

SUPPLEMENTS USE IN ELITE ATHLETES IN RELATION TO ATTITUDES, BELIEFS AND KNOWLEDGE

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Abstract

Introduction: Doping in sports has been studied from different perspectives such as medical, physiological and social science; however, being a taboo topic, it is not easy to get objective information on use of banned performance enhancing substances. There is a continuous focus for years on determination of predictors of doping behaviour. In order to obtain a reliable view of how widespread is the doping in sports, determining the prevalence of doping is a prime goal for many international and national sport-governing bodies.

Objective: To gather and critically examine the most recent publications describing elite athletes' prevalence rates of supplements and banned substances.

Methods: A systematic literature search was performed using a set of relevant criteria and a set of doping-related keywords to identify potentially relevant articles. We searched PubMed, Medline, Web of Knowledge, Scopus, and SPORTDiscus using a set of doping-related keywords to identify potentially relevant articles. We next performed a manual search of the references cited in the studies retrieved in the electronic search.

Results: A total of 22 papers, which reported the prevalence rates of doping and supplements use in elite athletes from different sports, were retrieved and evaluated.

Conclusion: As expected, the frequencies of non-banned substances use are higher than doping substances. However, the use of supplements is widespread existing among different sports and countries, so this should be analysed exhaustively to intervene more effectively on those potentially risky users from prevention perspective.

Key words: *doping, use, attitudes, elite athletes, prevention*

Introduction

Dietary supplementation is a common practice in athletes with a desire to enhance performance, training, exercise recovery, and health in spite of being considered a risky habit due to the lack of knowledge or the possibility to be contaminated with banned substances [1].

Recently, Morente-Sánchez and Zabala [2] published an exhaustive review on doping in elite athletes focusing on attitudes, beliefs and knowledge. They obtained complementary data from other interesting variables such as prevalence rates of doping and permitted supplements, but did not mentioned in the study. Despite of being recent, these unpublished data should be updated adding last-year papers focused on different sports like tennis [3], sailing [4], judo [5], cycling [6], weightlifting [7] and swimming [8].

In general, doping in sports has been studied by medical, physiological and social science researchers [9]. In the absence of more objective information on banned performance enhancing substances use, researchers are looking for predictors of doping behaviour for years. According to Backhouse, Whitaker and Petróczi [10], those athletes who engage in legal performance enhancement practices appear to embody an "at risk" group for transition towards doping. Exactly, they observed in their study with 212 competitive

athletes that doping use is 3.5 times more prevalent in supplements users compared with non-users, and emphasised that this finding is accompanied by significant differences in doping attitudes, norms and beliefs.

We find this study interesting, because it, apart from the high quality of samples (elite athletes), analyses and compares the use of banned and non-banned supplements from papers focused on attitudes, beliefs and knowledge towards doping, giving an interesting perspective to this study. In addition, following Petróczi and Aidman [9], in order to obtain a reliable view of how widespread doping is in sports, estimating the prevalence of doping is a prime goal of many international and national sport governing bodies. Taking all the facts into account, the aim of this study was to gather and critically examine the most recent publications describing prevalence rates of supplements and banned substances among elite athletes.

Methods

A systematic literature search was performed using a set of relevant criteria and scientific methodology that were described in a previous review about elite athletes' attitudes, beliefs and knowledge regarding doping [2]. We searched PubMed, Medline, Web of Knowledge, Scopus, and SPORTDiscus using a set of doping-related keywords to identify potentially

relevant articles. Since each database has its unique indexing terms, bespoke search strategies were developed. The first search terms included combinations of “doping”, “sport”, “elite athletes”, “attitudes”, “beliefs”, and “knowledge”. Considering variations in usage of the terms, e.g. “doping”, in the scientific literature, we repeated the search by replacing “doping” with “performance-enhancing substance” and “performance-enhancing drugs”. We next performed a manual search of the references cited in the studies retrieved in the electronic search. The review compiled

by Morente-Sánchez and Zabala [2] contained papers only until December 2011 and it was not focused on nutritional supplements use, so data that only reported the prevalence rates or that did not specifically refer to attitudes, beliefs and knowledge related to doping in sport were excluded. In this manuscript, this unpublished information about prevalence of use rates is shown and updated. A total of 22 papers were retrieved and evaluated (Table 1). Only full papers published in peer-reviewed journals in English were included in this review.

