

## Anti-doping education and dietary supplementation practice in Korean elite university athletes

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### Abstract

This study was conducted to investigate relationships and gender differences in dietary supplement (DS) and oriental supplement (OS) prevalence as well as anti-doping awareness during training and the game period. Korea National Sport University athletes (343 male and 136 female) participated in this study and completed DS and OS practice and anti-doping awareness questionnaires. Forty-six percent of athletes used DS during the training period, and there was significantly higher DS use in females (53%) compared to males (43%) ( $P < 0.05$ ). Twenty-eight percent of athletes used OS, and there was significantly higher OS use in females (35%) than males (26%) ( $P < 0.05$ ) during the training period. The primary reason of DS use was to supply energy both in males (36%) and females (28%). The main reason for male athletes' OS use was to supply energy (41%). Meanwhile, the reasons for female athletes' OS use were to supply energy (23%), to maintain health (19%), and to improve recovery ability (20%), which showed a significant gender difference ( $P < 0.05$ ). Athletes rated their perceived degree of satisfaction, perceived importance, and beliefs in efficacy of DS and OS use all over 50% during the training period, and no gender differences were detected. In a comparison between athletes educated about anti-doping (at least more than one time) and non-received athletes, DS and OS use during the training period was 2.30 (1.47-3.60) and 1.71 (1.03-2.82), respectively. DS and OS use immediately before the game period was 2.38 (1.50-3.80) and 3.99 (1.20-13.28), respectively. Elite athletes' anti-doping education was highly related to increased DS use during the training period and immediately before the game. Although elite athletes use various DS and OS during the training period and before the game period, doping education for elite athletes is related with DS and OS use during the training period and before the game.

**Key Words:** Dietary supplementation, anti-doping education, elite athletes

### Introduction

Intake of dietary supplementation (DS) in elite athletes is very common in many countries. Forty-five to 74 percent of Olympic athletes [1-5], 53 to 95 percent of winter sports athletes [3,4], and 69 to 95 percent of summer sports athletes [2,6] took various DS in order to cure minor illness, supply energy, boost energy use, maintain health, and increase immune function for preventing illness. They also took DS to increase strength, muscle power, muscle mass, endurance performance, and recovery ability. Moreover, over 80 percent of Korean Olympic athletes took DS to increase muscle performance, improve recovery ability, maintain health, or prevent nutritional deficiency. Unlike Western athletes, it was reported that about 58 percent of Korean athletes also take oriental supplements (OS), such as traditional herbs, animal extracts from snakes, and gall bladder of bears, dogs, soft shell turtles, and black goats [7]. Previous studies [7-9] have reported DS and OS use by Korean elite athletes; however, there is little information on DS and OS use during the training period and

before the game, or on gender differences in DS and OS use.

National Complementary and Alternative Medicine Use Survey in 2006 (2006 NCAMUS) [10] recently reported that 62 percent of 3,000 Korean adults (aged 30 - 69 years) take DS, of which the top five were ginseng (23%), multivitamins (14%), glucosamin (10%), probiotics (10%), and vitamin C (9%). This survey showed quite different results compared to recently reported studies. Professional elite athletes' DS use [11] and adolescent elite athletes' DS use [9] study showed that athletes mostly took oriental supplements and ergogenic aids. Moreover, H. Kim and Keen [12] reported that adolescent elite athletes show higher vitamin use than NCAMUS' report [10], and this implies that there may be a difference between elite athletes' and non-elite athletes' DS use. In addition, J. Kim and colleagues [9] reported that there is a relationship between DS use and anti-doping awareness in male adolescent elite athletes, as well as a gender difference; however, they did not consider anti-doping education and environmental factors such as training and the game period that could cause an unclear relationship between anti-doping

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awareness and DS use. Further, Chun *et al.* [11] reported that DS use by elite athletes is related with anti-doping education, and athletes educated about anti-doping use DS 80% more frequently compared to non-experienced doping education athletes; however, they did not consider gender, OS use, or doping education experience time.

