Original Communication

Nutritional Supplements Usage by Portuguese Athletes

Mónica Sousa[1], Maria João Fernandes[2], Pedro Moreira[2,3], and Vítor Hugo Teixeira[2,3]

[1]Centro de Investigação, Formação, Intervenção e Inovação em Desporto (CIFI2D), Faculdade de Desporto, Universidade do Porto, Portugal
[2]Faculdade de Ciências da Nutrição e Alimentação, Universidade do Porto, Portugal
[3]Centro de Investigação em Actividade Física, Saúde e Lazer, Faculdade de Desporto, Universidade do Porto, Portugal

Received: July 20, 2012; Accepted: February 4, 2013

Abstract: In this study, we determined the prevalence of nutritional supplements (NS) usage, the type of supplements used, the reasons for usage, and the source of nutritional advice among Portuguese athletes. Two hundred ninety-two athletes (68 % male, 12–37 years old) from 13 national sports federations completed a questionnaire that sought information on socio-demographics, sports data, and NS usage. Most athletes (66 %) consumed NS, with a median consumption of 4 supplements per athlete. The most popular supplements included multivitamins/minerals (67 %), sport drinks (62 %), and magnesium (53 %). Significant differences for the type of NS consumed were found between gender and age groups and the number of weekly training hours. Most athletes used NS to accelerate recovery (63 %), improve sports performance (62 %), and have more energy/reduce fatigue (60 %). Athletes sought advice on supplementation mainly from physicians (56 %) and coaches (46 %). Age and gender were found to influence reasons for use and the source of information. Reasons for NS usage were supported scientifically in some cases (e. g., muscle gain upon protein supplementation), but others did not have a scientific basis (e. g., use of glutamine and magnesium). Given the high percentage of NS users, there is an urgent need to provide athletes with education and access to scientific and unbiased information, so that athletes can make assertive and rational choices about the utilization of these products.

Key words: vitamins and minerals, sport drinks, performance, recovery, fatigue, physicians, coaches

Introduction

As training programs become ever more demanding, athletes rely increasingly on nutrition to get an advantage over the competition [1]. It is known that the use of nutritional supplements (NS) among sportsmen and sportswomen is more widespread than in the general population, and that elite athletes tend to use these substances more than the non-elite do [2]. However, good evidence of efficacy and safety exists for only a limited number of these substances [3]. To worsen the scenario, as many as 25 % of supplements are contaminated with prohibited compounds [4]. Therefore, besides posing a potential risk to health, the use of NS can lead to positive results in a doping test.

There is not a single definition of what constitutes an NS [3], but it is generally accepted that an NS is a product taken orally with the intention to supplement the diet by increasing the total intake of vitamins, minerals, or other nutritional substances. In this context, supplements may contain vitamins, minerals, herbs, amino acids and/or a concentrate,

metabolites, constituents, extracts, or a combination of any of these [5].

To better inform athletes about the risks and benefits of oral supplementation, however, it is crucial to identify the factors determining the rational practice of NS use. In Portugal—the setting of this study—information on the use of NS among athletes is scarce, contrary to the situation in other countries [6–9]. Therefore, the objectives of this research were to: determine the prevalence of NS usage among Portuguese athletes, describe the type of supplements used, the main reasons for using them, and the source of advice for their usage according to age, gender, and sport. It was also a purpose for this study to access athletes' understanding of the benefits of NS and to investigate the presence or absence of informed choices. Moreover, previous research has identified gender differences, but less focus has been placed on the differences in NS use between types of sport, age, and training frequency. Therefore, it was also an aim of this study to describe the types of relationships that have been neglected in previous studies.

Material and Methods

Sample

Three hundred four athletes representing the Portuguese national teams of 13 national sports federations (cycling, athletics, triathlon, gymnastics, rugby, basketball, volleyball, judo, swimming, baseball, handball, boxing, and fencing) volunteered to participate in this study by filling out a questionnaire about the use of NS. The sports were conveniently selected for this study. Twelve athletes were excluded from the study due to incomplete questionnaires.

Informed consent was obtained from all athletes. Additionally, for those under 18 years old, formal authorization from their guardians was required. 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.

Questionnaire

Thirty-one questions were developed by a group of experienced nutritionists in order to characterize the prevalence of NS usage, the main reasons for consumption, and the advisors that athletes relied on for information for the 12 months prior to questionnaire administration. This questionnaire also assessed information on socio-demographic and sports data. A pilot study with 11 athletes was conducted to pre-test the questionnaire for clarity and relevance.

The questionnaire was filled out in the presence of a qualified and trained nutritionist or was sent in to the sports federation (boxing and fencing) throughout the year of 2008; the two methods yielded similar results regarding NS usage ($p = 0.334$).

