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**Research article**

# Performance Level Affects the Dietary Supplement Intake of Both Individual and Team Sports Athletes

**Ifigenia Giannopoulou, Kostantinos Noutsos, Nikolaos Apostolidis, Ioannis Bayios and George P. Nassis** ✉
Department of Sport Medicine and Biology of Exercise, Faculty of Physical Education and Sport Science, National and Kapodistrian University of Athens, Athens, Greece

**Abstract**
Dietary supplement (DS) intake is high in elite level athletes, however few studies have investigated the impact that the performance level of the athletes has on supplementation intake in individual and team sports. The purpose of the study was to determine and compare the DS intake among individual and team sport athletes of various performance levels. A total of 2845 participants (athletes: 2783, controls: 62) between the ages of 11 and 44 years old participated in the study. A 3-page questionnaire was developed to assess the intake of DS. Athletes were categorized based on participation in individual (n = 775) and team sports (n = 2008). To assess the effect of performance level in supplementation intake, athletes were categorized based on training volume, participation in the national team, and winning at least one medal in provincial, national, international or Olympic games. Overall, 37% of all athletes of various performance levels reported taking at least one DS in the last month. A higher prevalence of DS intake was reported in individual (44%) compared to team sport athletes (35%) ($p < 0.001$). Athletes of high performance level reported greater DS intake compared to lower performance athletes. Males reported a significantly greater prevalence of DS intake compared to females. The most popular supplement reported was amino acid preparation with the main reason of supplementation being endurance improvements. In conclusion, performance level and type of sport appear to impact the DS practices of male and female athletes. These findings should be validated in other populations.

**Key words:** Nutritional aids, sports, team sports, performance.

## Introduction

A high prevalence of dietary supplement (DS) intake in elite level athletes has been reported in the literature, ranging from 32-90% (Baylis et al., 2001; Lazic et al., 2011; Ronsen et al., 1999; Schroder et al., 2002; Sundgot-Borgen et al., 2003). Creatine, antioxidant vitamins, multivitamins and amino acids are among the most popular DS (Erdman et al., 2006; 2007, Froiland et al., 2004; Sobal and Marquart, 1994). A number of factors have been reported to impact the prevalence of supplementation in athletes such as age, type of sport, and in some cases gender (Erdman et al., 2006; 2007; Sundgot-Borgen et al., 2003). One of the main factors that appears to significantly affect DS intake is the performance level of the athletes (Bond-Brill and Keane, 1994; Erdman et al., 2006; Nieman et al., 1989; Slater et al., 2003; Sundgot-Borgen et al., 2003). As athletes improve their performance through years of intense training and as they participate in higher level competition, they are more likely to seek some form of ergogenic aid in order to continue enhancing their performance. Hence, it is expected that a greater prevalence of DS intake would be exhibited in higher performance level athletes. However, very few studies with a relatively small population sample have addressed this issue with confounding results. While some studies exhibit greater DS intake in international compared to national level athletes (Bond-Brill and Keane, 1994; Erdman et al., 2006; Nieman et al., 1989), others show no differences in supplementation practices in various performance levels (Slater et al., 2003).

The DS intake of individual compared to team sport athletes is still under question. To the authors' knowledge there is a lack of research on this area as the majority of research has focused on specific sports; however from the few studies that have been conducted it appears that athletes in individuals sports such as rowing, canoeing & kayaking and wrestling report higher intake and dosage of DS compared to team sport athletes (Huang et al., 2006; Lazic et al., 2011). This finding is of primary importance to be further investigated as in individual sports success and wining is affected primarily by the athletes' personal training and effort, hence it is possible that individual athletes will more likely use DS compared to team sport athletes. Furthermore, the need for more research is apparent by the recent World Anti Doping Agency (WADA) laboratory reports that demonstrate a greater percentage of doping in individual vs team sports (WADA, 2007).