Table 1. Summary of the articles retrieved and assessed

Reference	n	Country	Methodology	Main results
Waddington I, Malcolm D, Roderick M, et al. Drug use in English professional football. <i>Br J Sports Med</i> 2005; 39: e18-e18.	706	United Kingdom	Postal questionnaire	6% personally knew players who used performance enhancing drugs 45% knew players who used recreational drugs.
Slater G, Tan B, KongChuan T. Dietary supplementation practices of Singaporean athletes. <i>Int J Sport Nutr Exerc Metab</i> 2003; 13: 320-32	160	Singapour	Anonymous questionnaire	77% used of supplement. Each athlete using on average 3.6 ± 0.3 different products. Sports drinks, caffeine, vitamin C, multi-vitamin/mineral supplements, and essence of chicken were most commonly ingested products. Respondents ingested a total of 59 different supplements.
Maughan RJ, Depiesse F, Geyer H. The use of dietary supplements by athletes. <i>J Sports Sci</i> 2007; 25: 103-13.	310	United Kingdom	Survey	85% of elite track and field athletes used dietary supplement Most commonly: vitamins and antioxidants (84%), minerals (73%), protein and creatine supplements (53%), and ergogenic supplements, including coenzyme Q10, caffeine, ginseng, and ephedrine (52%).
Somerville S, Lewis M. Accidental breaches of the doping regulations in sport: is there a need to improve the education of sportspeople? <i>Br J Sports Med</i> 2005; 39: 512-16.	74	United Kingdom	Mail-questionnaire	Four athletes admitted taking a banned substance by accident. Forty one (55%) reported taking supplements.
Erdman KA, Fung TS, Doyle-Baker PK, et al. Dietary supplementation of high-performance Canadian athletes by age and gender. <i>Clin J Sport Med</i> 2007; 17: 458-64.	582	Canada	Anonymous questionnaire	88.4% of participants taking ≥ 1 DS (mean of 3.08 ± 1.87 per user) during the previous 6 months. Overall, sport drinks (22.4%), sport bars (14.0%), multivitamins and minerals (13.5%), protein supplements (9.0%), and vitamin C (6.4%) were most frequently.
Nieper A. Nutritional supplement practices in UK junior national track and field athletes. <i>Br J Sports Med</i> 2005; 39: 645-9.	32	United Kingdom	Anonymous questionnaire	62% of respondents declaring supplement use. Prevalence in female athletes (75%) was higher than in males (55%). No differences for age, training volume, 17 different supplements were taken, with each athlete using an average of 2.4 products, multivitamins and minerals being the most popular.
Lun V, Erdman KA, Fung TS, et al. Dietary supplementation practices in Canadian high-performance athletes. <i>Int J Sport Nutr Exerc Metab</i> 2012; 22: 31-7.	440	Canada	Validated survey	87% declared having taken 3 dietary supplements within the previous 6 months. Sports drinks, multivitamin and mineral preparations, carbohydrate sports bars, protein powder, and meal-replacement products were the most prevalent supplements reported.