We used a broad definition of NS that included all types of supplements, namely ergogenic aids, sports foods, and dietary/nutritional supplements. In order to help athletes remember which type of supplements they had taken over the previous year, 30 closed-ended options were provided: multivitamins/minerals; antioxidants; β-carotene; vitamins E, B1, C, B6, and B12, calcium, iron, and magnesium; proteins; branch-chain amino acids (BCAAs); glutamine; arginine; other amino acids; β-alanine; sport drinks; gels; other carbohydrate supplements (for example, bars); creatine; herbs or plants; testosterone/*Tribulus terrestris*; omega-3; conjugated linoleic acid (CLA); hydroxymethylbutyrate (HMB); glucosamine; ginseng; caffeine; and l-carnitine. Reasons for NS usage were chosen from a 13-item list and included: stay healthy; increase strength; increase speed; increase endurance; accelerate recovery; increase focus; improve sports performance; have more energy/reduce fatigue; prevent/treat diseases or injuries; correct dietary flaws; gain muscle mass; decrease stress; and lose weight. Advisor type was chosen from an 8-item list: physician; coach; family; nutritionist; friends, him/herself; other athletes; and media. In all 3 topics, an additional open-ended question was included to allow answers other than those provided in the given list.

The lists of options considered in this study were based on other studies [6, 8, 10, 11] and on the authors' anecdotal experience with Portuguese athletes.

Data Analysis

For statistical analyses, the 10 most taken supplements, the 6 most chosen reasons for usage, and the 6 most reported sources of information were used. Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 18. Descriptive data were reported as percentages, as the mean ± standard deviation when data were normally distributed (height, weight, body mass index, and age), or as the median when not (international performances, hours of training per week, and number

of NS used). Chi-square test for categorical variables and Mann-Whitney test and Spearman correlation for non-parametric data were also used.

Phi (φ) coefficients were calculated to describe the relationships between reasons for NS usage and type of NS (Table III), and between type of advisor and type of NS (Table IV) [12]. To evaluate normality, the Kolmogorov–Smirnov test was performed. Values of $p < 0.05$ were considered statistically significant.

Table I: Selected socio-demographic and athletic data of athletes. Data are presented as percentages (%), the mean ± standard deviation or the median (minimum–maximum value).

Characteristics	
Height (cm)	178.9 ± 10.8
Weight (kg)	72.6 ± 13.5
Body mass index (kg/m^2)	22.5 ± 2.5
Male	68 %
Female	32 %
Age (years)	20.4 ± 4.9
< 18 years	31 %
≥18 years	69 %
Years of education	
≤9	15.0 %
10–12	42.5 %
≥13	42.5 %
International performances	6 (0–200)
Hours of training per week (h)	13 (4–33)

Results

Sample Characterization

The final sample (n = 292, 68 % males, 12–37 years of age) comprised athletes belonging to the following Portuguese national teams: volleyball (22.6 %), swimming (12.3 %), triathlon (10.6 %), cycling (9.6 %), judo (8.2 %), athletics (6.2 %), baseball (5.5 %), handball (5.5 %), rugby (5.5 %), gymnastics (5.1 %), basketball (4.1 %), fencing (3.4 %), and boxing (1.4 %). The sample characterization is given in Table I. Table II shows the gender and age distribution by sport.

Supplement Intake

The majority of athletes (66 %) reported using at least one NS. In total, 997 supplements were reported for 192 athletes, with a median consumption of 4 supplements per athlete (range, 1–16).

Differences in the median number of NS were found according to age groups (< 18 years = 2, ≥18 years = 5; $p < 0.001$), gender (male = 5, female = 4; $p = 0.039$), and sport ($p < 0.001$; Figure 1). A positive and significant correlation between the number of NS and weekly hours of training ($\rho = 0.465$; $p < 0.001$) was also found.

No statistically significant correlation was found between the number of NS used and the number of international performances.

Table II: Relative percentages (number) of athletes per sport by gender and age.

Sport	Gender		Age	
	Male	Female	< 18 years	≥18 years
Volleyball	52 % (34)	48 % (32)	74 % (49)	26 % (17)
Swimming	61 % (22)	39 % (14)	56 % (20)	44 % (16)
Triathlon	68 % (21)	32 % (10)	48 % (15)	52 % (16)
Cycling	89 % (25)	11 % (3)	0 %	100 % (28)
Judo	79 % (19)	21 % (5)	0 %	100 % (24)
Athletics	56 % (10)	44 % (8)	0 %	100 % (18)
Baseball	100 % (16)	0 %	0 %	100 % (16)
Handball	100 % (16)	0 %	0 %	100 % (16)
Rugby	0 %	100 % (16)	12.5 % (2)	87.5 % (14)
Gymnastics	73 % (11)	27 % (4)	13 % (2)	87 % (13)
Basketball	100 % (12)	0 %	0 %	100 % (12)
Fencing	100 % (10)	0 %	20 % (2)	80 % (8)
Boxing	100 % (4)	0 %	0 %	100 % (4)