The worldwide use of DS by athletes warrants attention and more research as there is a number of commonly used supplements that have not been thoroughly investigated and may have serious side-effects (Haller and Benowitz, 2000; Morrow et al., 2005). Furthermore, the intake of more than one supplement (polypharmacy) in high doses and for long periods of time poses serious concerns regarding their safety (Haller and Benowitz, 2000). Positive doping on the other hand, is another issue that has been reported in the literature and warrants more attention. As regulations and control of DS are less austere compared to food and drug regulations, there have been numerous cases of supplements containing or being contaminated by illegal and banned substances by the WADA and athletes being disqualified from the games (Baylis et al., 2001; Burke, 2000; Catlin

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et al., 2000; Pipe and Ayotte, 2002). Hence, there is a great need to assess the DS intake in a large population of athletes in various sports, performance levels and ethnicities and to further understand the reasons that athletes take supplements and the sources from where they receive information regarding supplements.

The primary purpose of this study was to assess and compare the prevalence of DS intake between athletes of various performance levels in individual and team sports. Moreover, a secondary goal of the study was to investigate the reasons of supplementation and the sources of information regarding supplements.

## Methods

### Participants

The study population comprised of a total of 2845 participants (males: 2013, females: 832), between the ages of 11 and 44 years old (mean age: 21.4 ± 4.8 years). From the total subject pool, 1783 participants were Greek athletes of various performance levels from across a spectrum of different individual and team sports, and 62 participants did not compete in any sport. All athletes were recruited during the competition season. Prior to participation in the study, all individuals completed a consent form approved by the Ethics Committee of the University of Athens. The study was approved by the Institution Review Board of the University of Athens, Department of Physical Education and Sport Science.

Participants were required to have no health, musculoskeletal problems or injuries due to competition. Athletes that were under any medical treatment, or were planning to stop training or competing in the following six months were excluded from the study.

Participants were firstly categorized based on sport and secondly based on individual or team sport participation. In order to assess the athletes' performance level and its effect on DS intake, they were classified in five different performance level groups based on winning or not at least one medal in provincial, national, international or Olympic games: No medal, Provincial, National, International and Olympic Group. Athletes were also categorized based on participation or not in the National Team of their sport. Finally, in order to control for the effect of the athletes' training volume on DS intake, athletes were categorized in three different groups: high training (HT: ≥ 5 days per week), moderate training (MT: ≥ 3 days/week) and low training volume (LT: 1-2 days per week).

### Questionnaire design

A 3-page questionnaire was developed in order to assess the participants' intake of DS. The questionnaire was designed and reviewed by health and sport nutrition professionals and researchers at the University of Athens. The questionnaire was answered anonymously and by recall. All questionnaires were collected from September to December of 2011. Athletes were asked to report the DS intake consumed at anytime within the last one month. DS were defined as caffeine, amino acids and protein preparations, carbohydrate preparations, essential fatty acid preparations, creatine, vitamins, minerals, metabolites or concentrates. In addition, athletes were required to list supplements that they could not classify. The questionnaire also included questions on years of training, duration and frequency of training and performance level, as well as questions on reasons/ motives for supplementation, advice and sources of supplementation information and place of purchase. To test the understandability and applicability of the questionnaire, a pilot version was given to undergraduate students of the University of Athens, Department of Physical Education and Sport Science before the questionnaire was distributed to the participants of the study.

### Statistical analysis

Statistical analysis was performed using the SPSS software for Windows 19 (SPSS Inc, Chicago, IL, USA). Descriptive data are reported as mean ± SD or frequencies and percentages. Chi-square test and post hoc Fisher exact test were used to assess differences in the dependent variables between participants. Where appropriate, continuous variables were compared by Student's t-test for independent variables and ANOVA. The level of significance was set at $p < 0.05$.

## Results

### Subject characteristics and sport participation

The questionnaires were completed by 2845 participants (males: 2013 (71%), females: 832 (29%)). From the total of 2845 participants, 2783 were athletes (males: 1991 (72%), females: 792 (28%)) and 62 were non-athletes (males: 22, females: 40). Forty-six questionnaires were incomplete and were not used for the study and 156 participants refused to participate in the study.

