

Review article

## Supplement use by young athletes

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### Abstract

This paper reviews studies of supplement use among child and adolescent athletes, focusing on prevalence and type of supplement use, as well as gender comparisons. Supplement use among adult athletes has been well documented however there are a limited number of studies investigating supplement use by child and adolescent athletes. A trend in the current literature revealed that the most frequently used supplements are in the form of vitamin and minerals. While health and illness prevention are the main reasons for taking supplements, enhanced athletic performance was also reported as a strong motivating factor. Generally, females are found to use supplements more frequently and are associated with reasons of health, recovery, and replacing an inadequate diet. Males are more likely to report taking supplements for enhanced performance. Both genders equally rated increased energy as another reason for engaging in supplement use. Many dietary supplements are highly accessible to young athletes and they are particularly vulnerable to pressures from the media and the prospect of playing sport at increasingly elite levels. Future research should provide more direct evidence regarding any physiological side effects of taking supplements, as well as the exact vitamin and mineral requirements for child and adolescent athletes. Increased education for young athletes regarding supplement use, parents and coaches should be targeted to help the athletes make the appropriate choices.

**Key words:** Nutrition, sport, adolescent athletes, dietary supplement.

### Introduction

Nutrition is an important aspect of an athlete's training program. Although exercise and athletic training is considered to increase nutrient needs in some athletes, a balanced diet with adequate calories can potentially provide the necessary nutrients (American Dietetic Association, 2000; Maughan et al., 2004). It is likely, however, that for various reasons, not all athletes are able to consume a diet that meets their nutritional needs and thus resort to nutritional supplements with the intention of preventing deficiencies and even enhancing performance (Maughan et al., 2004).

Today, the supplement industry is an international market worth billions of dollars. In 2000, it was reported that sales of dietary supplements in the US reached US\$17.1 billion with an annual increase in consumer spending of more than 10% (Food and Drug Administration, 2002). Although many individuals use supplements, those engaged in sport and physical activity represent a substantial portion of the population purchasing supplements (Maughan et al., 2004).

A past review of supplement use among athletes was conducted by Sobal and Marquart (1994a), which analyzed literature, published primarily in the 1980's. With the supplement market being what it is today, supplements are readily available to athletes and are more accepted within the athletic culture, thus investigation into current supplementation behaviours is warranted. This review will look at the current literature on supplement use among young athletes, a population particularly vulnerable to the hype and claims put forth by the supplement industry.

### Prevalence of supplement use

First, to place the current paediatric literature into context it is necessary to briefly summarise the adult literature. A major area of the adult research literature regarding athlete supplement use focuses on athletes at the university or college level, thus involving athletes over the age of 18 and adult athletes (Froiland et al., 2004; Kristiansen et al., 2005; Sobal and Marquart, 1994a). A study involving athletes attending a US Division I university revealed that 89% of the subjects had used supplements or were using supplements at the time the study took place (Froiland et al., 2004). Another study involving US NCAA Division I university student athletes found that 88% of respondents consumed at least one nutritional supplement and 58% used two or more supplements (Burns et al., 2004). Additionally, Canadian varsity athletes (94.3%) have been found to use one or more supplements at least once per month (Kristiansen et al., 2005).

Supplement use among elite athletes is well documented, as a high percentage of Canadian Olympic athletes were found to consume dietary supplements at the Atlanta (69%) and Sydney (74%) Olympic Games (Huang et al., 2006), 77% Singaporean elite athletes reported consuming dietary supplements (Slater et al., 2003), and a high prevalence of supplement use was found among competitive athletes (53%) in the United Kingdom (Airstone et al., 2005). The population reported to most frequently engage in supplementation is elite athletes who compete at national, international, and Olympic levels (Sobal and Marquart, 1994a). For example, Erdman et al., (2006) found that 88.4% of Canadian elite athletes competing at the provincial, varsity, national, North American, and international/professional levels reported taking one or more dietary supplements. All levels of athletes engaged in supplement use more frequently during the training phase, however athletes competing at the international/professional level reported using supplements most frequently during both training