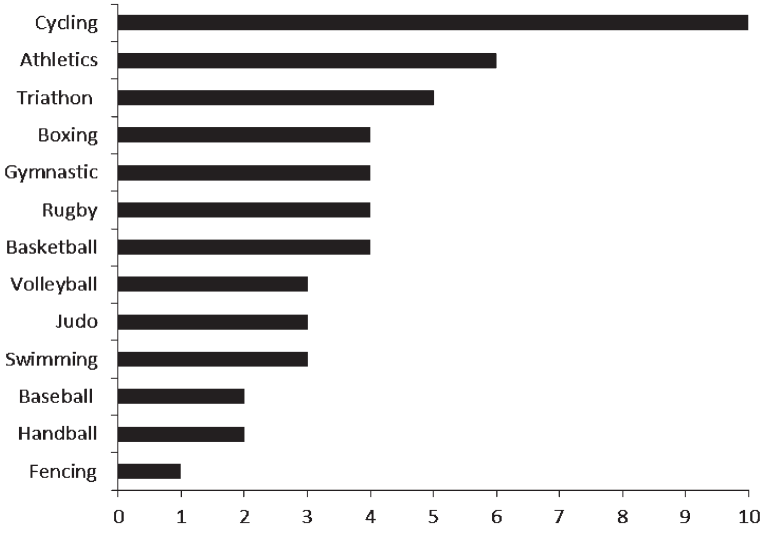

Figure 1: Median number of nutritional supplements consumed per athlete per sport.

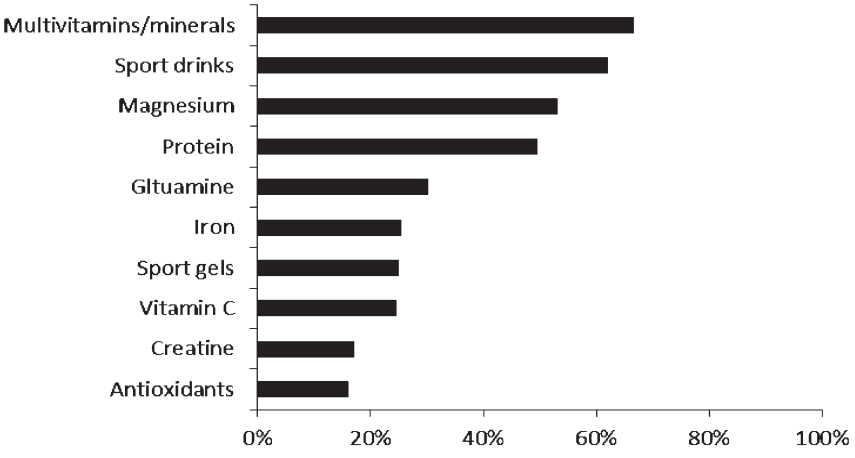

Figure 2: Relative percentages of use of the 10 most taken supplements.

Type of Supplements

The most widely used supplement was multivitamins/minerals (67 %), followed by sport drinks (62 %), and magnesium (53 %). The 10 most commonly used supplements are shown in Figure 2.

Regarding gender, males used more protein (56 % vs. 33 %, $p = 0.003$), vitamin C (29 % vs. 13 %, $p = 0.011$), and iron (31 % vs. 13 %, $p = 0.007$) supplements than females did.

Age-based differences were found between the consumption of multivitamins/minerals (<18 years=54 %, ≥18 years = 71 %, $p = 0.030$), protein (<18 years=28 %, ≥18 years = 56 %, $p = 0.001$), antioxidants (<18 years = 0 %, ≥18 years = 21 %, $p < 0.001$), creatine (<18 years = 0 %, ≥18 years = 22 %, $p < 0.001$), vitamin C (<18 years = 9 %, ≥18 years = 29 %, $p = 0.005$), and iron (<18 years = 14 %, ≥18 years = 29 %, $p = 0.034$).

No association was found between the type of supplements consumed and sport. However, differences were found in weekly hours of training for the use of proteins (users=19 h, non-users = 13 h; $p < 0.001$), sport drinks (users=18 h, non-users = 12 h; $p < 0.001$), sport gels (users=20 h, non-users = 13 h; $p < 0.001$), glutamine (users = 20 h, non-users = 13 h; $p < 0.001$), creatine (users = 12 h, non-users = 16 h; $p = 0.012$), vitamin C (users=20 h; non-users = 14 h; $p < 0.001$), and iron (users = 20 h; non-users = 13 h; $p < 0.001$).

Reasons for Usage

The most cited reasons for the usage of NS (Figure 3) were to accelerate recovery (63 %), improve sports performance (62 %), and have more energy/reduce fatigue (60 %).

