

## Dietary Supplementation Practices of Singaporean Athletes

*Gary Slater, Benedict Tan, and Kong Chuan Teh*

The supplementation practices of elite athletes in Singapore were studied using an anonymous questionnaire. Information was sought on not only the type of supplements used but also dosage, rationale for use, and other factors that might influence supplement use including selected demographic parameters and sources of information relating to supplements. Data was collected from 160 athletes across a spectrum of 30 sports. Use of supplements was widespread, with 77% of respondents acknowledging use of at least 1 product. Respondents ingested a total of 59 different supplements, with each athlete using on average  $3.6 \pm 0.3$  different products. Sports drinks, caffeine, vitamin C, multivitamin/mineral supplements, and essence of chicken were some of the most commonly ingested products, confirming that while vitamin/mineral supplements are popular, sports supplements and traditional/herbal preparations were also well accepted. Respondents preferred to source information pertaining to supplements from "significant others" and other readily accessible sources. A small number of respondents acknowledged the use of International Olympic Committee (IOC) banned or restricted substances, highlighting the need for athletes to consult sports medicine professionals with specialist knowledge of dietary supplements in advance of initiating any supplementation regime.

*Key Words:* nutrition, ergogenic aid, sport, doping

### Overview

By nature athletes are competitive. It should not be surprising therefore that they are particularly vulnerable to sports supplement marketing and report higher use of supplements than the general population, possibly in search of a direct ergogenic effect (3, 13, 26, 41). In an extensive review of 51 studies on the prevalence of supplement use, Sobal and Marquart (41) identified a higher rate of supplement use in athletes (mean, 46%; range, 6–100%) compared to the general population (35–40%), with the highest prevalence among elite athletes (59%).

Most of the information about supplementation practices of athletes is provided, in brief, from surveys of dietary intake in high school and college athletic

---

S.G. Slater is with the Department of Physiology in the Sports Science Sports Medicine Centre at the Australian Institute of Sport, Belconnen ACT, Australia 2616. B. Tan and K.C. Teh are with the Sports Medicine and Research Centre, Singapore Sports Council, 15 Stadium Road, National Stadium, Singapore 397718.

populations. From this limited data, supplement practices appear to vary with sporting aspirations (42), the type (30, 32, 38, 41, 42) and level of sport (30, 41), training volume (39), gender (20, 30, 32, 38, 39, 41), age (31), perception of supplements (42), and supplement knowledge (3, 30, 41), plus recommendations or patterns of supplement use among significant others (24, 38, 44). However, investigations specifically addressing the supplementation practices of national level athletes are limited, and it is unknown if similar patterns of supplement use occur in elite athletes. Furthermore, most investigations fail to provide details on some of the most valuable information relating to the supplementation practices of athletes: the type of supplements, amounts taken, and rationale for their use, together with issues such as sources of information relating to sports supplements and nutrition knowledge (7).

The supplementation practices of Asian athletes remain relatively unknown. Kim and Keen (24) reported that 35.8% of adolescents attending athletic high schools in Korea had ingested vitamin/mineral supplements within the last year, a prevalence rate similar to reports from the United States (30, 42). While this investigation surveyed a large number of subjects ( $N = 1355$ ), assessment was limited solely to vitamin/mineral supplements, just one of the wide array of products used by athletes. Recent investigations indicate that non-vitamin, non-mineral preparations are now some of the most popular supplements among athletes (36, 44). Furthermore, in Singapore where "east meets west," traditional herbal preparations are also likely to remain popular.

The objectives of the present investigation were to (a) determine the prevalence and type of supplement use, including banned/restricted products together with traditional and herbal preparations, among elite athletes within the Republic of Singapore; (b) determine the frequency, dosage, and reasons for use of supplements; (c) identify knowledge and sources of supplement information; and (d) establish if factors such as age, gender, ethnicity, training load, and sporting aspirations influence supplement use.

## Methods

### *Subjects*

All athletes categorized under the Sports Excellence Scheme of the Singapore Sports Council were targeted for this trial. Questionnaires, including reply-paid envelopes, were distributed via mail to 554 athletes on August 14, 2000. Responses were requested no later than August 31, 2000, allowing athletes approximately 2 weeks to peruse, complete, and return the survey. The study was approved by the Singapore Sports Council Human Ethics Committee. Signed informed consent documents were not considered appropriate for this anonymous investigation. Consequently, athletes were advised in a letter of introduction, inclusive of specifications of volunteer rights, that completion and return of the questionnaire would be considered as informed consent.