Rodek J, Idrizović K, Zenić N, et al. Differential Analysis of the Doping Behaviour Templates in Three Types of Sports. <i>Coll Antropol</i> 2013; 37: 211-7.	44	Croatia	Anonymous questionnaire	More than 77% of athletes used dietary supplements and 38% did so on a regular basis (daily).
Kondric M, Sekulic D, Uljevic O, et al. Sport nutrition and doping in tennis: an analysis of athletes' attitudes and knowledge. <i>J Sports Sci Med</i> 2013; 12: 290-7.	65	Slovenia	Anonymous questionnaire	Almost of all the females and 80% of the males using nutritional supplements at least occasionally. Athletes showed a low tendency regarding future doping usage, although most of them are convinced that doping does exist in tennis.
Connor J, Woolf J, Mazanov J. Would they dope? Revisiting the Goldman dilemma. <i>Br J Sports Med</i> 2013; 47: 697-700.	212	USA	Interview and online questionnaire	25/212 indicated that they would take banned substances (no death condition). 13/212 even with death as a consequence. No statistical difference between the interview and online collection method.
Alaranta A, Alaranta H, Holmila J, et al. Self-reported attitudes of elite athletes towards doping: differences between type of sport. <i>Int J Sports Med</i> 2006; 27: 842-6.	446	Finland	Structured questionnaire	35% males and 23% of females reported they personally know an athlete using banned substances. 15% reported that they had been offered banned substances. Stimulants were the most often offered substance group (to 7% of all the athletes) followed by anabolic steroids (4%).
Pitsch W, Emrich E, Klein M. Doping in elite sports in Germany: results of a www survey. <i>Eur J Sport Soc</i> 2007; 4: 89-102.	448	Germany	Interview	38.7% admitted to using illegal drugs or methods. Throughout their whole athletic career, we calculated 51.9% honest non-dopers and in the current season 61.3%.
Lazuras L, Barkoukis V, Rodafinos A, et al. Predictors of doping intentions in elite-level athletes: a social cognition approach. <i>J Sport Exerc Psychol</i> 2010; 32:694-710.	750	Greece	Anonymous questionnaires	9.9% of athletes reported doping use. Ever users were significantly more in individual (14.4%) than in team sports (7.4%). No significant differences in doping use (ever/never) were found between female and male athletes.
Corrigan B, Kazlauskas R. Medication use in athletes selected for doping control at the Sydney Olympics (2000). <i>Clin J Sport Med</i> 2003; 13: 33-40.	2758	United Kingdom	Anonymous questionnaire	78% took medications and supplements. 542 athletes took 5 or more, including one who took 26, 2 who took 19 and 2 others took 20.
Huang S-HS, Johnson K, Pipe AL. The use of dietary supplements and medications by Canadian athletes at the Atlanta and Sydney Olympic Games. <i>Clin J Sport Med</i> 2006; 16: 27-33.	257 (Atlanta) 300 (Sydney)	Canada	Interview	At the Atlanta Games, 69% of the athletes used some form of dietary supplements, whereas 74% of the athletes used dietary supplements at the Sydney Games.
Tsitsimpikou C, Tsiokanos A, Tsarouhas K, et al. Medication use by athletes at the Athens 2004 Summer Olympic Games. <i>Clin J Sport Med</i> 2009; 19: 33-8.	493	Greece	Anonymous questionnaire	64.2% declared use of medications or food supplements, and 81.3% of these athletes declared intake of fewer than four preparations. Food supplements (42.1%), non-steroidal anti-inflammatory agents (9.8%), analgesics (5.6), inhaled beta2-agonist (4.8%)
Kim J, Lee N, Lee J, et al. Dietary Supplementation of High Performance Korean and Japanese Judoists. <i>Int J Sport Nutr Exerc Metab</i> 2013; 23: 119-27.	172	Republic of Korea	Anonymous questionnaire	88% of high-level judoists consumed dietary supplements. Oriental supplements (34%), vitamins (23%), and protein powder (12%) were the most commonly consumed dietary supplements in Korean judoists. Vitamins (45%), protein powder (33%), and minerals (15%) were the most commonly consumed dietary supplements in Japanese judoist.