Anti-doping awareness can be increased by anti-doping education. To improve anti-doping awareness, Korean elite athletes have received compulsory education since 2007. Anti-doping education is conducted one time per year upon request by sports event cities and province associations, national representative teams, professional physical education high schools, and national sports universities. Before an international game, all Korean athletes should receive compulsory anti-doping education. However, compared to sports advanced nations, such as the USA (1982) and Japan (2001) (Unpublished), Korea has little experience in periodical and compulsory anti-doping education. This fact may affect Korean athletes' anti-doping awareness. Moreover, it was reported that DS use can be increased by 77% under high anti-doping awareness status [7], which implies that anti-doping education may be very much important for enhancing athletes' anti-doping knowledge and awareness. DS use directly increases with age, along with expensive DS patterns [7]. According to previous studies, it is expected that there would be differences in DS use and anti-doping awareness between adolescent elite athletes [9] and elite athletes [11].

Although it is recognized that anti-doping education is practically important and needed for athletes and coaches, the relationship between anti-doping education and DS use remains unclear. Therefore, the purpose of this study was to investigate relationships between DS and OS use during the training and game periods, anti-doping education, gender differences in anti-doping knowledge, and awareness and anti-doping education. Our study results provide useful information for coaches and families and make athletes actively participate in doping education.

## Subjects and Methods

### *Participants*

Korea National Sport University athletes (343 male and 136 female) participated in this study. Athletes continuously undergo training for the Asian games, Olympic games, and world championships. All participants visited the sports science center from November 7, 2010 to December 14, 2010 and completed questionnaires. The questionnaires corresponded to a response rate of 98% (male: 97%, female: 98%) for all participants. Subject characteristics are presented in Table 1. Ethical approval was granted by the Human Research & Ethics Committee of Korea National Sport University, and written informed consent was obtained from each participant before completing the survey.

### *Study design*

This study was a descriptive and cross-sectional study, examining elite university athletes' training DS and OS practices (experience, intake reasons, intake information, and intake advice) and DS use immediately before game period (DS experience, DS use informants, beliefs in DS efficacy, anti-doping understanding related to DS use, and DS intake time). This study also investigated the degree of satisfaction of DS and OS use, perceived importance, beliefs in efficacy, anti-doping education experience, anti-doping education frequency, anti-doping education method, anti-doping informants, understanding of anti-doping guidelines provided by the Korea Anti-Doping Agency (KADA), anti-doping knowledge, and doping education importance. DS included sports foods, ergogenic aids, and herbal/traditional products. The description of DS also included information regarding OS, which by definition are animal and plant sources principally found in oriental, Chinese, Korean, and/or herbal medicine prescriptions. The World Health Organization defines East Asian medicine as a theory-based medicine that originated in ancient China, but has been modified and is now practiced in Korea, Japan, and Vietnam [13,14].

### *Questionnaires*

Participants completed a standardized questionnaire. Recent 1 year training DS and OS practice questionnaires included the following: intake experience (yes or no), intake reasons (open-ended responses), intake information (open-ended responses), intake informants (open-ended responses), DS use experience immediately before the game (yes or no), DS use informants immediately before the game (open-ended responses), beliefs in DS efficacy immediately before the game (100 mm visual analogue scale) [15], anti-doping understanding related to DS use immediately before the game (100 mm visual analogue scale), DS intake time immediately before the game (multiple choice), DS and OS satisfaction (100 mm visual analogue scale), DS importance level (100 mm visual analogue scale), beliefs in DS efficacy (100 mm visual analogue scale), anti-doping education experience (yes or no), anti-doping education frequency (open-ended responses), effective anti-doping education method (open-ended responses), anti-doping informants (open-ended responses), understanding of anti-doping guidelines provided by the KADA (100 mm visual analogue scale), anti-doping knowledge (100 mm visual analogue scale), and importance of doping education (100 mm visual analogue scale). Based upon a 100 mm visual analogue scale, we considered 50 mm as an average.

The questionnaire was developed and reviewed by health and sports professionals, including dietitians, sports medicine physicians and sports administrators, pharmacists, and researchers [7]. Clear and understandable words were used in the questionnaire. The questionnaire was evaluated for face validity; DS use experience (yes or no);  $\phi = 0.99$ , recent 1 year anti-doping education experience more than one time per year (yes or no);  $\phi = 0.98$

[16] with 75 varsity athletes from Yong-in University, Gyeonggi-do, Republic of Korea (DS use experience (yes or no); KR (Kuder-Richardson) 20 = 0.99). Recent 1 year anti-doping education experience more than one time per year questionnaire created for university varsity and professional athletes in Asia [4,6,7, 12,17,18]. By design, all participants completed the questionnaires in approximately 30 min. After participants completed and returned the questionnaire, we asked if they found any questions confusing. Then, we gave them a supplementary questionnaire containing few simplified questions. After collecting all questionnaires, we identified words and sentences that could potentially affect participants' responses.