**Table 1. Prevalence of dietary supplement use in young athletes**

Author, year	N	Age (yrs)	Prevalence	3 Most Common Supplements (%)
Sobal and Marquart, 1994	742	High School students	38%	Vitamin C (25) Multivitamins (19) Iron (11)
Kim and Keen, 1999	1,355	16-19	35.8%	Vitamin C (41.2) Multivitamins (27) Calcium (10.7)
O'Dea, 2003	78	11-18	n/a	Sports drinks (56.4) Vitamin/minerals (48.7) Energy drinks (42.3)
Ziegler et al., 2003	105	16	71%	Multivitamin/mineral (M-61, F 83) Herbals (M-44, F-48) Multivitamin only ( F-42) Protein bars (M-38)
Bell et al., 2004	333	13-19	n/a	Multivitamin/minerals (42.5) Protein (13.5) Energizers (6)
Nieper, 2005	32	18	62%	Multivitamins (45) Vitamin C (35) Iron (30)
Scofield and Unruh, 2006	139	14-19	22.3%	Meal replacement protein (23.7) Vitamin-minerals (19.4) Creatine (16)

(98.3%) and competition (87.1%) while provincial-level athletes used supplements least frequently during both training (89.6%) and competition (73.6%) (Erdman et al., 2006).

Prevalence of supplement use among young athletes is not as clearly documented as the adult and elite athlete literature. There are a limited number of recent studies conducted in the 1990's and 2000's investigating supplement use by child and adolescent athletes though the same issues also appear to be pertinent to this younger age group. Investigating this particular population is important as studies show that supplement uses amongst the child and adolescent athlete population is widespread (see Table 1).

Sample sizes used in the reviewed studies varied substantially from 32 to 1,355 and the prevalence of supplement use among child and adolescent athletes ranged from 22.3% to 71% (Table 1). With the exception of the Scofield and Unruh (2006) study, the larger studies found a lower prevalence rate than the studies with the smaller sample sizes. This substantial difference could be the result of the inconsistent methodologies of the studies thus implying that the prevalence rate may not be as high as anticipated. Two studies (O'Dea, 2003; Bell et al., 2004) did not look at the overall prevalence of supplement use and instead focused only on the use of individual supplements, thus narrowing still the amount of available data on overall prevalence rates of supplementation practices in young athletes.

Variation also occurred among the ages of the participants included in the studies. Although the focus was on 'young' athletes, five studies examined a range of ages (Kim and Keen, 1999; O'Dea, 2003; Scofield and Unruh, 2006; Sobal and Marquart, 1994a) while two studies focused only on a single age (Nieper, 2005; Ziegler et al., 2003). Studies also differed in the actual ages included in the studies; one included subjects as young as 11 years (O'Dea, 2003), others included athletes aged 19 years, and another investigated high school athletes, reporting

grade levels but not actual ages (Sobal and Marquart, 1994b) (Table 1). A few recent studies of elite athletes have included young athletes in the population sample, however with the exception of Slater et al. (2003), the ages included in the studies did not distinguish between the age groups thus it was not possible to determine the prevalence of supplement use by the young athletes in the sample. Slater et al. (2003), on the other hand, found that 77% of respondents used dietary supplements within the year previous to the study, however, no difference was found in relation to age and 53.8% of respondents were under the age of 20 (Slater et al., 2003).

Such a variance in age could affect the results, as the older athletes may have more access to supplements and may be more exposed to supplement use. Dietary intakes of younger athletes are most likely to be monitored by a parents or guardian and therefore they would have less freedom to engage in supplement use compared to older athletes who would have more opportunity to engage in unsupervised supplement use. The older adolescent athletes may be pressured by their peers and team mates to use supplements, and would have easier access to supplements than their younger counterparts. On the other hand, one study found that young athletes reported taking supplement because their mothers gave them to them (O'Dea, 2003) thus suggesting that younger athletes might have little control over their supplement intake.