Morente-Sánchez J, Mateo-March M, Zabala M. Attitudes towards Doping and Related Experience in Spanish National Cycling Teams According to Different Olympic Disciplines. <i>PLoS One</i> 2013; 8: e70999.	72	Spain	Anonymous questionnaires	5% riders recognized having been suggested to dope. 9.72% saw other people inciting others or being incited.
Chester N, Reilly T, Mottram D. Over-the-counter drug use amongst athletes and non-athletes. <i>J Sports Med Phys Fitness</i> 2003; 43: 111-18.	199	United Kingdom	Anonymous questionnaire	3.4% used over-the-counter drug enhance performance, but less than half of those believed they had been effective. 23.5% believed that OTC drugs should be banned.
Alaranta A, Alaranta H, Heliövaara M, et al. Ample use of physician-prescribed medications in Finnish elite athletes. <i>Int J Sports Med</i> 2006; 27: 919-25.	446	Finland	Structured questionnaire	The most frequently reported physician-prescribed medications: anti-allergic medicines (12.6% of the respondents), nonsteroidal anti-inflammatory drugs (NSAIDs; 8.1%), anti-asthmatic medicines (7.0 %), and oral antibiotics (2.7 %).
Dunn M, Thomas JO, Swift W, et al. Recreational substance use among elite Australian athletes. <i>Drug Alcohol Rev</i> 2011; 30: 63-8.	974	Australia	Survey	One-third of the sample had been offered or had the opportunity to use illicit drugs in the past year.
Kim, J., Kang, S., Jung, H., Chun, Y., Trilk, J., & Jung, S. H. Dietary supplementation patterns of Korean olympic athletes participating in the Beijing 2008 summer olympic games. <i>Int J Sport Nutr Exerc Metab</i> 2011; 21: 166-74.	112	Republic of Korea	Anonymous questionnaire	Almost 80% of Olympians take more than 1 dietary supplements during the training period and that vitamins and Oriental supplements are the 2 top-ranked supplements.

Results and Discussion

There are many studies revealing different and interesting data about the use of different performance enhancing substances (PES) by elite athletes; however, we have to take into account that not all of them are doping. We are obliged to tell that dietary supplements may be adulterate with banned substances [11]. Slater, Tan and Kong-Chuan [12] stated that the use of the supplements was widespread in Singaporean elite athletes ($n=160$) with a 77% of responders acknowledging the use of at least one product. Many athletes use dietary supplements as a part of their regular training or competition routine, including about 85% of elite track and field athletes [13]. Nevertheless, a small number of them admitted the use of banned or restricted substances enlisted by International Olympic Committee (IOC). Somerville and Lewis [14] conducted a similar survey ($n=74$) in elite athletes from UK and stated that 55% of responders took supplements. Similar results were obtained in Canada ($n= 582$ high-performance athletes) by Erdman et al. [15], who observed that there was an extensive dietary supplement use (88,4%). Nieper [16] observed that the use of supplements was widespread with 62% ($n=34$) of responders acknowledging it. Kondric et al. [3] stated

that use of supplements was widespread (80%; $n=43$) in female high level tennis players. Lun et al. [1] observed that 87% of 440 athletes from 34 different sports used dietary supplementation. In a study with high level sailing athletes ($n=44$), more than 77% of them stated using supplements [4]. Kim et al. [5] observed similar prevalence (61% and 59%) in Japanese ($n=71$) and Korean ($n=101$) judo athletes. Similar results were shown by Goldman, Bush and Klatz [17] and Connor, Woolf, & Mazanov [18], where the prevalence of banned substances use for 198 world class athletes was of 52% (103/198). Alaranta et al. [19] conducted a survey ($n=446$) among Finish elite players and only 23% of the athletes surveyed believed that there was no steroid use in their sports. Stimulants were the most often used substances (to 7% of all the athletes) followed by anabolic steroids (4%). In addition, of the athletes knowing another athlete using banned substances, 28.4% (38/134) used stimulants by themselves compared with 6.7% (21/302) of those who reported not to know users.

Pitsch et al. [20] interviewed 448 German top athletes about their current use of doping practices as well as their exposure to such practices in the past. Results contained the following data: 25.8% of these

athletes admitted that they had taken banned substances (honest dopers); 51.9% stated that they did not use this kind of substances (honest non-dopers); and 22.3% affirmed that they had taken banned substances but they did not acknowledge (deniers). According to them [20], there were significantly more honest dopers in “centimeters, grams or seconds sports” than in “sport games”. In relation to cited data, Lazuras et al. [21] analysed a sample of 750 Greek elite athletes and observed that one out of ten athletes reported doping use (9.9% or $n=74$). Particularly, 32 athletes (4.3%) acknowledged that they used doping substances once and not ever since, 27 (3.6%) reported occasional consumption of banned substances, and 15 (2%) stated systematic use of prohibited PES.

