

Dietary Supplement Use Among Elite Young German Athletes

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Little is known about the prevalence and motives of supplement use among elite young athletes who compete on national and international levels. Therefore, the current survey was performed to assess information regarding the past and present use of dietary supplements among 164 elite young athletes (16.6 ± 3.0 years of age). A 5-page questionnaire was designed to assess their past and present (last 4 weeks) use of vitamins, minerals, carbohydrate, protein, and fat supplements; sport drinks; and other ergogenic aids. Furthermore, information about motives, sources of advice, supplement sources, and supplement contamination was assessed. Eighty percent of all athletes reported using at least 1 supplement, and the prevalence of use was significantly higher in older athletes ($p < .05$). Among supplement users, minerals, vitamins, sport drinks, energy drinks, and carbohydrates were most frequently consumed. Only a minority of the athletes declared that they used protein/amino acids, creatine, or other ergogenic aids. Major motives for supplement use were health related, whereas performance enhancement and recommendations by others were less frequently reported. Supplements were mainly obtained from parents or by athletes themselves and were mostly purchased in pharmacies, supermarkets, and health-food stores. Among all athletes, only 36% were aware of the problem of supplement contamination. The survey shows that supplement use is common and widespread among German elite young athletes. This stands in strong contrast to recommendations by leading sport organizations against supplement use by underage athletes.

Keywords: adolescent, nutrition, vitamins, minerals, prevalence, nutritional consulting

In the past years many studies have shown that the use of dietary supplements (DS) is widespread among athletes (Maughan, King, & Lea, 2004; Sobal & Marquart, 1994). It should be noted that the term *dietary supplement* is not used consistently among scientific publications; terms such as *nutritional supplement*, *nutritional ergogenic aid*, or *sports supplement* have also been used by authors in

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the same context. Apparently, there is no clear definition of supplements, which are explicitly used by athletes (Maughan, Depiessse, & Geyer, 2007).

According to the U.S. Food and Drug Administration, a DS is a product (other than tobacco) that is intended to supplement the diet and bears or contains one or more of the following dietary ingredients: a vitamin, a mineral, an herb or other botanical, an amino acid, a dietary substance for use by humans to supplement the diet by increasing its total daily intake, or a concentrate, metabolite, constituent, extract, or combination of these ingredients (Food and Drug Administration, 1995).

Despite the heterogeneous definition of the term *supplement*, it is indisputable that the prevalence of supplement use is far greater in athletes than in the general (sedentary) population (Sobal & Marquart, 1994; Sundgot-Borgen, Berglund, & Torstveit, 2003). Figures for elite athletes lie in the range of 44–100% use, strongly depending on age, sport, and level of competition (Erdman, Fung, & Reimer, 2006; Maughan et al., 2007; Sobal & Marquart; Striegel, Simon, Wurster, Niess, & Ulrich, 2006).

Generally, there is good evidence that DS use increases with age both in elite athletes (Maughan et al., 2007) and in the general population. Recently published data of the German National Nutrition Survey II showed that 16–19% of German adolescents (age 14–18) reported using supplements, and use among 18- to 24-year-old Germans was more common (21%) and increased further with age (Federal Research Center for Nutrition and Food, 2008).

To our knowledge, the supplementation practices of young German athletes have not been described in the literature so far. In young U.S. figure skaters (mean age: males 16.9 years, females 15.2 years) DS use was reported to be 65% for male and 76% for female athletes (Ziegler, Nelson, & Jonnalagadda, 2003). For British junior national track and field athletes the use of DS was documented to be 62% (Nieper, 2005). Even though a generalization of these results to other sports and other levels of competition might be critical, this study indicates that supplement use by young athletes seems to be lower than in adult athletes—a prevalence of 85% was reported for elite senior track and field athletes competing at international championships (Maughan et al., 2007).

When considering the supplement use of adolescent athletes, high school and college athletes have been studied to a far greater extent than elite athletes. Percentages of use have been reported to be 13–76% (Scofield & Unruh, 2006). This group is not comparable to elite young athletes who compete at national and international levels, however, because level of competition is considered a major indicator for supplement use (Erdman et al., 2006).