**Table 1. Categorization of athletes based on Sport Representation, Training Volume, National Team Participation and Level of Performance.**

| | | Frequency n (%) |
|---|---|---|
| **Sport Representation** | Individual | 775 (28) |
| | Team | 2008 (72) |
| **Training volume** | 1-2 days/week | 204 (7) |
| | ≥3 days/week | 820 (30) |
| | ≥5 days/week | 1759 (63) |
| **National Team Participation** | Yes | 571 (20) |
| | No | 2212 (80) |
| **Performance Level** | No medal | 1314 (47) |
| | Provincial | 575 (21) |
| | National | 788 (28) |
| | International | 85 (3) |
| | Olympic | 21 (1) |

Table 1 demonstrates the categorization of athletes based on type of sport (individual vs team), the volume of training (training days/week), the participation in national team or not, and the level of performance. In terms of sport participation, the greatest number of athletes participated in team sports (n = 2008, 72%) compared to individual sports (n = 775, 28%). In terms of training

volume, the majority (63%) of the athletes trained ≥ 5 days per week, 30% of the athletes trained ≥ 3 days/week, and a very small percentage of athletes (7%) trained 1-2 days per week (Table 1). A small number of athletes participated in the national team of their sport (20%) compared to athletes who did not make it to the national team (80%). Finally, categorization for performance level revealed that 47% of the athletes did not win any medal in competition, 28% won at least one medal in national competition, 21% won at least one medal in provincial competition and only 3% and 1% won at least one medal in international and Olympic competition, respectively. Since the athletes gaining a metal in Olympic competition were extremely few, their data were not used in the statistical analysis and results of the study. Table 2 shows the categorization of the athletes in various sports. Overall, athletes participated in 33 different sports.

**Table 2. Athletes' participation in various competitive sports.**

| Sport Represented | Frequency n (%) |
|---|---|
| Soccer | 608 (21.4) |
| Basketball | 573 (20.1) |
| Water polo | 371 (13.0) |
| Swimming | 345 (12.1) |
| Handball | 214 (7.5) |
| Track and Field | 201 (7.1) |
| Volleyball | 201 (7.1) |
| Tennis | 49 (1.7) |
| Gym | 23 (0.8) |
| Kick boxing | 22 (0.8) |
| Softball | 18 (0.6) |
| Gymnastics | 17 (0.6) |
| Field Hockey | 16 (47) |
| Archery | 14 (0.6) |
| Aerobics | 14 (0.5) |
| Boxing | 13 (0.5) |
| Tae Kwon Do | 12 (0.4) |
| Cycling | 10 (0.4) |
| Judo | 9 (0.3) |
| Table Tennis | 8 (0.3) |
| Karate | 8 (0.3) |
| Rowing | 7 (0.2) |
| Dance | 7 (0.2) |
| Sailing | 4 (0.1) |
| Weight Lifting | 4 (0.1) |
| Wall climbing | 3 (0.1) |
| Skiing | 3 (0.1) |
| Climbing | 3 (0.1) |
| Wrestling | 2 (0.1) |
| Horseback riding | 1 (0.1) |
| Fencing | 1 (0.1) |
| Shooting | 1 (0.1) |
| Modern Pentathlon | 1 (0.1) |
| **Total** = 33 Sports | **n** = 2783 |

## Prevalence of dietary supplementation

A higher percentage of athletes (37.5%) reported taking at least 1 DS in the last 1 month compared to controls (4.8%) ($\chi^2$ =56.42, $p < 0.001$). However, the percentage of athletes taking supplements (37%) was significantly lower compared to the athletes that were not taking supplements (63%) ($\chi^2$ = 48.52, $p < 0.001$). A higher prevalence of DS intake was also reported in individual athletes (44%) compared to team sport athletes (35%) ($\chi^2$ = 46.68, $p < 0.001$). In terms of gender, males reported a significantly greater prevalence of DS intake compared to female athletes ($\chi^2$ = 16.07, $p < 0.001$). No differences were found in DS intake when the age of the athletes was taken into account.