Several studies considered the samples that included Olympic athletes. Corrigan and Kazlauskas [22] reported that 78% of the 2758 athletes tested in Olympic Games in Sydney took a large variety of medications and supplements. A total of 25.6% recognised that they had taken non-steroid anti-inflammatory drugs (NSAIDs) in the past three days. Similar results were shown by Huang et al. [23], who analysed the use of dietary supplements by Canadian athletes in Olympic Games in Atlanta ($n=257$) and Sydney ($n=300$). At the Atlanta Games, 69% of the athletes used some form of dietary supplements, whereas 74% of the athletes used the same at the Sydney Games. Overall use of medications was stated as 61% and 54% of the athletes in Atlanta and Sydney, respectively. NSAIDs were used by 33% of the athletes in Atlanta and by 38% of those in Sydney. Tsitsimpikou et al. [24] examined the use of food supplements and pharmaceutical preparations by elite Olympic athletes ($n=445$) at the Athens 2004 Summer Olympic games and 24.3% of the athletes tested for doping control declared no use of medications or food supplements, while NSAIDs and analgesics were commonly used by athletes (11.1% and 3.7%, respectively). Kim et al. [5] examined use of dietary supplements in Korean Olympians during Beijing 2008 Summer Olympic Games. Results showed that 79% of male and 82% of female Korean Olympians took more than one supplement during the training period. Spanish national teams of cycling were assessed in training camps during last 2012 London Olympic Games by Morente-Sánchez et al. [6]; five riders of the total (5/72, 6.94%) recognised that they had been suggested to dope, while seven (7/72, 9.72%) had ever seen other people inciting other teammates.

According to Chester et al. [25] some over-the-counter (OTC) medicines, especially those used for the treatment of upper respiratory tract (URT) infections, contain substances that are banned by sports governing bodies. This paper reported on a survey of athletes (elite and non-elite) and non-athletes ($n=401$) with regard to use of and attitudes toward these substances.

Almost four percent (3.4%) of athletes stated that they had used OTC drugs to enhance performance, but less than half of them believed these drugs to be effective. A higher proportion of elite, as opposed to non-elite, athletes did not take OTC medicines. Of those that used OTC treatments, elite athletes were more likely to use only the drugs which did not contain banned substances. Alaranta et al. [26] assessed, on the other hand, the use of physician-prescribed medication in elite athletes ($n=446$) compared with a representative control sample of the general population ($n=1503$). The use of physician-prescribed antiasthmatic (7.0% vs. 2.3%) and antiallergic (12.6% vs. 6.0%) medications, NSAIDs (8.1% vs. 2.7%) and oral antibacterials (2.7% vs. 1.3%), during the past 7 days was 2 to 4 times higher in elite athletes compared with the general population of the same age.

Waddington et al. [11] examined several issues related to drug use in English professional footballers ($n=706$). Almost the half of the sample (49%) felt that there was no use of illicit performance enhancing substances in professional football. Although one third (34%) felt that some players were using doping. Almost 6% of responders indicated that they personally knew players those used non-permitted substances (anabolic steroids, stimulants). Curiously, it was indicated that the use of recreational drugs (cocaine, cannabis) was more widespread than PES. Only 29% of professional football players stated that these kinds of substances were not used by professional footballers. Almost a half of all players (45%) indicated that they personally knew players who used recreational drugs. Finally, they emphasised as conclusion that in spite of the fact that use of recreational drugs in English is common, there is no evidence to affirm that the utilisation of PES is also common. Similarly, Dunn, Thomas, Swift and Burns [27] conducted a survey to investigate the prevalence of illicit drug use among elite Australian athletes, and concluded that 33% of the sample ($n=974$) had been offered or had the opportunity to use illicit drugs in the past year. It was stated that knowing other athletes who use illicit drugs, being offered or having the opportunity to use drugs and identifying as a ‘full-time athlete’ were significant predictors of recent drug use. On the other hand, Alaranta et al. [19] conducted a survey among Finnish elite players ($n=446$) and stated that recreational drugs (cannabis, ecstasy, amphetamines, cocaine) were never used by 91.5% (408/446) of the athletes. A total of 7.6% (34/446) of the athletes had used cannabis one to five times in their life and an additional 0.4% (2/446) over six times.