### *Questionnaire*

An anonymous questionnaire was developed based on questionnaires used in previous surveys of athletic populations assessing dietary supplement use (24, 26, 37,

42). A draft of the questionnaire was given randomly to 10 athletes who attended the Sports Medicine and Research Centre for treatment. Feedback was specifically sought on the length, language, and content of the questionnaire. After modifying the questionnaire in accordance with recommendations, a final draft was critiqued by all researchers. This 6-page document sought information on demographics (age, gender, ethnicity), sport (including training type and volume, performance level), and motivation/sporting aspirations through closed-ended questions. Additional closed-ended questions subjectively assessed knowledge of sports supplements, risk behavior associated with supplement use, and sources of dietary supplement advice. An open-ended question asked volunteers to specify how much they spent on supplements each month. Specific supplement use was assessed via 60 closed-ended questions (one for each supplement) relating to readily available dietary supplements, including herbal or botanical preparations. Respondents were required to specify frequency of use, dosage, and rationale for use of any product consumed within the previous 12 months. While additional space was made available for information relating to “other” products—that is, those not included in the list of 60 products—closed-ended questions were used for individual supplements, as previous research has indicated that athletes may not be able to recall the name of supplements consumed (44).

To enhance compliance in the detailed completion and return of questionnaires, all athletes were advised that they would be promptly provided with results of the investigation. A review of the most common supplements used (including information relating to their claims), scientific support or lack thereof, legality, safety and, if appropriate, application and dosage, was mailed out to athletes within one month of receiving completed questionnaires.

### ***Statistical Analysis***

Descriptive data were calculated as frequencies. Associations between overall supplement use and age, sex, race, sport, training load, sporting aspirations, supplement knowledge, risk profile, and sources of dietary advice were assessed by chi-square ( $\chi^2$ ) analyses using *SPSS* software (v. 10.0, SPSS Inc., Chicago, IL, USA). Differences in selected demographic and training variables between users and nonusers of specific supplements were assessed by one-way ANOVA. Significance was accepted at  $p < .05$ . All data are presented as the mean  $\pm$  standard deviation.

## **Results**

### ***Subjects***

A total of 160 completed questionnaires were received from athletes across a spectrum of 30 sports, equating to a response rate of 29%—that is, 160 responses from a total of 554 questionnaires. Incomplete questionnaires were discarded. Selected demographic data of volunteers are presented in Table 1. Because there were relatively few representative responses from some sports, data from individuals involved in similar sports were combined where sample size was less than 10 or when sample size did not equal athlete numbers required to form a team within a specified sport. Respondents had been competing at a national level for  $4.0 \pm 2.7$  years (range, 0.5–16 years). On average, athletes undertook  $12.9 \pm 6.3$  hours (range, 2–33 hours)

of training per week. Respondents reported the use of sports specific (86.9%), resistance (79.4%), and aerobic conditioning (70.0%) training.

### Supplement Use

Three quarters (77%) of respondents, including 73% of males and 81% of females, reported using one or more dietary supplements during the previous 12 months.

**Table 1 Characteristics of Subjects Returning Supplementation Questionnaires**

Variable	Subjects ( <i>n</i> )	% total respondents
Sex		
Male	85	53.1
Female	75	46.9
Age		
< 15	20	12.5
15–20	66	41.3
20–25	50	31.3
25–30	15	9.4
30–35	3	1.9
> 35	6	3.8
Race		
Chinese	119	74.4
Malay	22	13.8
Indian	8	5.0
Other	11	6.9
Sport		
Swimming/waterpolo	44	27.5
Combat <sup>1</sup>	27	16.9
Skill <sup>2</sup>	14	8.8
Hockey	13	8.1
Rugby	11	6.9
Sailing	10	6.3
Racket sports <sup>3</sup>	9	5.6
Volleyball	7	4.4
Netball	5	3.1
Sepak takraw	5	3.1
Other <sup>4</sup>	15	9.4

<sup>1</sup>Silat, taekwondo, wushu, fencing. <sup>2</sup>Archery, bowling (lawn and ten pin), shooting, snooker, equestrian. <sup>3</sup>Badminton, tennis, table tennis, squash. <sup>4</sup>Cycling, triathlon, track and field, rowing, body building, water skiing, unspecified sports (*n* = 2).