## Effect of training volume, national team participation and performance level on DS intake

Significant differences were found in DS intake between athletes of different training volume both in individual and team sports (Figure 1). Overall, a greater percentage of athletes (44.8%) were taking DS in the HT group, compared to athletes taking DS in the MT (26.1%) or LT group (16.7%) ($\chi^2$ = 72.59, $p < 0.001$) in both males and females. When the type of sport was taken into account, individual athletes reported a greater prevalence of DS compared to team sport athletes but only in the HT group ($\chi^2$ =48.24 , $p < 0.001$) (Figure 1).

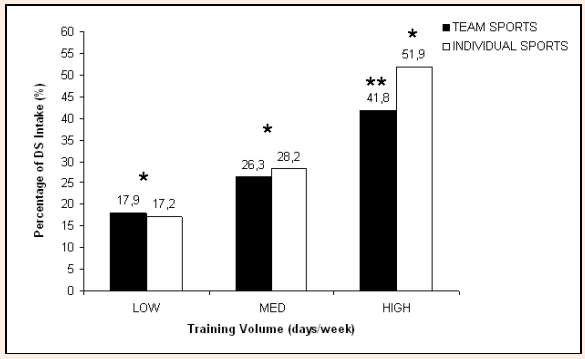


**Figure 1. Impact of training volume on prevalence of dietary supplement intake in individual and team sport athletes.**
* $p < 0.001$ between low, med and high training groups in all athletes.
** $p < 0.001$ between individual and team sports

A higher prevalence of DS intake was found in athletes in the national team (53.4%) compared to athletes that were not in the national team (32.6%) ($\chi^2$ =85.17 , $p < 0.001$) and this difference was greater in individual vs team sport athletes (Figure 2). In terms of performance level, athletes in the national (44.4%) and international (50.6%) group reported a greater prevalence of DS intake compared to athletes that won no medals (36.2%) or were in the provincial group (25.9%) (($\chi^2$ =56.47 , $p < 0.001$). No comparison could be made on DS intake between individual and team sport athletes in the various performance groups, as the number of individual athletes in the national, international and Olympic group was very low. Gender did impact the aforementioned findings, with lower percentages of females taking DS compared to males in all different performance levels of the athletes.

## Type of supplement

The most popular DS reported being taken by all athletes were protein/amino acid preparations (46.3%) followed by electrolytes (36.8%) and carbohydrate preparations (36.0%). No significant differences in the type of

supplement taken were found between athletes of individual vs team sports or athletes of different performance levels. The more popular supplements for male athletes were protein/amino acid preparations (19.7%), carbohydrates (16.0%) and electrolytes (15.9%), while females reported taking primarily protein/amino acid preparations (10.6%), electrolytes (10.0%) and carbohydrates (6.9%). Older athletes reported taking similar supplements (protein/amino acids, creatine, electrolyte and carbohydrates) but at significantly greater percentages compared to younger athletes.

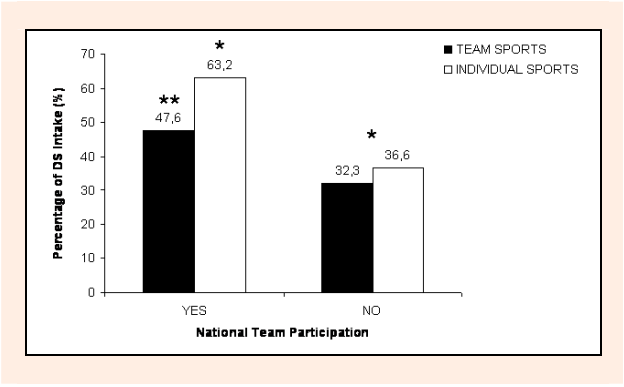


**Figure 2. Impact of participation or not in the National team on prevalence of dietary supplement intake in individual and team sport athletes.** * $p < 0.001$ between national team participation or not in all athletes, ** $p < 0.001$ between individual and team sports