### Statistical analysis

Based on a 95% confidence interval, with 2.5% marginal error, the minimum sample size required was 176 participants who completed questionnaires consisting of at least 101 male and 75 female athletes [19]. We performed statistical analyses using the Statistical Package for Social Science version 16.0 software (SPSS Inc., Chicago, IL, USA).

The descriptive statistics summarize participants' baseline characteristics according to age, height, weight, exercise career, training time per day, training time per week, DS and OS satisfaction, perceived importance, and response of beliefs in efficacy. We used Chi-square tests ( $\chi^2$ ) to examine training DS and OS practice (use experience, intake reasons, intake information, intake informants, DS use immediately before the game, DS use time immediately before the game), anti-doping education (anti-doping education experience and anti-doping education frequency), and anti-doping informants. Independent *t*-test was used to test beliefs in DS efficacy immediately before the game, anti-doping understanding related to DS use immediately before the game, DS and OS satisfaction, perceived importance, beliefs in efficacy, understanding of anti-doping guidelines provided by the KADA, doping knowledge status, and gender difference in doping education importance. Multiple response analysis was used to summarize responses of DS use types and effective doping education method during training and immediately before the game [20]. Logistics regression was used to estimate odds ratios (OR) and 95% confidence intervals (CI) for examination of anti-doping education experience and anti-doping education frequency related to DS and OS prevalence during the training period and immediately before the game. We set the significance level for all statistical data at  $P < 0.05$ . All data are presented as the mean  $\pm$  standard deviation (SD) and frequency (percent, %).

## Results

Four hundred and seventy-nine university athletes (male = 343, female = 136) participated in this study. Archery ( $n = 14$ ), badminton

**Table 1.** Summary of participant characteristics

Characteristics	All	Men	Women
Frequency (N (%))	479 (100)	343 (71.6)	136 (28.4)
Age, years	20.89 $\pm$ 1.03	20.92 $\pm$ 1.06	20.79 $\pm$ 0.97
Height, cm	173.69 $\pm$ 8.15	176.88 $\pm$ 6.46	165.63 $\pm$ 6.20
Weight, kg	71.08 $\pm$ 13.86	74.94 $\pm$ 13.16	61.35 $\pm$ 10.42
Exercise career, years	8.10 $\pm$ 2.42	7.95 $\pm$ 2.45	8.48 $\pm$ 2.31
Exercise time per day (N (%))			
Below 2 hours	7 (1.5)	5 (1.5)	2 (1.5)
Over 2- below 3 hours	73 (15.2)	56 (16.3)	17 (12.5)
Over 3- below 4 hours	169 (35.3)	122 (35.6)	47 (34.6)
Over 4- below 5 hours	144 (30.1)	100 (29.2)	44 (32.4)
Over 5- below 6 hours	58 (12.1)	40 (11.7)	18 (13.2)
Over 6 hours	28 (5.8)	20 (5.8)	8 (5.9)
Exercise time per week (N (%))			
Below 5 hours	21 (4.4)	13 (3.8)	8 (5.9)
Over 5- below 10 hours	10 (2.1)	10 (2.9)	-
Over 10- below 15 hours	47 (9.8)	36 (10.5)	11 (8.1)
Over 15- below 20 hours	121 (25.3)	91 (26.5)	30 (22.1)
Over 20- below 25 hours	161 (33.6)	112 (32.7)	49 (36.0)
Over 25 hours	119 (24.8)	81 (23.6)	38 (27.9)
Response rate (N (%))			
DS satisfaction	257 (53.7)	181 (52.8)	76 (55.9)
DS perceived importance	258 (53.9)	183 (53.4)	75 (55.1)
Beliefs in DS efficacy	439 (91.6)	310 (90.4)	129 (94.9)
OS satisfaction	216 (45.1)	152 (44.3)	64 (47.1)
OS perceived importance	412 (86.0)	285 (83.1)	127 (93.4)
Beliefs in OS efficacy	411 (85.8)	285 (83.1)	126 (92.6)