Table 2 The 10 Most Popular Supplements Used By Singapore's National Athletes, Primary Reason for Consumption and Frequency of Use

Supplement	% use	Reason for use	Frequency of use	Dosage per day	
				Mean $\pm$ SEM	Range
Sports drink	39	"Obtain energy"	Training days only	631.9 $\pm$ 423.6 ml (n =47)	75-2000 ml
Caffeine	37	"Reduce fatigue"/ "Improve athletic performance"	Unrelated to training	90.4 $\pm$ 44.2 mg (n =38)	31-240 mg
Vitamin C	33	"Prevent/treat illness"	Daily	712.2 $\pm$ 385.0 mg (n =37)	10-2000 mg
Multivitamin/mineral	21	"Improve general health"	Daily	1.1 $\pm$ 0.3 tablets (n =12)	1-2 tablets
Essence of chicken	19	"Improve general health"	Unrelated to training	75.5 $\pm$ 60.5 ml (n =23)	5-320 ml
Creatine	16	"Improve athletic performance"	Training days only	14.6 $\pm$ 18.1 g (n =23)	0.1-64 g
Ginseng	15	"Improve general health"	Unrelated to training	N/A	N/A
Sports bar	15	"Improve athletic performance"	Competition only	1.3 $\pm$ 0.7 bars (n =17)	0.3-3 bars
Birds nest	14	"Improve general health"	Unrelated to training	N/A	N/A
Protein/weight gain powder	13	"Build muscle"	Daily	112.6 $\pm$ 88.9 g (n =12)	20-360 g

Note. N/A = Dosage data was not possible due to the range of forms in which the products can be ingested and potential lack of quality control over the amount of active ingredients used.

Respondents ingested a total of 59 different supplements, with each athlete using on average  $3.6 \pm 3.8$  different products (range, 0–19) during the previous 12 months. Of athletes reporting supplement use, the majority (89%) were using more than one product (i.e., “polypharmacy”), 40% were using 5 or more supplements, and 9% ingested 10 or more products in the previous year. The 10 most popular supplements identified among Singaporean athletes are listed in Table 2. The primary reason for use, frequency of use, and dosage of these products is also provided in Table 2. Specific questionnaires were not included in assessment of dosage if units of measurement were not specified.

No relationship was identified between overall supplement use in the previous 12 months and gender ( $p = .30$ ). However, differences were observed in the use of some of the most popular supplements. Males were more likely to use creatine (males, 25%; females, 7%;  $p < .01$ ) and protein/weight gain powders (males, 20%; females, 4%;  $p < .01$ ), while females reported greater use of ginseng (males, 8%; females, 25%;  $p < .01$ ) and birds nest (males, 7%; females, 21%;  $p = .01$ ).

No differences in supplement use were observed according to race ( $p = .07$ ), sport ( $p = .08$ ), age ( $p = .33$ ), years of participation in sport at the national level ( $p = .42$ ), weekly training load ( $p = .75$ ), or training undertaken. Furthermore, no relationship was identified between supplement use and responses to questions relating to motivation for success in sport. On their list of priorities in life, 89% of respondents rated their sport as *high* or *very high*; the same percentage agreed or strongly agreed that their goal was to be the best athlete. Ninety-four percent of athletes agreed or strongly agreed that they work hard to be successful in their sport, while 95% were motivated each time they competed.

### **Supplement Knowledge and Beliefs**

Sixty percent of respondents self-reported *no* or *limited* knowledge of supplements, while a further 30% claimed to have *average* knowledge. Only 10% of athletes surveyed reported a *good* ( $n = 14$ ) or *excellent* ( $n = 2$ ) knowledge of supplements. No relationship existed between supplement use and knowledge ( $p = .09$ ). However, when those reporting *nil*, *limited*, and *average* knowledge were grouped and compared to those self-reporting *good* and *excellent* knowledge, an association was identified ( $p = .02$ ). Specifically, respondents specifying *good* or *excellent* knowledge were more likely ( $p = .02$ ) to use supplements than those reporting *nil*, *limited*, or *average* supplement knowledge.

Of the 16 subjects proclaiming a *good* or *excellent* knowledge of supplements, all reported use of supplements within the previous 12 months, while 74% of respondents with *nil*, *limited*, or *average* knowledge reported supplement use. Eleven of the 16 responses received from volunteers with *good* or *excellent* nutrition knowledge reported use of supplements that are without scientific support for their administration among an athletic population. These products included amino acids, cordiceps, essence of chicken, birds nest, evening primrose oil, fat metabolizers, cod liver oil, chromium, and ATP supplements.

The vast majority of athletes (90%) believed there were no risks (health or otherwise) associated with any supplements ingested, yet only a little over half (57%) of respondents attempted to locate information relating to potential side effects of products they were taking. Twelve athletes acknowledged ingestion of products they perceived to be associated with some degree of health/other risk.