## Reasons for supplementation

The main reasons for supplementation by order of importance were: to increase endurance (36.7%), to increase power (20.6%) and to increase power and muscle mass (17.8%), with individual athletes reporting greater percentages but no difference in their reasons of DS intake compared to team sport athletes. Athletes of the highest performance level (either exhibited by training volume, national team participation or medals in high level competition) reported similar reasons of DS intake as above (improvements in endurance, power, power and muscle mass) but at greater percentages compared to athletes of lower performance level. Finally, females chose to take supplements primarily to induce improvements in endurance (13.2%), power (6.6%) and also to be more alert (3.0%) compared to males that took DS primarily for improvements in endurance (13.8%), power (8%) and muscle hypertrophy (7.7%).

## Sources of supplementation information

Overall, coaches (35%), physicians (29.5%) and nutritionists (15%) were most often identified as sources for DS information. Individual athletes were more likely to seek advice from their coach (16.8%), nutritionist (8.3%) and physician (8.2%) compared to team sport athletes that sought advice primarily from their physician (18.6%), and to a lesser degree from their coach (11.8%) and nutritionist (4.7%). Differences in the information source of DS were found depending on the athletes' training volume, performance level and national team participation, but overall the majority of high performance athletes sought information primarily from their coach, physician and nutritionist. Finally, males tended to seek information on supplements primarily from their coach (14.4%), physician (10.0%) and nutritionist (6.1%) compared to females that tended to seek advice more from their physician (13.0%) and then their coach (9.1%) and nutritionist (4.2%).

# Discussion

Dietary supplementation is a common practice among competitive and elite level athletes, with a number of studies reporting a supplementation intake of 32-90% in athletes participating in various sports (Baylis et al., 2001; Lazic et al., 2011; Ronsen et al., 1999; Schroder et al., 2002; Sundgot-Borgen et al., 2003). However, few studies with a relatively small population sample have investigated the degree to which supplementation intake is affected by the performance level of the athlete and the type of sport (individual vs team sport) he/she participates (Bond-Brill and Keane, 1994; Erdman et al., 2006; Nieman et al., 1989; Slater et al., 2003; Sundgot-Borgen et al., 2003). The present study demonstrated in a large athletic sample (n = 2783) of 33 different sports that the performance level of the athlete and the participation in individual vs team sports does affect DS intake, with a greater prevalence of supplementation reported in high level athletes and athletes participating in individual sports compared to lower level and team sports athletes. These findings are of great importance as they exhibit for the first time in such a large population sample of various sports the need for differentiation between type of sport, performance level and gender when evaluating the dietary supplementation intake of athletes.

The main aim of the present study was to identify the impact that the athletes' performance level has on DS intake. We investigated this effect by examining three different performance parameters: training volume, national team participation and medals won in different level competitions. Independent of the method used to assess performance level, the results were similar. We found that the higher the performance level of the athlete the greater the DS intake. On average, international and national level athletes reported a 20-30% greater prevalence of supplementation compared to provincial athletes or athletes winning no medal in competition. National team participation also influenced the degree of DS intake, with ~20% more athletes in the national team reporting taking supplements compared to athletes that were not in the national team. Finally, training volume also appears to impact DS intake, as athletes training at high volume reported a 20% greater prevalence of DS intake compared to athletes with lower training volume. The aforementioned findings are in agreement with the studies by Erdman et al. (2006; 2007) that have reported a significantly greater prevalence of supplementation by 10-20% in higher level Canadian athletes compared to lower level athletes and the study by Sundgot-Borgen et al. (2003) where a greater percentage of DS users were observed in the high international ranking Norwegian athletes compared to the lower ones, but only in female athletes and not in male ones (Sundgot-Borgen et al.,

2003). A previous study by Slater et al. (2003) however, has found no differences in supplementation practices in Singaporean athletes of different performance level. It is possible that the different ethnicity of the athletes might have influenced these findings. Overall, it appears that information such as the performance level as well as the training volume of the athlete is important to be taken into account and does provide more insight on the dietary supplementation profile of the athletes.