The level of competition the subjects engaged in differed and thus could have had an effect on the prevalence of supplement use. Five studies (Kim and Keen, 1999; Metz et al., 2001; O'Dea, 2003; Scofield and Unruh, 2006; Sobal and Marquart, 1994b) investigated supplement use among high school athletes, one study (Bell et al., 2004) focused on students enrolled in health and wellness classes, and two studies (Nieper, 2005; Ziegler, et al., 2003) focused on elite-level athletes. Some studies covered a wide scope of sports, especially those focusing on high school athletes, where others examined athletes of particular sports, such as track and field

**Table 2. Prevalence of most commonly used vitamin/mineral supplements.**

Author, year	N	Multi-vit and mineral	Multi-vit (%)	Multi-mineral (%)	Vit C (%)	Iron (%)	Ca	Vit A	B Vits	Vit E
Sobal and Marquart, 1994b	742	-	19	-	25	11	9	9	8	8
Kim and Keen, 1999*	1,355	3.1	27	-	41.2	9.5	10.7	4	2.8	1.2
O'Dea, 2003	78	47.8	-	-	-	-	-	-	-	-
Ziegler et al., 2003	105	61(M), 83 (F)	33 (M), 42 (F)	8 (M), 21 (F)	-	-	-	-	-	-
Bell et al., 2004	333	42.5	-	-	-	-	-	-	-	-
Nieper, 2005	32	-	45	-	35	30	-	-	-	-
Scotfield and Unruh, 2006	139	19.4	-	-	-	-	-	-	-	-

(Nieper, 2005) and figure skating (Ziegler et al., 2003).

There is also diversity in the type of sport, which the various participants were engaged in. Athletes involved in multisports (2 or more sports) tend to engage in supplement use more frequently than athletes involved in a single sport (Scotfield and Unruh, 2006). Two studies included athletes from only specific sports (Ziegler et al., 2003; Nieper, 2005), while others explored supplement use across a range of sports. Supplement use among particular sports, mainly those requiring athletes to 'make weight' or the more aesthetic sports is also more prevalent. Sobal and Marquart (1994b) found that wrestlers (59%) were more likely to use supplements than others such as softball, hockey, and golf players (each 50%) with gymnasts not far behind (40%).

Also, most studies used questionnaires to investigate supplement use, however, one study (O'Dea, 2003) used focus groups and another study (Ziegler et al., 2003) used anthropometric measures and food records, as well as questionnaires.

### Types of supplements used

Despite these methodological variances a trend emerged which revealed that the most frequently used supplement among young athletes is a form of vitamin/mineral supplement. Studies investigating only vitamin and mineral supplementation (Sobal and Marquart, 1994b; Kim and Keen, 1999) found the most frequent forms of vitamin/minerals consumed tend to be vitamin C, multivitamins, iron, and calcium (see Table 2). These results coincide with a more recent study which also included a range of what were termed 'ergogenic aids' such as Creatine and caffeine, and again, the most commonly used supplements by adolescent athletes were multivitamins, vitamin C, and iron (Nieper, 2005).

The supplement list included in the reviewed studies differed however vitamin/mineral supplements were consistently one of the most frequently used supplements. A study of adolescent athletes (Bell et al., 2004) investigated the use of several supplements which are readily accessible to adolescents found that in addition to vitamins and minerals, protein (14%), energizers (6%), and Creatine (5%) were also consumed. Contradicting these findings are results from another study (O'Dea, 2003) in which the most frequently used nutritional supplement was sports drinks (56%), with vitamin/mineral tablets second (49%), followed by energy drinks (42%), herbal supplements (18%), guarana and creatine (5%), high

protein milk supplements (4%), and coenzyme Q<sub>10</sub> (1%). Ziegler et al. (2003) also found multivitamin/minerals to be the most popular supplement by both male (61%) and female (83%) adolescent athletes. To specifically investigate creatine use among young athletes, Metzler et al. (2001) surveyed middle and high school athletes aged 10 to 18 years and found that 62% reported using Creatine. This usage is despite recommendations for athletes under the age of 18 not to consume it or any performance-enhancing substance (American Academy of Pediatrics, 2005).