( $n = 18$ ), bowling ( $n = 13$ ), boxing ( $n = 23$ ), canoe ( $n = 19$ ), cycling ( $n = 8$ ), gymnastics ( $n = 23$ ), handball ( $n = 27$ ), hockey ( $n = 34$ ), Judo ( $n = 36$ ), modern pentathlon ( $n = 11$ ), rowing ( $n = 16$ ), skating ( $n = 16$ ), shooting ( $n = 29$ ), swimming ( $n = 24$ ), Taekwondo ( $n = 35$ ), tennis ( $n = 9$ ), throw ( $n = 17$ ), track ( $n = 48$ ), weightlifting ( $n = 24$ ), and wrestling ( $n = 35$ ) athletes participated in this study. Mean exercise time per day was 3-5 hours, accounting for over 60% of the total response, and there were no statistical differences according to gender. Mean exercise time per week was longer than 16 hours, accounting for over 80% of the total response, and no differences according to gender were detected (Table 1).

### DS and OS use during training period

DS and OS practices based on gender during the training period are presented in Table 2. Forty-six percent of athletes used DS during the training period, and there was significantly higher DS use by female athletes (53%) than males (43%) ( $P < 0.05$ ). Twenty-eight percent of athletes used OS, and there was significantly higher OS use in female athletes (35%) than males (26%) ( $P < 0.05$ ). The primary reason for DS use was to supply energy in both male (36%) and female (28%) athletes.

Moreover, reasons for prevalent DS use showed significant gender differences ( $P < 0.05$ ). Reasons for male athletes' DS use

**Table 2.** Dietary supplementation practices according to differences in gender.

	All	Men	Women	$\chi^2$
DS use	219 (45.7)	147 (42.9)	72 (52.9)	3.99*
Top 4 ranked reasons for taking DS				
Energy supplement	73 (33.3)	53 (36.1)	20 (27.8)	
Increase in strength, muscle mass, and muscle power	38 (17.4)	31 (21.1)	7 (9.7)	19.12**
Health maintenance	32 (14.6)	16 (10.9)	16 (22.2)	
Increase in fatigue recovery	31 (14.2)	18 (12.2)	13 (18.1)	
Top 3 ranked DS information				
Family	82 (37.4)	46 (31.3)	36 (50.0)	
Internet	54 (24.7)	44 (29.9)	10 (13.9)	18.66*
Health supplement stores	28 (12.8)	18 (12.2)	10 (13.9)	
Top 3 ranked DS informants				
Family	144 (65.8)	86 (58.5)	58 (80.6)	
Teammates	37 (16.9)	35 (23.8)	2 (2.8)	19.25**
Coaches	12 (5.5)	8 (5.4)	4 (5.6)	
OS use	136 (28.4)	88 (25.7)	48 (35.3)	4.45*
Top 4 ranked reasons for taking OS				
Energy supplement	47 (34.6)	36 (40.9)	11 (23.4)	
Health maintenance	20 (14.7)	11 (12.5)	9 (18.8)	18.05*
Improve recovery ability	20 (14.7)	10 (11.4)	10 (20.8)	
Improve energy use	13 (9.6)	10 (11.4)	3 (6.2)	
Top 3 ranked OS information				
Family	85 (62.5)	53 (60.2)	32 (66.7)	
Oriental doctors	20 (14.7)	12 (13.6)	8 (16.7)	7.62
Internet	7 (5.1)	6 (6.8)	1 (2.1)	
Top 3 ranked OS informants				
Family	115 (83.9)	74 (84.1)	41 (83.7)	
Coaches	9 (6.6)	5 (5.7)	4 (8.2)	0.47
Teammates	3 (2.2)	2 (2.3)	1 (2.0)	
DS use immediately before the game	194 (40.5)	134 (39.1)	60 (44.1)	1.03
OS use immediately before the game	92 (19.2)	63 (18.4)	29 (21.3)	0.52
Top 3 ranked DS informants before the game				
Family	113 (58.2)	70 (52.2)	43 (71.7)	
Coaches	32 (16.5)	25 (18.7)	7 (11.7)	14.46*
Teammates	16 (8.2)	15 (11.2)	1 (1.7)	
Intake trends immediately before the game				
30 mins after breakfast on the game day	125 (64.4)	84 (62.7)	41 (68.3)	
One hour before the game	21 (10.8)	19 (14.2)	2 (3.3)	
30 mins before the game	21 (10.8)	16 (11.9)	5 (8.3)	14.73**
10 mins before the game	14 (7.2)	11 (8.2)	3 (5.0)	
Re-intake right after the game	13 (6.7)	4 (3.0)	9 (15.0)	
Beliefs in DS efficacy immediately before the game (mean $\pm$ SD) <sup>†</sup>	6.90 $\pm$ 2.35	7.12 $\pm$ 2.70	6.40 $\pm$ 2.47	0.63 <sup>‡</sup>
Anti-doping understanding concerning DS intake right immediately before the game (mean $\pm$ SD) <sup>†</sup>	5.91 $\pm$ 2.52	5.73 $\pm$ 2.49	6.33 $\pm$ 2.58	-1.53 <sup>‡</sup>
DS satisfaction (mean $\pm$ SD) <sup>†</sup>	6.89 $\pm$ 2.78	6.73 $\pm$ 2.85	6.60 $\pm$ 2.62	0.34 <sup>‡</sup>
DS intake importance (mean $\pm$ SD) <sup>†</sup>	6.73 $\pm$ 2.61	6.79 $\pm$ 2.65	6.59 $\pm$ 2.49	0.59 <sup>‡</sup>
Beliefs in DS efficacy (mean $\pm$ SD) <sup>†</sup>	5.84 $\pm$ 2.55	5.82 $\pm$ 2.63	5.87 $\pm$ 2.35	-0.20 <sup>‡</sup>
OS satisfaction (mean $\pm$ SD) <sup>†</sup>	6.20 $\pm$ 2.95	6.23 $\pm$ 3.04	6.03 $\pm$ 2.76	0.45 <sup>‡</sup>
OS intake importance (mean $\pm$ SD) <sup>†</sup>	5.45 $\pm$ 2.71	5.54 $\pm$ 2.74	5.23 $\pm$ 2.63	1.10 <sup>‡</sup>
Beliefs in OS efficacy (mean $\pm$ SD) <sup>†</sup>	5.47 $\pm$ 2.74	5.43 $\pm$ 2.80	5.58 $\pm$ 2.62	-0.53 <sup>‡</sup>