An interesting finding of the present study was the significant difference in supplementation prevalence between individual and team sport athletes that was primarily evident in the high level athletes. To the author's knowledge few studies have investigated this phenomenon, as previous studies have focused primarily on specific sports or on a smaller range of sports. Our findings are in accordance with the study by Huang et al. (2006) where a greater prevalence of vitamin and mineral supplementation was found in individual sport compared to team sport athletes and the study by Lazic et al. (2011) where individual athletes reported taking greater amounts of supplements when compared to team sport athletes. Future research is needed to further investigate this phenomenon and to examine whether these differences in supplementation affect performance and potentially lead to a greater risk for side effects.

The most popular supplements reported in the present study were protein/amino acid preparations, electrolytes and carbohydrates preparations. The performance level of the athletes or the type of sport did not appear to affect the type of DS taken. Previous studies have reported either multivitamins, minerals and sport drinks as the most popular supplements taken or amino acids and creatine (Braun et al., 2009; Erdman et al., 2006; 2007; Froiland et al., 2004; Sobal and Marquart, 1994; Sundgot-Borgen et al., 2003). The main reasons of supplementation reported by the athletes in the present study were improvements in performance and in body composition and specifically muscle mass, in contrast to other studies where improvements in general well-being and health maintenance, increases in energy and improved exercise recovery have been reported (Braun et al., 2009; Erdman et al., 2006; 2007; Sundgot-Borgen et al., 2003). It is possible that the different ethnicity of the athletes and possibly the different level of performance in Greece compared to other countries might have influenced the aforementioned findings. It is also possible that the different source of information regarding supplements could have affected the results of our study. In the present study athletes reported their coach as the main source of information and secondly their physicians and nutritionist. Previous studies have reported various informants on supplements such as family/friends, teammates, coaches and athletic trainers, media, internet etc. (Braun et al., 2009 ; De Silva et al., 2010 ; Erdman et al., 2006; 2007 ; Froiland et al., 2004 ; Slater et al., 2003).

In the present study, males appeared to report a greater prevalence of DS intake compared to females at all performance levels, a finding that has been previously reported in the literature (Sobal and Marquart, 1994; Ronsen et al., 1999). One of the parameters that might have contributed to this gender difference is the different source of information that females and males used. Females reported the physicians as their main source of information on supplements, while males reported their coach. It is possible that as females primarily received information from a physician, they were advised to use supplements more carefully and in moderation compared to males that received information from their coach. However, only small differences were found on the type of supplement and reason of supplementation that males and females reported taking despite the different source of information. Previous studies have found gender differences on the motives of supplementation, with males being more likely to use DS for performance improvements while females for health benefits (Jacobson et al., 2001; Krumbach et al., 1999; Sobal and Marquart, 1994). More research is needed to establish whether gender differences exist in dietary supplementation in athletes.

The overall prevalence of DS intake was significantly lower in the present study (37%) compared to other studies in the literature. However, in high performance level athletes the percentage of DS intake (~53%) is much closer to the ones reported in the literature, ranging between 40-60% (Schroder et al., 2002; Sobal and Marquart, 1994; Sundgot-Borgen et al., 2003). Hence it is important to differentiate between performance levels when trying to assess the DS intake of athletes. It is possible that ethnicity might have also influenced these results. There is only one study with a small population sample (n = 55) that have investigated the DS practices of Mediterranean (Spanish) elite basketball athletes and have found similar results to the present study (Schroder et al., 2002). There is a possibility that differences exist in the DS prevalence between athletes of different regions of the world due to differences in nutrition, education on supplements and sport culture. More research is needed in various ethnicities with large population samples and various performance levels in order to more accurately assess the DS intake practices of athletes.