Although the risks associated with vitamin and mineral supplementation are not as severe as the risks involved with using ergogenic aids such as steroids, amphetamines, and human growth hormone, young athletes could potentially start out using vitamin and mineral supplements, then progress to more dangerous substances (Sobal and Marquart, 1994b). Many dietary or nutritional supplements have the reputation of being harmless because they consist mainly of naturally occurring compounds and tend to be advertised as safe and legal performance-enhancing substances as opposed to the banned substances such as anabolic steroids. Unfortunately, despite their seemingly 'natural' composition, not all supplements are tested by the Food and Drug Administration (FDA) therefore claims of safety and reliability cannot be trusted (Metzler et al., 2001). The effects and dosage recommendations of supplements are also not regulated so there is no guarantee that they will provide the alleged outcome (Clarkson et al., 2002). Furthermore, taking single vitamins and minerals is potentially harmful, as large doses can lead to toxicity and interactions with other nutrients (Kim and Keen, 1999; Maughan et al., 2004; Sobal and Herbert, 1988).

### Reasons for supplementation

With the use of supplements increasing amongst the child and adolescent athlete population, it is important to investigate the reasons for the athletes adopting this behaviour. Burns et al. (2004) found that adult athletes reported using vitamin and mineral supplements frequently and considered them to have the highest impact on healing/rehabilitation, while protein supplements and Creatine were considered to have the highest perceived impact on sport performance. Other reasons for supplement use cited by adult and elite athletes include increased energy, enhanced performance, improved health, prevention of nutritional deficiencies, prevention of illness, increased

**Table 3. Prevalence of supplement use of male vs. female adolescent athletes.**

Author	N (Total)		N (Users)		Prevalence (%) of Use	
	M	F	M	F	M	F
Ziegler et al., 2003	46	59	30	45	65	76
Nieper, 2005	20	12	11	9	55	75
Schofield and Unruh, 2006	99	34	28	2	28	6

muscle mass, and improved recovery (Erdman, et al., 2006; Froiland, et al., 2004; Kristiansen, et al., 2005; Slater et al., 2003).

In the child and adolescent athlete literature, the reasons for supplementation are similar. High school athletes have reported growth (48%), illness prevention (44%), illness treatment (37%), enhanced performance (31%), tiredness (28%), and muscle development (28%) as the important reasons for consuming supplements (Sobal and Marquart, 1994b).

Nieper (2005) found that the primary reasons for UK junior national track and field athletes to consume supplements included health (45%), immune system (40%), and performance (25%). Enhancement of athletic performance is certainly on the minds of adolescent athletes, as a study conducted by Perko et al. (2000) found that adolescent athletes agreed that most athletes their age need dietary supplements a) to improve sports performance (17.7%), b) taking dietary supplements would help all athletes perform better (27.4%), c) taking supplements is a safe way to improve sports performance (32.7%), d) that supplements give you more energy (41%), and e) taking supplements is a good way to build muscle (44.8%).

The influence of elite and professional athletes engaging in supplement use cannot be ignored. Highly publicized accounts of athletes, who are idolized by children and adolescents, using supplements and ergogenic aids may glamorize supplement use and encourage young athletes to mimic their actions (Calfee and Fadale, 2006).

Young athletes are under great pressure to attain increasingly higher levels in sport, thus they may be enticed to seek alternative means to be able play at elite levels or to be noticed by professional scouts. The high economic value and social status of a professional athletic career may lure young athletes to engage in supplement use as a means for developing the competitive edge to 'make it' as a professional sports person (Calfee and Fadale, 2006).