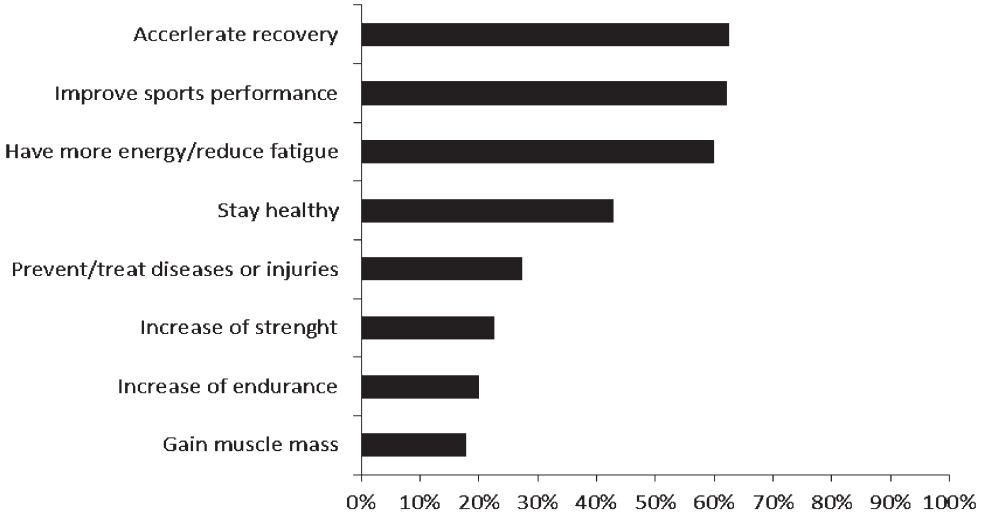

Figure 3: Relative percentages of athletes that chose the 10 most reported reasons for taking nutritional supplements.

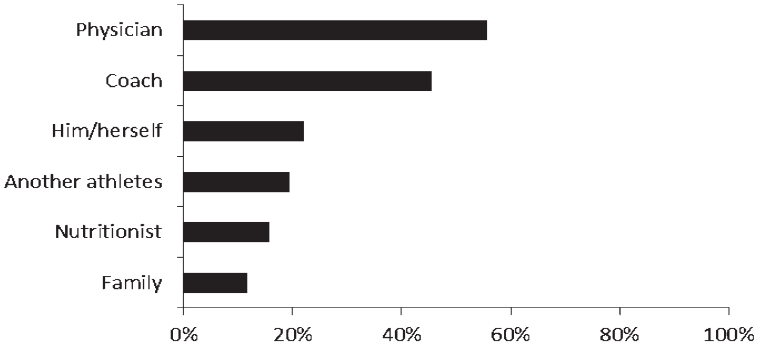

Figure 4: Relative percentages of athletes that chose the 6 most reported sources of information for nutritional supplement usage.

To increase strength (27 % vs. 11 %; $p = 0.009$), increase endurance (25 % vs. 7 %; $p = 0.003$), accelerate recovery (67 % vs. 51 %; $p = 0.025$), and gain muscle mass (22 % vs. 7 %; $p = 0.010$) were referred to as reasons more often by males than by their female counterparts.

Age-based differences were also found for reasons such as increasing strength (<18 years = 2 %, ≥18 years = 28 %; $p < 0.001$), accelerating recovery (<18 years = 31 %, ≥18 years = 72 %; $p = 0.029$), and gaining muscle mass (<18 years = 7 %, ≥18 years = 21 %; $p = 0.027$).

No association was found between type of sport and the reasons for consuming NS.

In order to assess the athletes' understanding of the benefits of consuming NS and their informed use, associations between supplements and reasons for their use were made. Twenty-nine associations were found (Table III). Based on the scientific information available to date, it was not surprising to see the use of multivitamins/minerals ($p = 0.017$; $\varphi = 0.167$, $p = 0.024$), vitamin C ($p = 0.009$; $\varphi = 0.184$, $p = 0.011$), and iron ($p = 0.002$; $\varphi = 0.222$, $p = 0.002$) for staying healthy; sport drinks for accelerating recovery ($p < 0.001$; $\varphi = 0.325$, $p < 0.001$) and having more energy/reduce fatigue ($p = 0.031$; $\varphi = 0.147$, $p = 0.043$); and proteins for increasing strength ($p < 0.001$; $\varphi = 0.264$, $p < 0.001$) and gaining muscle mass ($p = 0.002$; $\varphi = 0.220$, $p = 0.002$). However, there were also some rational but non-scientific based associations as the use of multivitamin/mineral for giving more energy/reducing fatigue ($p = 0.003$; $\varphi = 0.214$, $p = 0.003$); glutamine for staying healthy ($p = 0.033$; $\varphi = 0.145$, $p = 0.046$), accelerating recovery ($p < 0.001$; $\varphi = 0.370$, $p < 0.001$), and preventing/treating diseases or injuries ($p = 0.010$; $\varphi = 0.183$, $p = 0.012$); and magnesium for accelerating recovery ($p = 0.011$; $\varphi = 0.177$, $p = 0.015$). There were some casuistic relationships between sport gels and the willingness for staying healthy ($p < 0.001$) and preventing/treating diseases or injuries ($p = 0.004$).