In general, performance enhancement, prevention of illness, behavior of teammates or opponents, and recommendations by influential individuals (such as coaches, friends, or family members) have been identified as the most important motives for supplement use in athletes (Sobal & Marquart, 1994).

To our knowledge, data on DS use among the unique group of elite young athletes is lacking. Understanding supplement-use patterns and motives is an important aspect for proper nutritional and medical education in potential future elite athletes.

Therefore, the major goal of the current study was to assess the prevalence of DS use among a wide spectrum of elite young German athletes with respect to

age, gender, and type of sport. Further objectives of the study were to identify the supplements used most frequently by the athletes and to assess motives and sources of recommendations, information, and products. In addition, the athletes were asked about their knowledge of the problem of contaminated supplements.

Methods

Study Population

A total of 228 athletes who participated in the monitoring program of the German Research Centre of Elite Sport between September 2006 and December 2007 were provided a questionnaire regarding their use of DS. The questionnaires were sent to the athletes by mail, along with other information, before a routine examination at the center. The monitoring program includes multidisciplinary testing and consulting of prospective athletes with the aim of improving individual performance in the area of psychology, aerobic and power performance, medicine, biomechanics, and nutrition.

Questionnaires were voluntarily returned by 181 athletes (79%). Because of incomplete data, 13 data sets were excluded before analysis. In addition, four questionnaires from athletes more than 25 years of age were omitted from the current analysis, resulting in a study-group size of 164 athletes. To explore age-related findings, we assigned the athletes to the following age groups: <15, 15–16, 17–18, and 19–25 years. There is no clear definition of *young athlete*; we used the age group 19–25 years because in some sports athletes are eligible for junior championships up to the age of 25. Written consent was obtained from all athletes participating in the program.

Body weight and body-fat percentage were assessed by bioelectric impedance after an overnight fast when athletes reported to the center for a medical examination. Daily practice was self-recorded by athletes in the week before the examination. Because of the large number of sports, athletes were divided into the following sport categories: endurance sports, racquet sports, ball sports, combat sports, and other sports. Participant characteristics and the distribution of sports can be found in Tables 1 and 2.

The performance level of each athlete was defined according to the classification of the corresponding sport federation, which is based on guidelines of the German Olympic Sports Confederation (Deutscher Sportbund, 2006). According to these guidelines, A-level athletes have achieved top-level positions at Olympic Games or world championships. B-level athletes display a considerable development of performance and are prospective candidates for A level. C level includes the highest national level for prospective young athletes who exhibit a potential to perform at international top level or who participate successfully at international junior competitions. D/C- and D-level athletes are long-term prospective young athletes, usually under 17 years of age, who are organized at national (D/C) or regional level (D) but train at regional level. Among the 164 participating athletes, the vast majority were D- ($n = 47$), D/C- (39), and C-level (28) athletes. Only a small number of B- (16) and A-level (7) athletes were included in the analysis. Twenty-seven athletes were not categorized into these performance levels by their sport federation.

