committees and conducted in accordance with the Declaration of Helsinki.

ANTHROPOMETRIC MEASUREMENTS

Body weight (kg) and fat mass (%) were measured twice (without shoes and in light clothes) to the nearest 0.11 kg by bioelectrical impedance analysis (TANITA BC-418MA®). A Harpenden stadiometer (Holtain 602VR®) was used for height measurements. Height was measured twice without shoes to the nearest 0.5 cm. The averages of the two values for each measurement were used in the analysis. Anthropometric measurements were performed in the morning after a 12-h fast and 24-h abstinence from exercise. BMI was calculated as weight over height squared (kg/m²).

CALCANEAL QUS

Bone mass status was measured by ultrasonography at the right calcaneus (BUA, dB/MHz) using the CUBA clinical ultrasound bone densitometer (McCue Ultrasonics Limited, Compton, Winchester, UK). The calcaneus is used for QUS assessment because it contains a high percentage of trabecular bone and it is easily accessible (19). Daily calibrations were made with physical phantom to control the long-term stability of the apparatus.

DAILY NUTRIENT INTAKE

Daily nutrient intake was assessed by a 72-hour diet recall interview considering intakes on Thursday, Friday and Saturday to capture weekly variations in weekdays and weekend. In a face-to-face interview with well-trained investigators, individuals were asked to recall all food consumed in the preceding 72 hours, including foods eaten outside the home, nutrition supplements and beverages. In order to improve the accuracy of the descriptions of meals, pictorial food models were employed. A computerized food analysis program (Nutriber 1.1.5) was used to assess completed food records (20). The food composition table reported by Mataix et al. was used for conversion of food into nutrients (21).

PHYSICAL ACTIVITY

Physical activity was assessed using a self-administered questionnaire (International Physical Activity Questionnaire -IPAQ). The questionnaire has proven to be a valid instrument for measuring PA in the European adult population (22). It was used to calculate the total hours of vigorous PA, moderate PA and walking over the last seven days. A MET-h was derived by multiplying the respective total hours by the metabolic equivalent of task (MET) value for vigorous PA (MET = 8.0), moderate PA (4.0) and walking (3.3), and then adding all three (22).
ANTIOXIDANT NUTRIENT INTAKE

A DAQs was used to calculate antioxidant nutrients (23). The test score assessed the consumption of vitamin C, vitamin E, vitamin A, selenium and zinc. Daily nutrient intake was compared to that of the daily recommended intake for the Spanish population (RDI) (24). When the nutrient intake was below 2/3 of the RDI, a value of 0 was obtained, and when the intake was above 2/3 of the RDI, a value of 1 was obtained. DAQs is scored with a final score range from 0 (very poor quality) to 5 (high quality).

STATISTICAL ANALYSIS

SPSS Statistic version 21.0 (SPSS, Chicago, IL, USA) was used for all the analyses. Mean and standard deviation (SD) where normally distributed and as median (interquartile range) where skewed are given as descriptive statistics. Sex-specific differences were assessed by independent t-test. Spearman’s correlation coefficient (r) was used to test the correlation between antioxidant nutrients, DAQs and calcaneus QUS adjusted by age, body weight, height, calcium intake and physical activity. To analyze the associations between single antioxidants intake, DAQs and calcaneus QUS, multiple regression analysis was performed after adjusting by age, body weight, height, calcium intake and physical activity. Results are reported as standardized β-coefficient, R, R², adjusted R², t and p value. p-values < 0.05 were considered to be statistically significant.

RESULTS

The basic characteristics were summarized separately for men and women in table I. The mean age for the study population was 20.4 ± 2.7, and the mean BMI was 22.6 ± 3.7 kg/m². Significant differences between men and women were observed in height, weight, BMI, fat mass, physical activity and BUA values. Men had a significantly higher body weight, height, BMI and men than women (p < 0.001), whereas women had a significantly higher fat mass than men (p < 0.001). The reported energy intake was higher in men than in women, but there was no evidence of any significant differences. Average calcium intake was below the recommended intake level (RDA) in both genders. The mean calcaneus BUA for the sample was 86.7 ± 17.6 (dB/MHz) and males had a significantly higher BUA than females (p < 0.001). Regarding the intake of antioxidant nutrients, the average intakes of vitamin E, vitamin A and zinc were lower than the recommended in both sexes. By contrast, the intake of vitamin C and selenium reached the dietary goals. Considering gender, a significant difference has been observed concerning the intake of vitamin C (p = 0.036).

The percentages of young adults that are below 2/3 of the RDI for antioxidant nutrients are shown in table II. Considering vitamin E, a higher percentage of women and men had inadequate antioxidant intake (defined as intakes below 2/3 of the DRI). As can be observed, most women were low antioxidant consumers (only 17.6% of women had a score of 4 or 5 in DAQs). In this line, only 20.3% of men showed a high-quality antioxidant intake (DAQs 4 or 5).

Spearman’s correlation revealed a positive relationship between DAQs and calcaneus BUA in women (r = 0.117; p = 0.024) (Table III). In order to analyze the influence of DAQs and each antioxidants intake on calcaneal QUS, multiple regression models were applied after adjusting by body weight, height, calcium intake and physical activity (Table IV). Interestingly, the multiple regression analysis revealed that DAQs was significantly associated with BUA parameter in women (p = 0.035). No significant

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associations between single antioxidant nutrient and calcaneus QUS measurement were found.

**DISCUSSION**

The present study explores the associations between DAQs and single antioxidant intakes on calcaneal QUS measurement in a sample of 605 young adults. Our findings provide evidence for the influence of DAQs on calcaneal BUA parameter in young women, supporting the hypothesis that a high-quality antioxidant intake could positively influence bone mass in young women. To our knowledge, there has been no previous study investigating the association of DAQs on bone mass assessed by calcaneal QUS measurement.

To date, only two studies have investigated the association between DAQs and bone status (11, 12). In agreement with our findings, Rivas et al. reported a significant positive association between DAQs and BMD among 280 healthy women aged 18 to > 45 (p = 0.021) (12). On the other hand, in the study of De França et al., 150 postmenopausal women over 45 years old with osteoporosis were included (11). In contrast to Rivas et al. and with our findings, any relationship was found between DAQs and BMD in any skeletal sites. One possible reason for this discrepancy may be attributed to the limited sample size or to the sample consisting of osteoporotic women. DAQs could not be suitable for assessing the association of antioxidant dietary intakes and bone mass in osteoporotic subjects since the antioxidant considered in this score could have a minimum effect on low BMD values. In addition, in this study they applied an adaption of the original DAQs since they used estimated averages requirements (EAR) instead of RDI. It should be noted that both previous studies used DXA for measurements of bone mass, none of them used calcaneal ultrasound, and hence, we could not compare our effect sizes for BUA.

This study is the first one to explore the association of DAQs with bone mass in a population of men. Although our study report-
QUANTITATIVE ULTRASOUND IN YOUNG WOMEN

DIETARY ANTIOXIDANT QUALITY SCORE (DAQs) IS ASSOCIATED WITH BONE MASS ASSESSED BY CALCANEAL

HUMAN AND ANIMAL RIGHTS AND INFORMED CONSENT

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the Declaration of Helsinki of 1964 and its later amendments or comparable ethical standards. Written informed consent was obtained for all participants.

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