Table III: Associations between the 8 most chosen reasons for nutritional supplements usage and the 10 most taken nutritional supplements.

	Multivitamins/ minerals	Protein	Sport drinks	Sport gels	Antioxidants	Glutamine	Creatine	Magnesium	Vitamin C	Iron
Stay healthy	YY: 75 % NY: 60 % p = 0.017 (φ = 0.167; p = 0.024)			YY: 41 % NY: 14 % p < 0.001 (φ = 0.307; p < 0.001)		YY: 38 % NY: 25 % p = 0.033 (φ = 0.145; p = 0.046)	YY: 9 % NY: 24 % p = 0.005 (φ = -0.199; p = 0.06)		YY: 33 % NY: 17 % p = 0.009 (φ = 0.184; p = 0.011)	YY: 37 % NY: 17 % p = 0.002 (φ = 0.222; p = 0.002)
Increase strength		YY: 74 % NY: 43 % p < 0.001 (φ = 0.264; p < 0.001)					YY: 56 % NY: 6 % p < 0.001 (φ = 0.549; p < 0.001)			
Increase endurance			YY: 76 % NY: 59 % p = 0.037 (φ = 0.141; p = 0.051)				YY: 32 % NY: 14 % p = 0.012 (φ = 0.188; p = 0.010)		YY: 40 % NY: 20 % p = 0.015 (φ = 0.178; p = 0.014)	YY: 47 % NY: 20 % p = 0.001 (φ = 0.247; p = 0.001)
Accelerate recovery		YY: 63 % NY: 28 % p < 0.001 (φ = 0.337; p < 0.001)	YY: 75 % NY: 42 % p < 0.001 (φ = 0.325; p < 0.001)			YY: 44 % NY: 9 % p < 0.001 (φ = 0.370; p < 0.001)	YY: 24 % NY: 7 % p = 0.002 (φ = 0.211; p = 0.04)	YY: 61 % NY: 42 % p = 0.011 (φ = 0.177; p = 0.015)	YY: 29 % NY: 17 % p = 0.049 (φ = 0.132; p = 0.069)	YY: 30 % NY: 18 % p = 0.048 (φ = 0.132; p = 0.069)
Improve sports performance										
Have more energy/reduce fatigue	YY: 75 % NY: 54 % p = 0.003 (φ = 0.214; p = 0.003)		YY: 68 % NY: 54 % p = 0.031 (φ = 0.147; p = 0.043)							
Prevent/treat diseases or injuries	YY: 81 % NY: 61 % p = 0.007 (φ = 0.188; p = 0.010)	YY: 67 % NY: 44 % p = 0.003 (φ = 0.212; p = 0.003)	YY: 73 % NY: 59 % p = 0.047 (φ = 0.133; p = 0.068)	YY: 40 % NY: 20 % p = 0.004 (φ = 0.214; p = 0.003)		YY: 44 % NY: 25 % p = 0.010 (φ = 0.183; p = 0.012)				YY: 40 % NY: 20 % p = 0.005 (φ = 0.205; p = 0.005)
Gain muscle mass		YY: 74 % NY: 45 % p = 0.002 (φ = 0.220; p = 0.002)					YY: 53 % NY: 10 % p < 0.001 (φ = 0.483; p < 0.001)			

YY: percentage of athletes that chose both variables; NY: percentage of athletes that used the nutritional supplement but did not point that reason. The significant p-values obtained by chi-square test, and the phi (φ) coefficients (and their corresponding p-values) are presented. Empty cells represent non-significant or non-valid chi-square tests.

Table IV: Associations between the 6 most chosen nutritional supplements advisor and the 10 most taken nutritional supplements.

	Multivitamins/ minerals	Protein	Sport drinks	Sport gels	Antioxidants	Glutamine	Creatine	Magnesium	Vitamin C	Iron
Physician	YY: 73 % NY: 59 % p = 0.028 (φ = 0.150; p = 0.038)								YY: 29 % NY: 18 % p = 0.049 (φ = 0.132; p = 0.069)	YY: 33 % NY: 17 % p = 0.008 (φ = 0.186; p = 0.011)
Coach			YY: 76 % NY: 52 % p = 0.001 (φ = 0.239; p = 0.001)	YY: 38 % NY: 15 % p < 0.001 (φ = 0.272; p < 0.001)	YY: 11 % NY: 21 % p = 0.033 (φ=-0.147; p = 0.044)	Y: 41 % N: 22 % p = 0.005 (φ = 0.198; p = 0.006)				YY: 34 % NY: 19 % p = 0.019 (φ = 0.163; p = 0.025)
Family										
Nutritionist										
Him/herself	YY: 81 % NY: 62 % p = 0.016 (φ = 0.165; p = 0.023)									
Other athletes										

YY: percentage of athletes that chose both variables; NY: percentage of athletes that used the nutritional supplement but did not indicate that advisor. The significant p-values obtained by chi-square test, and the phi (φ) coefficients (and their corresponding p-values) are presented. Empty cells represent non-significant or non-valid chi-square tests.