Table 1 Anthropometric Characteristics and Average Training of the Participants

Age group	Gender	n	Age (years)	Weight (kg)	Height (cm)	Body-mass index (kg/m ²)	Body fat (%)	Practice (min/day)
10-14	male	17	13.3 ± 0.9	59.9 ± 17.3	170.8 ± 11.2	20.2 ± 4.1	10.3 ± 5.3	82.3 ± 42.3
	female	19	13.3 ± 0.9	57.1 ± 11.4	167.8 ± 10.1	20.0 ± 2.2	17.9 ± 5.1	134.8 ± 86.4
15-16	male	31	15.6 ± 0.5	72.5 ± 14.3	181.3 ± 9.2	21.9 ± 3.4	10.3 ± 6.0	97.3 ± 52.1
	female	31	15.4 ± 0.5	58.1 ± 6.5	167.5 ± 6.9	20.7 ± 2.2	17.1 ± 5.3	93.3 ± 55.2
17-18	male	16	17.2 ± 0.4	74.6 ± 8.8	184.6 ± 7.5	21.9 ± 1.9	8.7 ± 2.9	86.1 ± 37.0
	female	16	17.3 ± 0.5	64.2 ± 9.1	173.1 ± 5.9	21.3 ± 1.9	18.2 ± 5.1	83.8 ± 40.1
>18	male	13	21.4 ± 2.1	73.8 ± 11.2	182.3 ± 7.0	22.1 ± 2.0	10.1 ± 4.8	97.0 ± 51.3
	female	21	21.7 ± 2.0	67.0 ± 7.2	176.2 ± 8.2	21.5 ± 1.4	19.0 ± 3.1	92.4 ± 48.6
Overall		164	16.6 ± 3.0	65.5 ± 12.8	175.0 ± 10.4	21.1 ± 2.6	14.2 ± 6.3	96.3 ± 55.1

Table 2 Distribution of Sports Among the Sport Categories

Endurance sports	47	Racquet sports	32	Ball sports	33	Combat sports	23	Other sports	29
Canoeing	15	Tennis	15	Handball	11	Judo	11	Track and field	7
Swimming	9	Badminton	12	Basketball	10	Taekwondo	6	Fencing	6
Nordic combined	8	Table tennis	5	Football/Soccer	10	Boxing	3	Luge	6
Biathlon	7			Volleyball	2	Wrestling	3	Archery	3
Triathlon	4							Horse riding	3
Rowing	3							Skeleton	2
Mountain biking	1							Diving	1
								Pentathlon	1

Questionnaire

A closed-ended 5-page questionnaire was designed to assess the past and present use of dietary supplements, sport drinks and foods, and other ergogenic aids.

If a specific supplement had been used within 4 weeks before filling out the survey, the athletes were asked to record the frequency of use (ranging from one or two times per month up to daily).

The listed supplements included vitamins (specific vitamins and multivitamin combinations), minerals (specific minerals and multimineral combinations), carbohydrate preparations, protein/amino acid preparations, specific fatty-acid preparations, sport beverages, other ergogenic aids, isolated compounds, and plant extracts. In addition, athletes were provided space to list supplements that they could not classify. When necessary, these supplements were classified by experienced nutritionists during data digitization. In a separate question, athletes were specifically asked whether they had ever consumed supplements.

Furthermore, information about motives, advice, supplement sources, and knowledge of supplement contamination was assessed using closed-ended questions. To answer these questions, athletes were allowed to choose multiple options.

To test for understandability and applicability of the questionnaire, a draft version was given out to 32 students of the German Sport University before we distributed the questionnaire to the athletes in our study.

Statistical Analysis

After digitization of the data, statistical analysis was performed with R software (version 2.5.1). Analyses were calculated for all participants, age groups, and sport categories and both genders separately. Associations between age, gender, sport group, and motives and supplement use were assessed by chi-square (χ^2) test. Anthropometric differences between users and nonusers were assessed with one-way analysis of variance (ANOVA). Associations and differences were considered statistically significant if the probability of error was smaller than .05. All data are presented as frequency (in percent) or as $M \pm SD$.

Results

In total, 131 participants (80% of all athletes who filled out the questionnaire) reported using or having used DS. Supplement use did significantly differ between age groups ($p < .05$) and was highest in athletes more than 18 years of age (Figure 1 top). Because an athlete's level of performance strongly depends on the athlete's age, the prevalence of DS use was highest in A- and B-level athletes (100%) and lower for C- (72%), D/C- (79%), and D-level athletes (81%).

There was no significant difference between sport groups ($p = .53$; Figure 1 bottom) even though prevalence was lowest in racquet sports (70%). Athletes from racquet sports tended to be younger, however, than other athletes ($p = .1$). There were no significant differences in body composition and average practice time between users and nonusers (data not shown).