Regarding gender, few studies carried out interesting comparisons between males and females. Alaranta et al. [19] reported that 30% of 446 Finnish elite athletes knew another athlete using banned drugs to boost performance. Men knew doping users

significantly more often than women (35.2% vs. 23%; $P=0.0044$). Uvacek et al. [28] observed that of the 82 athletes who comprised the sample, 12 (14.6%) admitted using banned PES and 26 (31.7%) reported using recreational drugs. In addition, it drew attention that more male athletes admitted using banned drugs than females (18.9% vs. 11.1%). No differences were found in other variables such as age, training volume, or type of event. On the contrary, a prevalence, though statistically not significant, was observed in female athletes (75%) in comparison to male athletes (55%). In the same way, in relation to gender and use of PES, Lazuras et al. [21] found no significant differences in doping use (ever/never) between female and male athletes.

In order to contrast with objective values, Rossi and Botrè [29] analysed 95,000 urine samples from doping control samples that were analysed in a 10-year period from 2000 to 2009. The samples originated from elite sporting events in Italy and were collected both in and out of competition. The percentage of adverse analytical findings varied on a yearly basis, but it was in the range 1.0–1.8% (not considering atypical findings, such as an altered endogenous steroid profile). Among positive results, there was a high prevalence of stimulants and illicit drugs. The most frequently found, drug of abuse is tetrahydrocannabinol (cannabis) metabolite and the second most frequently encountered is cocaine, as detected from cocaine metabolites, accounting for 0.1% of the total samples analysed (7% of positive results). These data are indicative of the widespread prevalence of cocaine and cannabis use among the young adult population. However, due to the particular population studied, an underestimation of the phenomenon among elite athletes must be considered with respect to the general population.

Finally, according to Bloodworth et al. [30], the extent to which banned substances are being utilised by elite athletes is difficult to determine. In that study, it was stated that the number of athletes reported, as testing positive by anti-doping bodies was small, often around 2% in terms of World Antidoping Agency (WADA) (2002–2008). However, the percentage of positive test results in some Olympic sports in which athletes can benefit from using performance enhancements (by increasing endurance or power) exceeds the usual 2% average (e.g. cycling 4.7%, baseball/softball 5.8%, weightlifting 2.9%, triathlon 2.8% and boxing 2.4%) [9]. In words of Rossi and Botrè [29], we cannot generalise results because all data from elite athletes suppose an underestimation of the phenomenon of doping for the general public. It is upon athletes to take better care of their health and be aware of anti-doping testing.

The analysis of this kind of doping related data is not free from limitations, since results from studies

based on questionnaires covering a banned practice have limits, the responses may be deliberately false, as the participants may not wish to reveal that they or others use banned substances. However, we suggest taking the two aspects into account: one is that access to this population (elite athletes) is extremely difficult, and other is the difficulty in getting elite athletes to open up to talk on such a taboo topic. We suggest further investigation in terms of descriptive studies to assess the situation properly and, consequently, to design effective intervention programs. One problem that we found in establishing comparisons among different samples from different sports or countries was the lack of existence of common measurement tools (e.g. surveys, interviews, etc.). This type of studies should be carried out by means of the same or similar validated tools in every sport so that data could be more reliable, comparable and inferable; and practical applications could be developed more efficiently. Controls are obviously required, but also more effective educational programs that do not require large investments.

Conclusion

The present study reported the prevalence rates of doping and supplements use in elite athletes from different sports, showing that the use of supplements is widespread in elite sport. As expected, the frequencies of non-banned substances use are higher than doping substances. However, results provided specific information about doping use to detect risky groups and, consequently, to be able to intervene more successfully from prevention perspective.

Declaration of interest

The authors report no conflict of interests.

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