**Sources of Supplement Information**

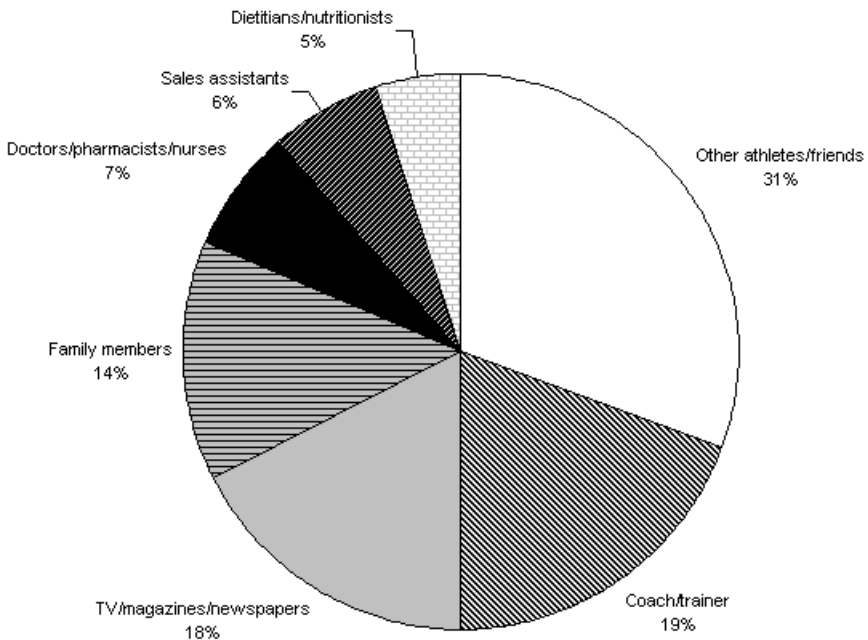
Primary sources of supplement information are specified in Figure 1. No association ( $p = .16$ ) was identified in supplement use between those who obtained advice from *reputable* versus *less reputable* sources. Classification of “reputable” and “less reputable” sources was totally at the discretion of researchers. Reputable sources of supplement information included *doctor/pharmacist/nurse* and *nutritionist/dietitian*, while less reputable sources were specified as *self, other athletes/friends, family members, coach/trainer, TV/magazines/newspapers, internet, and sales assistants*.

**Reason for Not Taking Supplements**

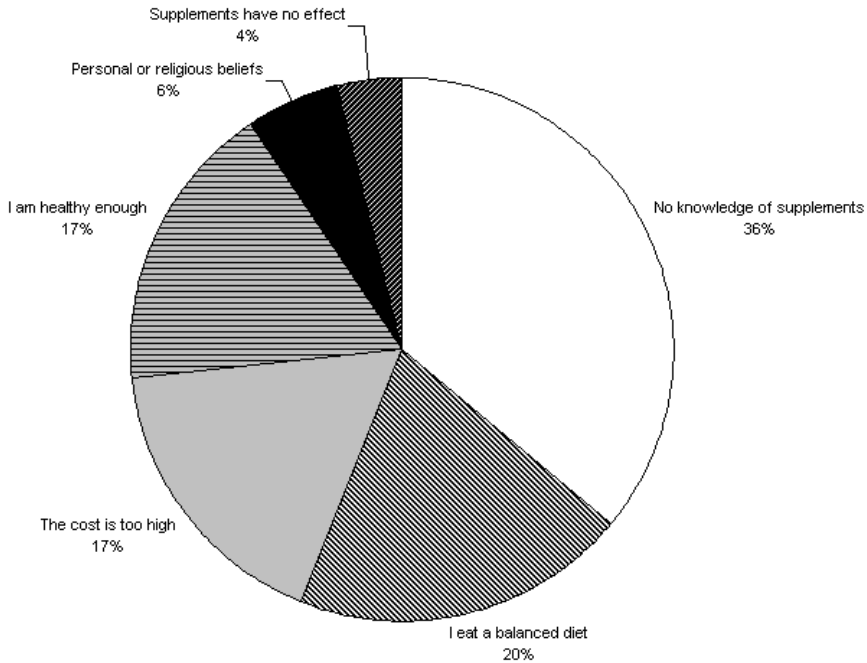
The main reasons for athletes not taking supplements are illustrated in Figure 2. Respondents were encouraged to select as many responses as was relevant to their decision to not use supplements.

**Expenditure**

The amount of money invested in supplements by respondents ranged from S\$0–1500 (US\$0–870) per month. Of those athletes using supplements, 16% spent S\$25 (US\$14.50) or less, 38% invested S\$26–50 (US\$15.10–29), 28% spent S\$51–100 (US\$29.60–58), and 18% reported spending > S\$100 per month on supplements. No data was collected on annual income of respondents.