## Conclusion

In conclusion, this is the first comprehensive study on a large population sample of Mediterranean athletes that offers some insight on dietary supplementation practices. It indicates that the prevalence of dietary supplementation is widespread in this sample of Mediterranean athletes especially of high performance level. In addition, it demonstrates the impact that the performance level and the type of sport (individual vs team sport) have on the prevalence of DS intake in both male and female athletes. The findings of the present study emphasize the need for more detailed investigations of the supplementation practices of athletes of different performance levels, type of sport, gender and possibly ethnicity. Furthermore, it demonstrates the need for more research and understanding of the reasons and educational sources of these athletes in order to form the basis for educational programs on dietary supplementation and to reduce the

chances of positive doping and disqualification from competition.

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## References

Baylis, A., Cameron-Smith, D. and Burke, L.M. (2001) Inadvertent doping through supplement use by athletes: assessment and management of the risk in Australia. *International Journal of Sport Nutrition and Exercise Metabolism* **11,** 365-383.

Bond-Brill, J.B. and Keane, M.W. (1994) Supplementation patterns of competitive male and female bodybuilders. *International Journal of Sport Nutrition* **4,** 398-412.

Braun, H., Koehler, K., Geyer, H., Kleinert, J., Mester, J. and Schanzer, W. (2009) Dietary supplement use among elite young german athletes. *International Journal of Sport Nutrition and Exercise Metabolism* **19(1),** 97-109.

Burke, L.M. (2000) Positive drug tests from supplements. *SportScience*. **4(3).** Available from URL: http://www.sportsci.org/jour/0003/lmb.html.

Catlin, D.H., Leder, B.Z., Ahrens, B., Starcevic, B., Hatton, C.K., Green, G.A. and Finkelstein, J.S. (2000)Trace contamination of over-the-counter androstenedione and positive urine test results for a nandrolone metabolite. *Journal of the American Medical Association* **284,** 2618-2621.

De Silva, A., Samarasinghe,Y., Senanayake, D. and Lanerolle, P. (2010) Dietary supplement intake in National-level Sri Lankan athletes. *International Journal of Sport Nutrtion and Exercise Metabolism* **20,** 15-20.

Erdman, K.A., Fung, T.S. and Reimer, R.A. (2006) Influence of performance level on dietary supplementation in elite Canadian athletes. *Medicine and Science in Sports and Exercise* **38,** 349-356.

Erdman, K.A., Fung, T.S., Doyle-Baker, P.K., Verhoef, M.J. and Reimer, R.A. (2007) Dietary supplementation of high-performance Canadian athletes by age and gender. *Clinical Journal of Sport Medicine* **17,** 458-464.

Froiland, K., Koszewski, W., Hingst, J. and Kopecky, L. (2004) Nutritional supplement use among college athletes and their sources of information. *International Journal of Sport Nutrition and Exercise Metabolism* **14,** 104-120.

Haller, C.A. and Benowitz, N.L. (2000) Adverse cardiovascular and central nervous system events associated with dietary supplements containing ephedra alkaloids. *The New England Journal of Medicine* **343,** 1886-1887.

Huang, S.H., Johnson, K. and Pipe, AL. (2006) The use of dietary supplements and medications by Canadian athletes at the Atlanta and Sydney Olympic Games. *Clinical Journal of Sport Medicine* **16,** 27-33.

Jacobson, B.H., Sobonya, C. and Ransone, J. (2001) Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research* **15,** 63-68.

Krumbach, C.J., Ellis, D.R. and Driskell, J.A. (1999) A report of vitamin and mineral supplement use among university athletes in a division I institution. *International Journal of Sport Nutrition* **9,** 416-425.