Source of Information

Physicians (56 %) and coaches (46 %) were the main sources of information and advice (Figure 4).

Gender-based differences were found for family advice (males = 7 %, females = 22 %; $p = 0.007$).

Age significantly influenced the search for advice from coaches (< 18 years = 60 %, ≥ 18 years = 42 %, $p = 0.029$) and family (< 18 years = 36 %, ≥ 18 years = 32 %, $p < 0.001$).

No statistical differences were found between sports and sources of information.

Table IV shows the relationships between the source of information and the type of NS used. When the source of information was the physician ($p = 0.028$; $\varphi = 0.150$, $p = 0.038$) or the athlete him/herself ($p = 0.016$; $\varphi = 0.165$, $p = 0.023$), the use of vitamins and minerals was more prevalent. On the other hand, supplements to improve training performance were used more often when the coach was the advisor ($p < 0.05$).

Discussion

Number and Type of NS Intake

To our knowledge, this is the first study to report NS usage in Portuguese national team athletes. Intake of dietary supplements was widespread among our sample population, with 66 % of the responders having consumed one or more type of NS over the year prior to data collection. This high percentage of usage was also reported in other countries [9, 13]. Regarding these numbers, we believe that key dietary issues and other major determinants of performance improvement and health maintenance might be receiving much less consideration than they merit [9]. Therefore, it is of high importance that athletes be advised by qualified health professionals, in particular specialists in food and sports nutrition, who can tailor diet and NS as per the athletes' specific needs.

It has been previously reported that a combination of NS is not unusual [10, 14]; similarly in this study, we found that the median level of consumption was 4 supplements per athlete. In accordance with other studies [9, 13], our data showed that the number of supplements taken was higher in older (over-18) athletes. Supplements such as multivitamins/minerals, protein, antioxidants, creatine, vitamin C, and iron were significantly more consumed by athletes aged 18 or older than by under-18 athletes.

We also found that males took more supplements than females, and that the number of supplements increased with increasing weekly training hours. Cycling was the sport where NS consumption was highest (10 supplements per athlete) and fencing the sport with the lowest consumption level (2 supplements per athlete). Not surprisingly, cycling is known for being one of the sports with the highest prevalence of NS use [15].

In agreement with other studies [13, 14], the most taken supplement was multivitamins/minerals. Exercise may indeed increase the requirements for certain vitamins and minerals, many of which are involved in energy production and muscle synthesis and repair, but vitamin and mineral supplements are not needed if adequate energy to maintain body weight is drawn from a rich diet [16]. However, athletes who follow low-energy, low-micronutrient-dense, or unbalanced diets may require these types of supplements [16].

A similar tendency was found for magnesium, also highly consumed by German athletes [13]. Although even marginal magnesium deficiency impairs exercise performance, magnesium supplementation of physically active individuals with good magnesium status does not enhance physical performance [17]. Therefore, increased dietary intake of magnesium from food or supplements should only be an option when a deficiency in this mineral is proven.

In accordance with published data [8, 13, 18], sport drinks were among the most taken NS. These findings are in agreement with the guidelines that encourage athletes to consume sports beverages in order to maximize exercise performance [19].

In the current study, male athletes were more likely to use protein preparations than female athletes, as also seen in other studies [6, 8, 13]. The same effect was observed for iron intake, contrary to what was found by Petroczi and collaborators [7], and to the fact that females are more prone to developing iron deficiency compared to males [20]. For vitamin C, the results of this study were similar to those of another [7] where the proportion of male users was higher than the proportion of female users. The higher use of both iron and vitamin C by male athletes in this study may be explained by the fact that vitamin C positively affects iron metabolism [21], which is why these two micronutrients are often prescribed simultaneously.

The number of weekly training hours was positively related with the use of 6 supplements (proteins, sport drinks, sport gels, glutamine, vitamin C, and iron) except for creatine, which showed an inverse association. Creatine is classically related to power, strength, and explosive force. Therefore, this result is in congruence

with the fewer training hours of a typical strength athlete, who is a usual consumer of creatine.

Reasons for Usage

In the present study, the primary reasons for taking supplements were to accelerate recovery, improve sports performance, and have more energy/reduce fatigue—all of which are performance-related. These findings contrast with other studies [11, 13, 22, 23] that report mainly health-related reasons. Moreover, in studies where performance-related reasons were most cited [9, 10], no specific reference to recovery is made. In the present study, not only was accelerated recovery the most important motivation, but also the reason for consuming more different types of supplements (Table III). An explanation for this might be that only high-level athletes participated in this study; these athletes are exposed to high training volumes, power, and intensities, and fast recovery is their major concern.