**Figure 1 — Primary sources of supplement information among Singaporean athletes.**



**Figure 2 — Main reasons for not taking supplements among athletes in Singapore.**

### *Doping*

Only a quarter (24%) of respondents using supplements checked with relevant authorities to ensure products consumed were considered legal by the International Olympic Committee (IOC). One athlete reported the use of dihydroepiandrosterone (DHEA), another four indicated use of *Ma Huang* or Chinese Ephedra, and an additional 4 individuals reporting using thermogenic stimulators within the last 12 months. Caffeine was consumed by over one third (37%) of all respondents.

### **Discussion**

This investigation indicates that elite athletes within Singapore are using supplements at levels similar to those identified in other nations. Similar large investigations ( $n \leq 50$ ) on elite athletes confirm this group of individuals have a high prevalence of supplement use, ranging from 52% to 99% (4, 5, 10, 15, 16, 34). In contrast to previous reports on non-elite athletes, supplementation was widespread across the subject pool and not restricted to specific demographic parameters or sports.

While we observed no difference in absolute supplement use across gender, males were more likely to report use of creatine and protein/weight gain powders, products primarily consumed to enhance athletic performance and build muscle, respectively. A greater rate of creatine use among males has been observed previously



(20, 39). Females were more likely to consume ginseng and birds nest, both primarily used to improve general health. Such differences in motivation for supplement use according to gender have been observed previously (26, 42) and may need to be considered when undertaking athlete education.

While an association was identified between supplement use and knowledge, results contrast with those of several investigations identifying a decrease in supplement use with increasing nutrition knowledge (2, 19, 30, 41). That is, we observed that athletes with greater self-reported supplement knowledge were more likely to report supplement use. This is most likely explained by the fact that the current investigation sought individuals' own perception of their supplement knowledge, while other investigations have directly assessed nutrition knowledge with the aid of tools such as questionnaires. Indeed, data indicating the use of supplements without scientific support among the majority of Singaporean athletes self-reporting *good* or *excellent* supplement knowledge questions the validity of such self-evaluation instruments.

Common reasons offered to justify supplement use include performance enhancement, prevention of illness, compensation for less than adequate diets or lifestyles, providing extra energy, and meeting unusual nutrient demands induced by heavy training (31, 41). However, motivation for supplement use is likely specific to the individual supplement (23, 24). Commercial sports supplements, including sports/electrolyte drinks, creatine, sports bars, and protein/weight gain powders, were consumed primarily to enhance athletic performance, while vitamin/mineral supplements and traditional/herbal preparations were used to improve health or prevent illness.

Although reputable scientific data supports the ergogenic potential of supplements, including caffeine, creatine, and sodium bicarbonate, most purported nutritional ergogenic aids have not been shown to enhance performance (7, 11, 45). Furthermore, even products scientifically proven to enhance performance will only offer ergogenic potential to a specific group of athletes and only then if administered appropriately. For example, while respondents primarily ingested caffeine to improve athletic performance, average daily caffeine intake, even if consumed in a bolus, would unlikely result in any measurable performance enhancement. Beneficial effects of caffeine ingestion begin to be detectable at intakes of 3 mg/kg body mass or approximately 180 mg for a 60-kg athlete (43).

To date, there is no conclusive scientific evidence supporting the use of supplementary sources of vitamins, minerals, and antioxidants above known requirements to enhance health and/or performance (14). Any ergogenic potential is likely limited to circumstances in which nutrient intake from food is compromised. Without an assessment of dietary intake, it is not possible to comment on the value of vitamin and/or mineral supplementation among the study population. Similarly, it is not possible to evaluate the benefit of protein supplementation among volunteers, although experts believe the increased protein requirements associated with regular exercise can easily be obtained from dietary sources (28). Surprisingly, those athletes with the most nutritionally sound eating strategies are often the most likely to supplement their diet (10, 34).

Creatine remains one of the most popular supplements among athletes. While mean daily dosage of creatine among respondents of the current investigation complies with current recommendations (18), data indicate that some athletes were

ingesting creatine at dosages three times above those advised by experts. While short-term use of creatine at recommended doses has not been shown to cause significant adverse effects, the health consequences of chronic creatine administration at doses in excess of recommendations remains unstudied but likely increases the risk of adverse side effects (21).

While the provision of carbohydrate during high-intensity intermittent activity and prolonged aerobic exercise via the use of supplements like sports/electrolyte drinks and sports bars is supported by sports nutrition experts (8), research on the ergogenic potential and/or health benefits of traditional/herbal preparations is often insufficient to make decisions about their safety and efficacy (33). Clearly additional well-controlled scientific investigations are warranted to allow informed decisions to be made regarding the ergogenic and other effects of these and other supplements. It is beyond the scope and direction of this investigation to critique in detail individual dietary supplements. The reader is directed to recent reviews that provide extensive assessment of the ergogenic potential of sports supplements (1, 7, 11, 25, 45) and herbal preparations (6).