\*  $P < 0.05$ , \*\*  $P < 0.01$ <sup>†</sup> 100mm visual analogue scale (minimum 0 (poor) to maximum 10 cm (excellent)) was used.<sup>‡</sup>  $t$  values based upon gender.

DS, dietary supplement; OS, oriental supplement

**Table 3.** Dietary supplementation pattern according to differences in gender.

	All	Men	Women
	During training period		
Top 4 ranked DS pattern			
Multi-vitamin	145 (70.0)	104 (75.9)	41 (58.6)
Vitamin C	78 (37.7)	50 (36.5)	28 (40.0)
Sports drink	38 (18.4)	17 (12.4)	21 (30.0)
Amino acid	36 (17.4)	30 (21.9)	6 (8.6)
Top 3 ranked OS pattern			
Red ginseng	80 (70.2)	47 (66.2)	33 (76.7)
Mixed oriental medicine <sup>†</sup>	51 (44.7)	34 (47.9)	17 (39.5)
Ginseng	12 (10.5)	8 (11.3)	4 (9.3)
Immediately before the game			
Top 4 ranked DS pattern <sup>†</sup>			
Multi-vitamin	72 (45.6)	55 (52.9)	17 (31.5)
Sports drink	67 (42.4)	37 (35.6)	30 (55.6)
Vitamin C	50 (31.6)	32 (30.8)	18 (33.3)
Amino acid	31 (19.6)	25 (24.0)	6 (11.1)
Top 3 ranked OS pattern			
Red ginseng	62 (67.4)	39 (61.9)	23 (79.3)
Mixed oriental medicine <sup>†</sup>	37 (40.2)	26 (41.3)	11 (37.9)
Ginseng	7 (7.6)	5 (7.9)	2 (6.9)

DS, dietary supplement; OS, oriental supplement

Top four ranked DS patterns during the training period; Multiple response rate resulted from 219 (male:  $n = 147$ , female:  $n = 72$ ) DS users. Response numbers including multiple answers (over 1 response) were 207 (male 137, female 70). Twelve participants were excluded (10 males and 2 females) because they answered they did not remember DS use.