Lazic, J.S., Dikic, N., Radivojevic, N., Mazic, S., Radovanovic, D., Mitrovic, N., Lazic, M., Zivanic, S. and Suzic, S. (2011) Dietary supplements and medications in elite sport-polypharmacy or real need? *Scandinavian Journal of Medicine and Science in Sports* 21(2), 260-267.

Morrow, J.D., El Mouelhi, M., Galinsky, R.E., Kovelesky, R., Noveck, R.J. and Preuss, C. (2005) American Society for Clinical Pharmacology and Theurapeutics position statement on dietary supplement safety and regulation. *Clinical Pharmacy Therapeutics* **77,** 113-121.

Nieman, D.C., Gates, J.R., Butler, J.V., Pollett, L.M., Dietrich, S.J. and Lutz, R.D. (1989) Supplementation patterns in marathon runner. *Journal of the American Dietetic Association* **89,** 1615-1619.

Pipe, A. and Ayotte, C. (2002) Nutritional supplements and doping. *Clinical Journal of Sport Medicine* **12,** 245-249.

Ronsen, O., Sundgot-Borgen, J. and Maehlum, S. (1999) Supplement use and nutritional habits in Norwegian elite athletes. *Scandinavian Journal of Medicine and Science in Sports* **9,** 280-235.

Slater, G., Tan, B. and The, K.C. (2003) Dietary supplementation practices of Singaporean athletes. *International Journal of Sport Nutrition and Exercise Metabolism* **13,** 320-332.

Sobal, J. and Marquart, L.F. (1994) Vitamin/mineral supplement use among athletes: a review of literature. *International Journal of Sport Nutrition* **4,** 320-334.

Schroder, H., Navarro, E., Mora, J., Seco, J., Torregrosa, J.M. and Tramullas, A. (2002) The type, amount, frequency and timing of dietary supplement use by elite players in the First Spanish Basketball League. *Journal of Sport Sciences* **20,** 353-358.

Sundgot-Borgen, J., Berglund, B. and Torstveit, M.K. (2003) Nutritional supplements in Norwegian elite athletes-impact of international ranking and advisors. *Scandinavian Journal of Medicine and Science in Sports* **13,** 18-144.

World Anti Doping Agency. (2007) The World anti doping code. Prohibited list: International standard. Avaliable from URL: http://www.wada-ama-org-rtecontent-document-200**.**

## Key points

- 37% of Mediterranean athletes of various sports and levels have reported taking dietary supplements.
- The performance level of the athletes affects the dietary supplementation intake.
- Athletes in individual sports appear to have a higher DS intake compared to team sport athletes.
- Male athletes appear to take more dietary supplements compared to female athletes.

## AUTHORS BIOGRAPHY

**Ifigenia GIANNOPOULOU**
**Employment**
National and Kapodistrian University of Athens
**Degree**
Lecturer, PhD
**Research interests**
Sport Nutrition, Clinical Exercise Physiology, Obesity and Type 2 Diabetes
**E-mail:** igiannop@phed.uoa.gr

**Kostantinos NOUTSOS**
**Employment**
National and Kapodistrian University of Athens
**Degree**
Lecturer, PhD
**E-mail:** knutsos@phed.uoa.gr

**Nikolaos APOSTOLIDIS**
**Employment**
National and Kapodistrian University of Athens
**Degree**
Associate Professor, PhD
**Research interests**
Sports Medicine
**E-mail:** napost@phed.uoa.gr

**Ioannis BAYIOS**
**Employment**
Professor, National and Kapodistrian University of Athens
**Degree**
PhD
**E-mail:** ibayios@phed.uoa.gr

**George P. NASSIS**
**Employment**
Lecturer, National and Kapodistrian University of Athens
**Degree**
MSc, PhD
**Research interests**
Football performance, exercise, obesity & insulin resistance
**E-mail:** gnassis@phed.uoa.gr

✉ **George P. Nassis**
Department of Sport Medicine and Biology of Exercise, Faculty of Physical Education and Sport Science, National and Kapodistrian University of Athens, Athens, Greece.