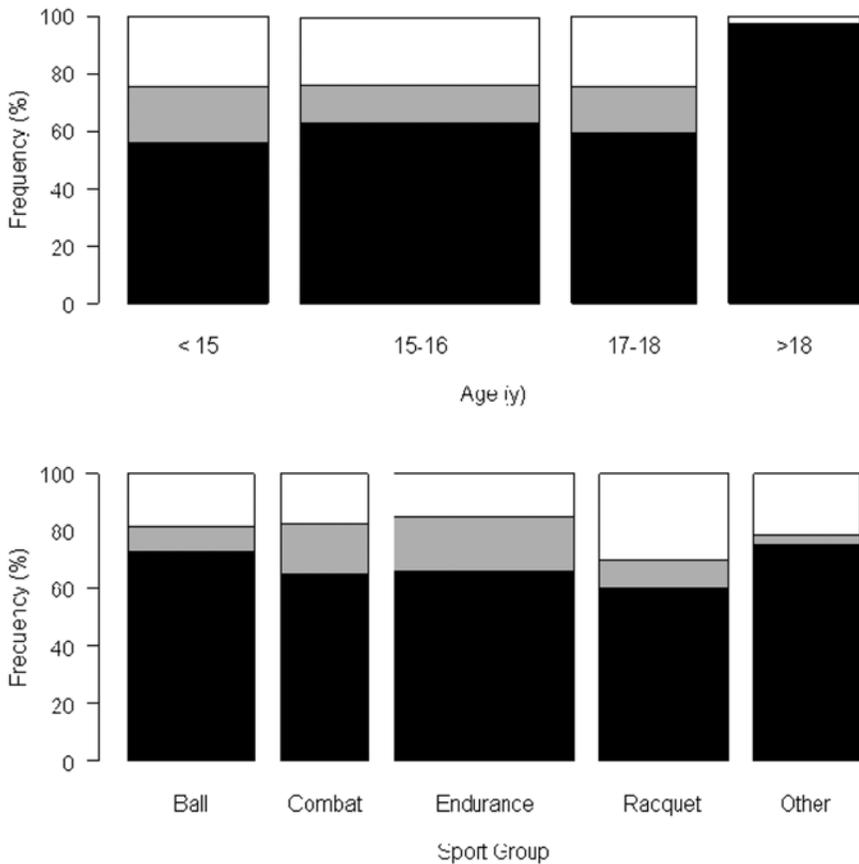


Figure 1 — Prevalence of dietary supplement use among German elite young athletes by age (top) and sport group (bottom). Black areas indicate supplement use at the time of the questionnaire, gray areas refer to athletes who reported to use supplements generally but did not at the time of the questionnaire, and white areas represent athletes using no supplements. The width of the boxes indicates relative group size.

Minerals (87%), vitamins (76%), sport beverages (69%), and carbohydrate preparations (64%) were most frequently taken by DS users, whereas the use of protein/amino acid products (30%), ergogenic aids (24%), fatty-acid preparations (6%), and other supplements (27%) was less widespread. For detailed distribution of specific substances, please refer to Table 3.

The use of protein products was greater in male than in female athletes (42% vs. 20% of male vs. female athletes using DS) but failed to reach statistical significance ($p = .07$). Regarding the use of all other supplements, there were no significant differences between genders (data not shown).

Only a small number of athletes (12%) reported that they generally used supplements but did not at the time of completing the questionnaire; a total of 111

Table 3 Distribution of Supplements Used by Elite Young German Athletes (*N* = 164)