Most athletes did not verify the legality of supplements they were consuming with a recognized authority and thus left themselves at risk of committing a doping offence. This was confirmed when 1 athlete acknowledged the use of DHEA, a testosterone precursor and IOC-banned substance. Furthermore, 4 athletes indicated use of *Ma Huang* or Chinese Ephedra, an IOC banned during competition substance. An additional 4 athletes reported use of *thermogenic stimulators*, products that often contain caffeine/guarana and pseudoephedrine, IOC-restricted and -banned substances, respectively. This is not the only investigation to identify the use of IOC-restricted/-banned supplements. Sallis and Jones (36) assessed the supplementation practices of 263 male college footballers. No less than 87% of respondents reported previously trying some type of dietary supplement to enhance performance, including high dose caffeine (19% respondents), androstenedione (13% respondents), and DHEA (8% respondents).

There is a small but very real risk of an athlete committing a doping offence as a result of ingesting a dietary supplement or traditional/herbal preparation. At least 2 athletes, including 1 Singaporean, have returned positive doping samples following the use of botanical food supplements, and many more may be breaching doping policy via the use of *laced* herbal preparations (35, 40). According to current government policy (9), the onus of quality control and ensuring products do not contain banned/restricted substances rests with the importer/manufacturer. Unfortunately, evidence suggests supplement manufacturers have a poor track record for quality control (17, 22). As government policy on the regulation of dietary supplements is unlikely to change in the short term, education campaigns remain the key strategy for prevention of inadvertent doping among athletes.

The prohormones androstenedione and DHEA are banned as ingredients in over-the-counter preparations within Singapore (9). However, international travel for training and/or competition commitments, mail order sales, and Internet sales ensure Singaporean athletes can still be exposed to such products and thus unwittingly committing a doping offence. Consequently, education campaigns should provide athletes with a global perspective in regards to dietary supplements.

Athletes rely on readily accessible sources for information relating to supplements including mass media, coaches, peers, and parents (26, 38, 39). Typically,

coaches, peers, and parents have no formal nutrition education, and thus the accuracy of information presented to athletes cannot be guaranteed (12, 20). Thus, health professionals who obtain information from peer-reviewed scientific publications are likely in the best position to provide unbiased information to athletes and their coaches who are considering dietary supplement. This is in agreement with recommendations of the U.S. Food and Drug Administration (27) and American College of Sports Medicine (29), which encourage individuals to use supplements with caution and examine a product for safety, efficacy, potency, and legality with a health care professional prior to administering any dietary supplement. However, if informed professionals are to truly influence supplementation practices of athletes, easily accessible distribution mediums such as television, magazines, newspapers, and the Internet must be used to help disseminate accurate information so an athlete is able to make informed decisions. Furthermore, education on dietary supplements should be extended to include significant others—the people athletes perceive to be valuable sources of nutrition information, including other athletes, friends, family, and coaching staff.

The current investigation is not without limitation. With just 29% of questionnaires returned, a potential bias in responses cannot be excluded. However, as similar rates of supplement use have been identified in other investigations, we believe results of the current investigation do represent the supplementation practices of athletes in Singapore. The poor response rate may reflect (a) short turnaround time for responses to be received (i.e., 2 weeks); (b) detailed format of the questionnaire—although pilot work indicated it took just 14 min to complete the questionnaire; (c) command of written English among some athletes; or (d) the methodology chosen. Five other manuscripts assessing the supplementation practices of athletes appear in the literature with a response rate of less than 50% (5, 20, 31, 39, 46). All but one study (5) used a similar methodology to the current investigation (i.e., questionnaire delivery and return via mail); thus the lower response rate likely reflects the methodology used. While direct/personal administration of questionnaires results in response rates within the range of 90% (26, 34, 44), potentially sensitive information was sought from athletes in the current investigation. Thus, it was imperative that athletes felt confident in their anonymity as respondents.

If this investigation was to be repeated, alternate methods of questionnaire distribution could be investigated. Furthermore, a direct assessment of nutrition knowledge should be sought. Nonetheless, the majority of existing data on the supplementation practices of athletes come from investigations based on 50 or fewer responses. Thus, while response rate to our questionnaire was less than desired, the absolute number of responses received was excellent when compared to other investigations restricted to an elite athletic population.

In summary, our results indicate that supplementation is widespread among elite athletes within the Republic of Singapore and not restricted to specific demographics or sports. Furthermore, if athletes are not vigilant in sourcing reputable information pertaining to dietary supplements, they may be allocating unnecessary resources to unproven products and also exposing themselves to a small but real risk of committing a doping offence. Consequently, athletes should be encouraged to consult sports medicine professionals with specialist knowledge of dietary supplements in regards to issues such as safety, efficacy, potency, and legality of a product prior to initiating any supplementation regime.