From a general perspective, multivitamins/minerals, vitamin C and iron were consumed primarily for health-related issues, whereas sport drinks were taken to guarantee endurance, energy, and recovery, and proteins and creatine to promote muscle mass and recovery. Other studies have also found an association between multivitamins/minerals and energy gain [11, 24, 25], and proteins with muscle build-up [18]. Whether these relationships were due to the athletes' knowledge about NS efficacy and potency was not assessed. Nonetheless, there seems to exist—at least in some cases—a rational choice for the supplement, albeit not supported by scientific information. That is, it seems that athletes look for information about supplements, yet perhaps not in scientific resources; e. g., peer-reviewed journals. For example, glutamine was taken to improve health and to accelerate recovery, but these effects have not been scientifically proven [26, 27]. Notwithstanding the lack of scientific proof, they are frequently suggested in glutamine supplement labels. Another example is that of multivitamins/minerals, magnesium, vitamin C, and iron, which were being taken for health and/or performance reasons. However, their use is only rational if athletes are at risk for poor micronutrient status [16].

Reasons for taking NS were related to gender and to age. As in our study, Tian *et al.* [18] found that males use supplements mainly for performance and strength enhancement. However, the sport did not influence the reasons for taking these substances; i. e. the 8 most chosen reasons were similar regardless of the type of sport. This phenomenon might be due to the fact that all sports have some goals in common.

Source of Information

In this study, the physician was the most common source of information, followed by the coach. Although the same results were obtained by de Silva *et al.* [9], in most studies the primary source of information is the coach or the family [6, 11, 23, 24, 28]. Therefore, it appears that Portuguese athletes perceive supplements as an issue that deserves medical attention. However, the percentage of athletes seeking the advice of nutritionists was low. This can be explained—at least partially—by the fact that in Portugal, few nutritionists are working directly with athletes.

On the other hand, as mentioned above, NS advice is often sought from coaches; this may be due to the close relationship between coaches and athletes favoring trust. Therefore, coaches must be aware of the benefits and risks of NS in order to provide good advice and recommendations. However, under-18 athletes obtained information on NS not only from their coaches but also from family members, suggesting that families should receive education on NS and, if necessary, be prepared to ask for medical/nutritional advice.

In this study, advice from physicians was sought in the case of health supplements, and that of coaches in the case of performance and ergogenic supplements. Therefore, a complementary approach might be necessary for the athlete's best interest.

A limitation of this study was that it was not possible to quantify the frequency and the duration of NS intake. The study of these variables in future studies may shed new light on sports supplementation patterns. Moreover, more specific studies about this topic are needed in order to investigate the consumption of NS within each specialty, namely in athletics (long- and middle-distance running, sprints, hurdles, jumps, throws, combined events, and race-walking), swimming (competitive swimming, synchronized swimming, and open-water swimming), cycling (road cycling, off-road cycling, and BMX riding), and also within weight classes in the case of sports with weight categories, such as boxing. Another limitation was the difference in the number of athletes per sport, which might have biased the comparisons between sports in favor of the most represented sports.

In conclusion, this study demonstrated that the prevalence of NS usage is widespread among Portuguese athletes. Non-scientifically supported choices revealed a lack of information and appropriate nu-

tritional strategies, which are essential for the safe use of NS. It is important that athletes choose NS with caution and be assisted by a professional health care provider specializing in sports nutrition. Given the high percentage of NS users, there is an urgent need to provide athletes with education and access to scientific and unbiased information, in order to make right and wise choices about the use, or not, of these products. Not only athletes, but also their families and all professionals working with them, must ensure the adequacy of NS for each individual sport and athlete. It is also important for athletes to understand that under a balanced diet, gains from the majority of NS are minimal or non-existent; in fact, their inadequate consumption could result in inadvertent doping.

Acknowledgements

The authors would like to thank all the athletes and the 13 federations that participated in this study. Mónica Sousa acknowledges the Fundaçao para a Ciencia e a Tecnologia (FCT) regarding the grant SFRH/BD/75276/2010. Vítor Hugo Teixeira and Pedro Moreira acknowledge the FCT for the funded project PEst-OE/SAU/UI0617/2011.

