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ScienceDirect

Journal of Sport and Health Science 5 (2016) 368–374

www.jshs.org.cn

Original article

Nutritional supplements use in high-performance athletes is related with lower nutritional inadequacy from food

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Received 19 September 2014; revised 18 November 2014; accepted 12 January 2015
Available online 30 April 2015

Abstract

Background: The use of nutritional supplements (NS) among athletes is widespread. However, little is known about the relationship between nutritional adequacy and NS usage. The aims of this study were to evaluate the NS usage and to compare the nutritional intake from food and prevalence of micronutrient inadequacy (PMI) between NS users and non-users.

Methods: Portuguese athletes from 13 sports completed an NS usage questionnaire and a semi-quantitative food-frequency questionnaire assessing information over the previous 12 months. The estimated average requirement cut-point method was used to calculate PMI. General linear models were used to compare nutritional intake and NS usage. Chi-squared tests and logistic regression were performed to study, respectively, relationships and associations between PMI and NS usage.

Results: From the 244 athletes (66% males, 13–37 years), 64% reported NS usage. After adjustment, NS users showed a higher intake from food ($p < 0.05$), for at least 1 gender, for energy, and for 7 of the 17 studied nutrients. The highest PMI were seen for vitamins D and E, calcium, folate, and magnesium. After adjustment, NS users, irrespective of gender, reported lower PMI for calcium (OR = 0.28, 95%CI: 0.12–0.65), and female users for magnesium (OR = 0.06, 95%CI: 0.00–0.98).

Conclusion: Athletes using NS reported a higher nutritional intake from food, and a lower PMI for several nutrients. Perhaps, those who were taking NS were probably the ones who would least benefit from it.

Keywords: Carbohydrates; Minerals; Proteins; Sport; Vitamins

1. Introduction

Athletic performance can be enhanced by an adequate and individually-adapted dietary intake. Sports nutrition guidelines suggest that protein intake should be between 1.2 g/kg/d and 1.7 g/kg/d,[1] carbohydrates (CHO) ingestion may range from 3 to 12 g/kg/d depending on the duration and type of exercise,[2] and fat should contribute to 20%–35% of total energy value (TEV).[1] Recently, these guidelines—developed for adults—were also considered adequate for adolescents.[3] Moreover, athletes should reach, at least, the dietary reference intakes (DRI) for all micronutrients.[1]

Regardless of the growing body of scientific evidence concerning the sports nutrition impact on performance, and the supposedly easier access to reliable information, athletes are still reporting slightly unbalanced diets. Generally, protein intake tends to be higher than recommended,[4] while that of carbohydrates is sometimes below the recommended range.[5] The adequate consumption of some micronutrients is also a source of concern, with some studies[6,7] showing intakes under the DRI.

The wide usage of nutritional supplements (NS) by athletic populations is largely recognized.[8] Though, in sports field, it has not been appropriately demonstrated if supplementation is advantageous and rationale for those who are taking it. Some studies[8,9] had already shown that the reasons to use certain types of NS, namely multivitamins/minerals and individual micronutrients such as vitamin C and iron, are not always science-based. Moreover, the use of these vitamin/mineral supplements by

Peer review under responsibility of Shanghai University of Sport.
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http://dx.doi.org/10.1016/j.jshs.2015.01.006

athletes will only result in a performance enhancement if it corrects a nutritionally unbalanced diet.[1] Additionally, epidemiological studies have been shown that NS users tend to have better health-related behaviors, namely a healthier nutritional intake.[10,11] Therefore, those taking NS are potentially the ones who need them less. However, little is known regarding the nutritional adequacy of athletes using NS.

Therefore, the aims of this study were to (1) assess the NS usage among high-performance athletes, (2) evaluate nutritional inadequacy considering the micronutrients from food, (3) compare nutritional intake, and (4) evaluate the prevalence of micronutrient inadequacy (PMI) between NS users and non-users. For this purpose, we used the NS definition suggested by Petróczi and collaborators[9] which considers that NS are products taken orally with the aim to supplement the diet with vitamins, minerals, and/or other substances. Supplements may contain vitamins, minerals, herbs, amino acids and/or a concentrate, metabolite, constituent, extract, or a combination of any of these.