## References

1. Applegate, E. Effective nutritional ergogenic aids. *Int. J. Sport Nutr.* 9:229-239, 1999.
2. Barr, S.I. Nutrition knowledge and selected nutritional practices of female recreational athletes. *J. Nutr. Educ.* 18:167-174, 1986.
3. Barr, S.I. Nutrition knowledge of female varsity athletes and university students. *J. Am. Diet. Assoc.* 87:1660-1664, 1987.
4. Barry, A., J. Cantwell, F. Doherty, J.C. Folan, M. Ingoldsby, J.P. Kevany, J.D. O'Broin, H. O'Connor, B. O'Shea, B.A. Ryan, and J. Vaughan. A nutritional study of Irish athletes. *Br. J. Sports Med.* 15:99-109, 1981.
5. Baylis, A., D. Cameron-Smith, and L.M. Burke. Inadvertent doping through supplement use by athletes: assessment and management of the risk in Australia. *Int. J. Sport Nutr. Exerc. Metab.* 11:285-303, 2001.
6. Bucci, L.R. Selected herbals and human exercise performance. *Am. J. Clin. Nutr.* 72(Suppl.):624S-636S, 2000.
7. Burke, L., B. Desbrow, and M. Minehan. Dietary supplements and nutritional ergogenic aids in sport. In: *Clinical Sports Nutrition* (2<sup>nd</sup> ed.), L.M. Burke and V. Deakin (Eds.). Sydney: McGraw-Hill, 2000, pp. 455-553.
8. Burke, L.M., and J.A. Hawley. Carbohydrate and exercise. *Curr. Opin. Clin. Nutr. Metab. Care.* 2:515-520, 1999.
9. Centre for Pharmaceutical Administration. *Guidelines for the Sale and Supply of Health Supplements*. Singapore: Health Sciences Authority, 2001.
10. Clark, N., M. Nelson, and W. Evans. Nutrition education for the elite female athlete. *The Physician and Sportsmedicine.* 16:124-136, 1988.
11. Clarkson, P.M. Nutrition for improved sports performance. Current issues on ergogenic aids. *Sports Med.* 21:393-401, 1996.
12. Corley, G. Nutrition knowledge and dietary practices of college coaches. *J. Am. Diet. Assoc.* 90:705-709, 1990.
13. Fleisher, B., and M. Reed. Food supplement usage by adolescent males. *Adolescence.* 17:831-845, 1982.
14. Fogelholm, M. Vitamin, mineral and antioxidant needs of athletes. In: *Clinical Sports Nutrition* (2<sup>nd</sup> ed.), L.M. Burke and V. Deakin (Eds.). Sydney: McGraw-Hill, 2000, pp. 312-340.
15. Grandjean, A.C. Vitamins, diet, and the athlete. *Clin. Sports Med.* 2:105-114, 1983.
16. Grandjean, A.C. Profile of nutritional beliefs and practices of elite athletes. In: *The Elite Athlete*, N.K. Butts, T. Gushiiken, and S. Zarins (Eds.). New York: Spectrum, 1985, pp. 239-247.
17. Gurley, B.J., P. Wang, and S.F. Gardner. Ephedrine-type alkaloid content of nutritional supplements containing Ephedra sinica (Ma Huang) as determined by high performance liquid chromatography. *J. Pharm. Sci. Technol.* 87:1547-1553, 1998.
18. Hultman, E., K. Soderlund, J.A. Timmons, G. Cederblad, and P.L. Greenhaff. Muscle creatine loading in men. *J. Appl. Physiol.* 81:232-237, 1996.
19. Jacobson, B.H., and S.G. Aldana. Current nutrition practice and knowledge of varsity athletes. *J. Appl. Sport Sci. Res.* 5:232-238, 1992.
20. Jacobson, B.H., C. Sobonya, and J. Ransone. Nutrition practices and knowledge of college varsity athletes: a follow-up. *Journal of Strength and Conditioning Research* 15(1):63-68, 2001.
21. Juhn, M.S., and M. Tarnopolsky. Potential side effects of oral creatine supplementation: a critical review. *Clin. J. Sport Med.* 8:298-304, 1998.
22. Kamber, M., N. Baume, M. Saugy, and L. Rivier. Nutritional supplements as a source for positive doping cases. *Int. J. Sport Nutr. Exerc. Metab.* 11:258-263, 2001.
23. Kennedy, J., and J. Arsenault. Dietary supplement use in U.S. army special operations candidates. *Mil. Med.* 7:495-501, 1999.