References

1. Maughan, R.J., King, D.S. and Lea, T. (2004) Dietary supplements. J. Sports Sci. 22 (1), 95–113.
2. Sobal, J. and Marquart, L.F. (1994) Vitamin/mineral supplement use among athletes: a review of the literature. Int. J. Sport Nutr. 4 (4), 320–334.
3. Maughan, R.J., Depiesse, F. and Geyer, H. (2007) The use of dietary supplements by athletes. J. Sports Sci. 25(SUPPL. 1), 103–113.
4. Burke, L.M., Castell, L.M. and Stear, S.J. (2009) BJSM reviews: A-Z of supplements: Dietary supplements, sports nutrition foods and ergogenic aids for health and performance Part 1. Br. J. Sports Med. 43 (10), 728–729.
5. Petróczi, A. and Naughton, D.P. (2007) Supplement use in sport: Is there a potentially dangerous incongruence between rationale and practice? J. Occup. Med. Toxicol. 2 (1).
6. Sundgot-Borgen, J., Berglund, B. and Torstveit, M.K. (2003) Nutritional supplements in Norwegian elite athletes – Impact of international ranking and advisors. Scand. J. Med. Sci. Sports. 13 (2), 138–144.
7. Petroczi, A. and Naughton, D.P. (2008) The age-gender-status profile of high performing athletes in the UK taking nutritional supplements: Lessons for the future. J. Int. Soc. Sports Nutr. 5.
8. Slater, G., Tan, B. and Teh, K.C. (2003) Dietary supplementation practices of Singaporean athletes. Int. J. Sport Nutr. Exerc. Metab. 13 (3), 320–332.
9. De Silva, A. et al. (2010) Dietary supplement intake in national-level Sri Lankan athletes. Int. J. Sport Nutr. Exerc. Metab. 20 (1), 15–20.
10. Petro'czi, A. et al. (2007) Performance enhancement with supplements: Incongruence between rationale and practice. J. Int. Soc. Sports Nutr. 4.
11. Froiland, K. et al. (2004) Nutritional Supplement Use among College Athletes and Their Sources of Information. Int. J. Sport Nutr. Exerc. Metab. 14 (1), 104–120.
12. Petróczi, A. et al. (2008) Nutritional supplement use by elite young UK athletes: Fallacies of advice regarding efficacy. J. Int. Soc. Sports Nutr. 5.
13. Braun, H. et al. (2009) Dietary supplement use among elite young German athletes. Int. J. Sport Nutr. Exerc. Metab. 19 (1), 97–109.
14. Suzic Lazic, J. et al. (2011) Dietary supplements and medications in elite sport – polypharmacy or real need? Scand. J. Med. Sci. Sports 21 (2), 260–7.
15. Huang, S.H., Johnson, K. and Pipe, A.L. (2006) The use of dietary supplements and medications by Canadian athletes at the Atlanta and Sydney Olympic games. Clin. J. Sport Med. 16 (1), 27–33.
16. Rodriguez, N.R., Di Marco, N.M. and Langley, S. (2009) American College of Sports Medicine position stand. Nutrition and athletic performance. Med. Sci. Sports Exerc. 41 (3), 709–731.
17. Nielsen, F.H. and Lukaski, H.C. (2006) Update on the relationship between magnesium and exercise. Magnes. Res. 19 (3), 180–189.
18. Tian, H.H., Ong, W.S. and Tan, C.L. (2009) Nutritional supplement use among university athletes in Singapore. Singapore Med. J. 50 (2), 165–172.
19. Rodriguez, N.R., Di Marco, N.M. and Langley, S. (2009) Nutrition and athletic performance. Med. Sci. Sports Exerc. 41 (3), 709–731.
20. Suedekum, N.A. and Dimeff, R.J. (2005) Iron and the athlete. Curr. Sports Med. Rep. 4 (4), 199–202.
21. Atanassova, B.D. and Tzatchev, K.N. (2008) Ascorbic acid–important for iron metabolism. Folia Med. 50 (4), 11–16.

22. Dascombe, B.J. et al. (2010) Nutritional supplementation habits and perceptions of elite athletes within a state-based sporting institute. J. Sci. Med. Sport 13(2), 274–280.

23. Nieper, A. (2005) Nutritional supplement practices in UK junior national track and field athletes. Br. J. Sports Med. 39(9), 645–649.

24. Burns, R.D. et al. (2004) Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutrition counseling. J. Am. Diet. Assoc. 104(2), 246–249.

25. O'Dea, J.A. (2003) Consumption of nutritional supplements among adolescents: Usage and perceived benefits. Health Educ. Res. 18(1), 98–107.

26. Nieman, D.C. and Bishop, N.C. (2006) Nutritional strategies to counter stress to the immune system in athletes, with special reference to football. J. Sports Sci. 24(7), 763–772.

27. Phillips, G.C. (2007) Glutamine: The nonessential amino acid for performance enhancement. Curr. Sports Med. Rep. 6(4), 265–268.

28. Erdman, K.A. et al. (2007) Dietary supplementation of high-performance Canadian athletes by age and gender. Clin. J. Sport Med. 17(6), 458–464.

V. H. Teixeira, PhD

Faculty of Nutrition and Food Sciences
University of Porto
Rua Dr. Roberto Frias
4200-465 Porto
Portugal
vhugoteixeira@fcna.up.pt