2. Methods

2.1. Participants and study design

Three hundred and four athletes representing the Portuguese national teams in 13 sports (cycling, athletics, triathlon, gymnastic, rugby, basketball, volleyball, judo, swimming, baseball, handball, boxing, and fencing) volunteered to participate in this study. The sports were conveniently selected for the study. Informed consent was obtained from all athletes. Additionally, formal authorisation from the guardians was required for those <18 years old. The study was approved by the Scientific Council of the Faculty of Nutrition and Food Sciences at the University of Porto, and by each of the 13 national sports federations.

The participants filled out 2 self-administered questionnaires: one about NS usage and one semi-quantitative food-frequency questionnaire (FFQ). Both questionnaires assessed information over the previous 12 months. The questionnaires were completed in the presence of a qualified and trained nutritionist or sent into the respective sport federation (boxing and fencing) throughout the year of 2008.

2.2. Nutritional intake

Dietary intake was obtained by a semi-quantitative FFQ, validated for the Portuguese adult population.[12] The FFQ is an 86-item questionnaire that includes food groups and beverage categories, and a frequency section with 9 possible responses, ranging from "never or less than 1 time per month" to "6 or more times per day". The food intake was calculated by weighting 1 of the 9 possibilities of frequency of consumption by the weight of the standard portion size of the food-item. A seasonal variation factor was considered for foods in which production and consumption were not regular over the year. Energy and nutrient intake with more sport relevance (proteins, carbohydrates, lipids, vitamins A, C, E, D, B6, and B12, thiamine, riboflavin, folate, magnesium, zinc, calcium, selenium, and iron), without including the NS contribution, were estimated using the software Food Processor SQL® (ESHA Research Inc., Salem, OR, USA) added with Portuguese foods and recipes.

To identify under- and over-reporting, the ratio of energy intake (EI) to basal metabolic rate (BMR) was used.[13] EI was obtained from data analyses whereas BMR was estimated using Schofield equations.[14] The under-reporting cut-off for this study was set at 0.9, as it was used in another study for a similar purpose,[15] and the one for over-reporting at 4.0, which corresponds to the physical activity level (PAL) upper limit for professional endurance athletes.[16]

The PMI was determined by the estimated average requirement (EAR) cut-point method,[17] calculating the proportion of individuals whose intake was below the EAR from the Food and Nutrition Board of the Institute of Medicine, for the respective gender and age group (to consult EAR values please see Ref.18). PMI for iron was not calculated since this method should not be used when requirements are not normally distributed.[17] Age groups were defined according to the Food and Nutrition Board of the Institute of Medicine categories.

2.3. NS usage and other information

A broad definition of NS was used, which included all types of supplements, namely ergogenic aids, sports food, and dietary/nutritional supplements. Thirty closed-ended options for NS were provided with an additional open-ended question.

This questionnaire also assessed information on weight, height, age, gender, years of education (year of attendance or concluded years if the athlete was not currently studying), type of sport, hours of training, and number of international performances, as described in detail elsewhere.[8]

2.4. Statistical analysis

Descriptive data were reported as proportions (%), mean ± SD when data were normally distributed (height, weight, body mass index (BMI)), or as medians (interquartile range) when not (age, number of international performances, hours of training, and energy and nutrients intake).

The Kolmogorov–Smirnov test was used to evaluate normality. Student's t test for normally distributed variables, Mann–Whitney U test for non-parametric data, and χ^2 test for categorical variables were used to compare groups. For the χ^2 tests with statistically significant results, φ coefficients were also calculated to describe the relationships between the variables.

In order to compare nutritional intake between NS users and non-users, nutritional variables were adjusted for total EI, using the nutrient residual model.[19] In this model, energy-adjusted nutrient intake is computed as the residuals from the regression analysis, with total EI as the independent variable and absolute intake as the dependent variable. Afterwards, univariate general linear models non-adjusted and adjusted for confounders were performed. Non-normal distributed variables (total EI, absolute nutrients intake, and hours of training) were logarithmically transformed to attain normal distribution for the purpose of residual models and univariate general linear models.

The relationships between PMI and NS usage were performed using χ^2 tests. For those with statistically significant