24. Kim, S.H., and C.L. Keen. Patterns of vitamin/mineral supplementation usage by adolescents attending athletic high schools in Korea. *Int. J. Sport Nutr.* 9:391-405, 1999.
25. Kreider, R.B. Dietary supplements and the promotion of muscle growth with resistance exercise. *Sports Med.* 27(2):97-110, 1999.
26. Krumbach, C.J., D.R. Ellis, and J.A. Driskell. A report of vitamin and mineral supplement use among university athletes in a division I institution. *Int. J. Sport Nutr.* 9:416-425, 1999.
27. Kurtzweil, P. An FDA guide to dietary supplements. *FDA Consumer.* 32:28-35, 1998.
28. Lemon, P.W.R. Do athletes need more dietary protein and amino acids? *Int. J. Sport Nutr.* 5(Suppl.):S39-S61, 1995.
29. Manore, M.M., S.I. Barr, and G.E. Butterfield. Position stand: nutrition and athletic performance. *Med. Sci. Sports Exerc.* 32:2130-2145, 2000.
30. Masad, S.J., N.W. Shier, D.M. Koceja, and N.T. Ellis. High school athletes and nutritional supplements: a study of knowledge and use. *Int. J. Sport Nutr.* 5:232-245, 1995.
31. Nieman, D.C., J.R. Gates, J.V. Butler, L.M. Pollett, S.J. Dietrich, and R.D. Lutz. Supplementation patterns in marathon runners. *J. Am. Diet. Assoc.* 89:1615-1619, 1989.
32. Parr, R.B., M.A. Porter, and S.C. Hodgson. Nutrition knowledge and practices of coaches, trainers and athletes. *The Physician and Sportsmedicine.* 12:127-138, 1984.
33. Philen, R.M., D.I. Ortiz, S.B. Auerbach, and H. Falk. Survey of advertising for nutritional supplements in health and bodybuilding magazines. *JAMA* 268:1008-1011, 1992.
34. Ronson, O., J. Sundgot-Borgen, and S. Maehlim. Supplementation use and nutritional habits in Norwegian elite athletes. *Scand. J. Med. Sci. Sports* 9:28-35, 1999.
35. Ros, J.J., M.G. Pelders, and P.A. De Smet. A case of positive doping associated with a botanical food supplement. *Pharm. World Sci.* 21:44-46, 1999.
36. Sallis, R.E., and K. Jones. Dietary supplement use among college football players. *Med. Sci. Sports Exerc.* 31(5):S118, 1999. (Abstract)
37. Schneider, K., L. Hervig, W.Y. Ensign Jr., W.K. Prusaczyk, and H.W. Goforth Jr. Use of supplements by U.S. navy seals. *Med. Sci. Sports Exerc.* 30(5):S60, 1998. (Abstract)
38. Schulz, L.O. Factors influencing the use of nutritional supplements by college students with varying levels of physical activity. *Nutr. Res.* 8:459-466, 1998.
39. Sheppard, H.L., S.M. Raichada, K.M. Kouri, L. Stenson-Bar-Maor, and J.D. Branch. Use of creatine and other supplements by members of civilian and military health clubs: a cross-sectional survey. *Int. J. Sport Nutr. Exerc. Metab.* 10:245-259, 2000.
40. Singh, S. First player to fail dope test. *Straits Times.* October 1, 1999.
41. Sobal, J., and L.F. Marquart. Vitamin/mineral supplement use among athletes: a review of the literature. *Int. J. Sport Nutr.* 4:320-334, 1994.
42. Sobal, J., and L.F. Marquart. Vitamin/mineral supplement use among high school athletes. *Adolescence* 29:835-843, 1994.
43. Spriet, L.L. Caffeine and performance. *Int. J. Sport Nutr.* 5(Suppl.):S84-S99, 1995.
44. Swirzinski, L., R.W. Latin, K. Berg, and A. Grandjean. A survey of sport nutrition supplements in high school football players. *Journal of Strength and Conditioning Research.* 14:464-469, 2000.
45. Williams, M.H. Nutritional ergogenic aids in athletics. *J. Sports Sci.* 13:S63-S74, 1995.
46. Worme, J.D., T.J. Doubt, A. Singh, C.J. Ryan, F.M. Moses, and P.A. Deuster. Dietary patterns, gastrointestinal complaints, and nutrition knowledge of recreational triathletes. *Am. J. Clin. Nutr.* 51:690-697, 1990.

### Acknowledgments

The authors would like to thank the athletes who took time out from their busy training schedule to complete and return the questionnaire. Thanks also to Vincent Ong for statistical analysis.