The desire to play sport at the varsity or collegiate level is another justification for young athletes to engage in supplement use. Athletes expecting to play sports after secondary school are more likely to take dietary supplements (Sobal and Marquart, 1994b). In North America, playing sport at the university or college level comes at a high financial cost thus the quest to secure and maintain an athletic scholarship may be another motivator for using performance-enhancing substances (Calfee and Fadale, 2006). This may also become a factor in the UK, as universities are beginning to offer sports scholarships to attract and retain skilled athletes.

### Gender comparisons

Supplement use tends to differ across genders for preva-

lence of use, types of supplements used, as well as reasons for use. Specific gender comparisons are largely confined to three of the reviewed studies, which explored the percentages of males and females using supplements. It was found that females engage in supplement use more frequently than their male counterparts which was consistent with the trend observed in previous reviews of the literature (Sobal and Marquart, 1994a; Sobal and Muncie, 1988) however in the current review, one study (Schofield and Unruh, 2006) found conflicting results (see Table 3). The other four original studies included in this review either accounted for gender differences only in particular aspects of data analysis (Kim and Keen, 1999; Perko et al., 2000; O'Dea, 2003; Sobal and Marquart, 1994b), or compared genders for individual supplements (Bell et al., 2004), not overall use.

In terms of reasons for supplement use, males tend to put more emphasis on the athletic performance-enhancing effects of supplements where as females tend to be more concerned with the health benefits (Slater et al., 2003; Sobal and Marquart, 1994b). Nieper (2005) confirmed this by revealing that female UK junior national track and field athletes reported taking supplements for health issues (33%) and strengthening the immune system (44%) with performance and strength (both 11%) reported as less important. The primary reason males consumed supplements was to improve performance (36%) and males (45%) consumed 'ergogenic aids' (defined as Creatine and caffeine) more often than females (11%).

Zeigler et al. (2003) found that male and female elite figure skaters differed considerably in terms of their motivation for consuming supplements. Females used supplements to prevent illness (61%), increase energy (39%), and make up for an inadequate diet (28%). Males used supplements to increase energy (41%), prevent illness (34%), and enhance performance (21%). This is evident in the types of supplements used most frequently used by each gender. Females consumed multivitamin/mineral supplements most frequently (83%), followed by herbal supplements (48%), and multivitamin-only supplements (42%). These supplements could be categorized as health-related supplements, where males also used multivitamin/mineral (61%) and herbal supplements (44%), they were taken less frequently, and instead, males consumed protein bars (38%), protein powders (15%), amino acid powders (8%), and Creatine (3%) more frequently than their female counterparts, confirming that males tend to use supplements claiming a more ergogenic effect. The only exception to this is that females (35%) consumed energy drinks and bars slightly more frequently than males (33%).

### Critique of literature and future research directions



Several limitations should be acknowledged whilst conducting this review of the supplement use literature. Most studies included in this review used a form of questionnaire to assess supplement use among athletes, however, one study (O'Dea, 2003) used focus groups, and another (Ziegler et al., 2003) used a combination of questionnaire and other anthropometric measurements. The questionnaires used were different, and although addressing similar matters, subtle differences could affect the overall results.

Another issue in reviewing the literature is that different studies investigated the use of different supplements in the questionnaires. For example, some included sports drinks, energy drinks, caffeine, herbal supplements while others included a few supplements, while others still focused only on vitamin and mineral supplements. To achieve an accurate account of the prevalence and frequency of use of all types of supplements, studies should incorporate a more uniform method of examining supplement use which would include a uniform categorization of supplements, as well as a standardized list of the types of supplements to include in the analysis to enable direct comparisons between the findings of various studies. This process would allow researchers to obtain a more complete interpretation of the current usage of supplements among the young athlete population.