Minerals	114	Vitamins	100	Sport beverages	90	Carbohydrates	84
Magnesium	85	Vitamin C	77	Sport drinks	87	Glucose/Grape sugar	68
Iron	56	Multivitamins	67	Energy drinks	41	Bars	28
Calcium	55	Mineral-vitamin combinations	42	Other drinks	7	Powders	19
Mineral-vitamin combinations	42	Vitamin E	20			Fructose	16
Selenium	15	Folic Acid	15			Gels	14
Multiminerals	13	Vitamin B12	18			Carbohydrate-protein combinations	10
Iodine	9	Vitamin B1	15			Other carbohydrates	3
Other minerals	3	Vitamin B6	14				
		Vitamin A	13				
		Other vitamins	4				
Proteins/Amino acids	39	Ergogenic aids	31	Fatty acids	8	Other supplements	35
Protein drinks	31	Caffeine	22	Omega-3 fatty acids	7	Concentrates (fruits/vegetables)	22
Protein bars	13	Carnithine	8	Other fatty acids	2	Gelatin	9
Carbohydrate-protein combinations	10	Creatine	8	Medium-chain triglycerides	1	Secondary plant sterols	5
Specific amino acids	4	Acid-base preparations	7			Ubiquinone (Q10)	3
						Extracts (fruits/vegetables)	2
						Other (not specified)	4

athletes (68%) admitted to having consumed at least one DS within the preceding 4 weeks. On average, those athletes were taking three (median) different supplements (range 1–17). The number of different supplements used at the time of the questionnaire increased significantly with age ($p < .05$).

Among athletes who used or had used supplements, 63% stated that they did so for health-related reasons (“maintenance of health,” 44%; “improvement of immune functions,” 34%; “prevention,” 27%). Performance-related reasons were cited by only 43% of users (“regeneration,” 35%; “improving performance,” 27%). Twenty-one percent of the athletes reported using supplements because it was recommended by others.

Athletes who cited performance-related reasons had been using significantly more protein ($p < .001$) and carbohydrate ($p < .05$) products. Athletes stating health-related reasons tended to use vitamins more frequently ($p < .05$).

Major sources of recommendations and information were family (34%), coaches (26%), physicians (24%), physical therapists (11%), and pharmacists (9%). Only 9 young athletes (7%) were documented to use DS based on self-obtained information.

Consequently, products were acquired from parents (39%) or by the athletes themselves (32%), whereas other sources such as physicians (14%), coaches (11%), and others were used only by a small group of athletes. The supplements were purchased mainly in pharmacies (56%), supermarkets (17%), and health-food stores (15%).

Among the athletes who filled out the questionnaire, only 36% were aware of the problem of supplement contamination. Awareness of this problem significantly increased with age ($p < .05$), however. Only 34% of the athletes unaware of the problem stated that they would like to receive information on the subject.

Discussion

To our knowledge, this was the first study designed to systematically assess DS use among the unique group of young athletes, who compete at national and international level and who can therefore be considered to be among the elite athletes of their age group. The current data demonstrate that supplement use is very common among elite young German athletes, even at the ages of 11–14 years.

As expected, the prevalence of use (80% of all athletes had used DS, 67% were using DS at the time of the study) was much greater in athletes than in the general German population (16–24% for those 14–24 years of age (Federal Research Center for Nutrition and Food, 2008). In American high school athletes, prevalence of supplement use was reported to be only 22% (Schofield & Unruh, 2006). Most likely this remarkable difference is a result of the higher level of competition of the athletes in the current study—previous reports identified level of competition to be a major determining factor of supplement use (Erdman et al., 2006).

With respect to the high performance level, the current figures are partly comparable to results from 32 British junior track and field athletes (prevalence 62%; Nieper, 2005) and Singaporean athletes (prevalence 77%). In contrast to the latter study, which did not find an association of DS use with age (Slater, Tan, & The, 2003), our data clearly show that both the prevalence of use and the number of supplements taken increase with age.

The high prevalence of DS use might be attributed to the very unconstrained definition of the term *dietary supplement*. Even though the inclusion of sport drinks, energy bars, and meal replacements is in agreement with other authors (Maughan et al., 2007), special items such as energy drinks and grape sugar are not necessarily sport-specific products. On the other hand, despite our inclusion of these products, the supplements most frequently used were minerals and vitamins, which have also been reported by other investigators (Corrigan & Kazlauskas, 2003; Sobal & Marquart, 1994) to be very popular among athletes.