Further research is needed regarding the effects of high toxicity levels of vitamins/minerals in adolescents, as they are the most frequently consumed supplement by the population. The nutritional component of the young athlete's training program is especially crucial as there are many connections between nutritional deficiencies, growth, development, athletic performance, and injury prevention (Petrie et al., 2004). A major concern for health professionals and the sporting community is that the effects of supplement use on the growth and development of children and adolescents are unclear. Minimal experimental research exists regarding the performance-enhancing qualities or adverse effects of ergogenic substances focusing exclusively on adolescent athletes under the age of 18 (American Academy of Pediatrics, 2005). Many physiological changes are occurring during these developmental stages thus making it difficult to fully understand the physiological implications of regular consumption of supplements by this age group (Calfee and Fadale, 2006). More direct evidence is also needed regarding potential physiological side effects of taking any type of supplement.

Another area requiring further research is the exact vitamin and mineral requirements of child and adolescent athletes. Most of the research currently available shows that athletes tend to have a greater food intake that negates any increased need for vitamins and minerals. The

majority of these studies are however, citing results of studies conducted in the 1980's and 1990's. More current empirical evidence would be beneficial, as although in theory, the diets of athletes should be better and more complete than their non-athletic counterparts, this cannot be assumed. It is quite possible that the diets of athletes are not supporting the increased requirements for vitamins and minerals. Nutrition knowledge of adolescent athletes has been found to be inadequate and laden

with misconceptions regarding the nutritional requirements for maximal sport performance, and thus their dietary habits tend to be poor (Reading et al., 1999).

To further investigate the factors influencing athletes to engage in supplement use, it may be beneficial to explore the link between health and athletic performance. Although research has demonstrated that enhancement of sport performance is a primary reason for supplementation, overall health concerns also emerged as a key motivator, especially for females, and was often more prominent than sport performance (Kim and Keen, 1999; Sobal and Marquart, 1994b). Vitamins and minerals are considered a nutritional supplement, however, it is possible that athletes, who are generally concerned about their health and aware of the impact optimal health has on athletic performance, view vitamins and minerals as more of a pharmaceutical or medicine than a supplement. Since vitamin and mineral use is so prevalent among athletes, it is likely that there is a misunderstanding as to the role of vitamins and minerals in the diet, their function in maintaining overall health, their role in athletic performance, and how they are best obtained from the diet. Athletes want to be as healthy as possible and tend to consume vitamins and minerals to maintain health rather than boost performance therefore it may be advantageous to determine a different approach to studying and addressing vitamin and mineral use by athletes.

## Conclusions

In conclusion, it is important to recognize sporting organizations such as UK Sport, who are acknowledging the need to educate young athletes about supplement use. To do this, UK Sport have decided to focus their efforts on their attitudes and values of supplement use in sport. UK Sport has commenced a research project involving over 1,000 young athletes in the UK (UK Sport, 2006). As well as increased education for young athletes regarding supplement use, parents and coaches also need to be targeted to help the athletes make the right choices.

Promoting physical activity in children and adolescents is particularly important at this time of increasing incidence of childhood obesity. Instilling a healthy attitude about exercise and sport in youth is imperative, but the message may become misconstrued if the emphasis is to excel at all costs, thus suggesting to young athletes that using supplements is the key to success. Supplement use among young athletes is a current and substantial issue that merits future study in order to provide as much accurate information as possible for both professionals and consumers.

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### Key points

- Supplement use among the child and adolescent athlete population is widespread with the most frequently used supplement being a form of vitamin/mineral supplement.
- The effects of supplement use on the growth and development of children and adolescents remain unclear and thus use of supplements by this population should be discouraged.
- It is likely that there is a misunderstanding as to the role of vitamins and minerals in the diet, their function in maintaining overall health, their role in athletic performance, and how they are best obtained from the diet therefore further education for adolescent athletes and athletes in general is needed.

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