In the current study, male athletes were more likely than female athletes to use protein preparations. Even though this effect failed to reach statistical significance, this is in agreement with other studies (Slater et al., 2003; Sundgot Borgen et al., 2003). There were no associations, however, between gender and use of other supplements such as iron and creatine, which have been reported previously (Petroczi & Naughton, 2008; Slater et al.).

With regard to the athletes who reported using caffeine (17% among DS users), one must consider that there was no distinction made between caffeine supplements and caffeine-containing foods (coffee, tea, cola beverages, etc.) in the questionnaire. Therefore, this number might not be representative of actual caffeine-supplement consumption.

The high prevalence rate among our athletes is not in agreement with scientific evidence on positive effects of DS, which is lacking for most supplements with respect to exercise performance (Maughan et al., 2007). Even though it has been established that there is limited congruency between supplement use and motives in athletes (Petroczi, Naughton, Mazanov, Holloway, & Bingham, 2007), our data are consistent with other studies identifying health concerns as a major motive for supplement use in athletes (Nieper, 2005; Slater et al., 2003; Sobal & Marquart, 1994).

Despite the fact that there is some evidence in the general population that supplement users display more favorable levels of disease-related biomarkers (Block et al., 2007), one should consider that other health-related factors such as lifestyle, dietary habits, and exercise might be strongly associated with supplement use. Among athletes, available data indicate that DS does not generally affect the hematological status of well-nourished individuals (Bazzarre et al., 1993).

Besides the lack of positive effects, there are also potential risks associated with the use of DS, especially for young athletes. For most substances, the general safety of supplementation has not been evaluated to a satisfying extent in adolescents (Maughan et al., 2007; Metz, Small, Levine, & Gershel, 2001). More important, data from the NIH-AARP Diet and Health Study show that under some circumstances multivitamin use might have harmful consequences (Lawson et al., 2007). In addition, the problem of supplement contamination has been well described (Geyer et al., 2004). Only a minority of the athletes participating in our survey (36%) were aware of this problem, however. This result leads to the assumption that coaches, physicians, and parents, as main sources of information for young athletes, are also not adequately informed on this topic.

Major motives for supplement use among elite young German athletes were health and performance related. This might indicate that the athletes do not believe that their diet is an appropriate source of nutrients to maintain health and exercise performance even at young ages.

The generally high prevalence of, as well as the motives for, supplement use stands in strong contrast to recommendations by leading sport organizations (American College of Sports Medicine, American Dietetic Association, & Dietitians of Canada, 2000; Fédération Internationale de Football, 2006; International Olympic Committee, 2003). According to a consensus statement by the International Association of Athletics Federations, supplements should not be used by underage athletes or when dietary nutrient intake is sufficient (Maughan et al., 2007).

In this context, one should also consider that young elite athletes are apparently not well educated about nutrition. Among a comparable group of participants visiting our center, only 18% of the athletes had experience with individual nutritional consulting (Braun et al., unpublished). This is in contrast to the recommendation that “athletes should ensure they have a good diet before contemplating supplement use” (Maughan et al., 2007, p. S111).

With respect to use of DS, family, coaches, and physicians were identified as the most influential individuals for elite young athletes. For nutritional and health-oriented education of athletes, this group has to be accounted for.

Based on the current results and with respect to recent recommendations, we suggest that

- Athletes should be better educated about the risks (and benefits) of supplements.
- Parents, coaches, physicians, and other staff members should be elucidated about the use of supplements.
- Nutritional education and consulting should be made available to more athletes.
- These aspects should be considered specifically for athletes 10–14 years of age, because our study showed a high prevalence of DS use (75%) even in this group.

In conclusion, the current study provides informative insight into supplement use by young elite athletes. Both the very high prevalence of use among all age groups and the rationale for supplement use strongly contradict scientifically based recommendations. Even though current data indicate that young elite athletes use DS to a similar extent as senior elite athletes, future research is needed to assess supplement use in combination with athletes’ nutrition status in a larger group of athletes.

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