Top three ranked OS patterns during the training period; Multiple response rate resulted from 136 (male:  $n = 88$ , female:  $n = 48$ ) OS users. Response numbers including multiple answers were 114 (male 71, female 43). Twenty-two participants were excluded (17 males and 5 females) because they answered they did not remember OS use.

Top four ranked DS patterns immediately before the game; Multiple response rate resulted from 194 (male:  $n = 134$ , female:  $n = 60$ ) DS users. Response numbers including multiple answers were 158 (male 104, female 54). Thirty-six participants were excluded (30 males and 6 females) because they answered they did not remember DS use.

Top three ranked OS patterns immediately before the game; Multiple response rate resulted from 92 (male:  $n = 63$ , female:  $n = 29$ ) OS users. Response numbers including multiple answers were 92 (male 63, female 29).

<sup>†</sup> Brewed with different herbs based on Korean/Oriental medicine prescriptions

were energy supplementation (36%) and increasing strength, muscle mass, and muscle power (21%). Reasons for female athletes' DS use were energy supplementation (28%) and health maintenance (22%) ( $P = 0.01$ ).

The main reason for male athletes' OS use was to supply energy (41%). Meanwhile, reasons for female athletes' OS use were to supply energy (23%), maintain health (19%), and improve recovery ability (20%), and these were significantly different according to gender ( $P < 0.05$ ). Family (31%) and Internet (30%) were the most often identified sources of DS information used by male athletes while family (50%) was the main source for female athletes, which showed a significant gender difference ( $P < 0.05$ ). The most often identified source of OS information was family for both genders, with no gender difference. Male athletes' DS informants were family (59%) and teammates (24%) while female athletes' DS informants were family (81%), which constituted

a significant gender difference ( $P < 0.05$ ). OS informants were family (84%), coaches (7%), and teammates (2%) for both genders, and there was no significant gender difference. DS and OS satisfaction, perceived importance, and beliefs in efficacy during the training period were all over average (over 50 mm), and there was no significant difference according to gender.

Table 3 shows dietary supplementation practice during the training period according to gender. During the training period, the top four ranked DS patterns were multi-vitamin (70%), vitamin C (38%), sports drink (18%), and amino acid (17%), whereas the top three ranked OS patterns were red ginseng (70%), mixed oriental medicine (45%), and ginseng (11%). DS and OS intake trends during the training period were similar between male and female athletes. The top four ranked DS patterns immediately before the game were multi-vitamin (46%), sports drink (42%), vitamin C (32%), and amino acid (20%), and this showed similar trends in gender. The top three ranked OS patterns immediately before the game were red ginseng (67%), mixed oriental medicine (40%), and ginseng (8%), and this also showed similar trends according to gender.

#### *DS use immediately before the game*

Dietary supplementation practice immediately before the game according to differences according to gender is shown in Table 2. DS use immediately before the game occurred in 41% of all participants, and there was no significant difference according to gender. DS informants immediately before the game were family (52%) and coaches (19%) for males and family (72%) for females, which constituted a significant difference according to gender. Female athletes' DS use immediately before the game occurred at 30 min after breakfast on game day. Male athletes showed higher response rates for DS use 1 hour and 30 min immediately before the game as compared to females, which was significantly different ( $P < 0.05$ ). Belief in DS efficacy immediately before the game and knowledge of anti-doping were higher in males than females; however, there was no significant difference according to gender (see Table 2).

#### *Knowledge and awareness in doping education*

The rate of doping education in all participants was 76% in this study (see Table 4). Periodical doping education experience was one time (66%), two times (24%), and over three times (10%) per year, and there was no significant difference according to gender. Athletes responded that the most effective doping education method was periodical anti-doping education provided by the Korea anti-doping agency (KADA) (71%). They also responded effective doping education method as follows: regular education by coaches immediately before the game (40%), periodical education by coaches (33%), anti-doping guidelines provided by the KADA (27%), and the Internet (25%). Anti-doping informants were more frequently found in the KADA

**Table 4.** Anti-doping education and pattern according to differences in gender

	All	Men	Women	$\chi^2$
Rate of doping education (n = 479)	363 (75.8)	258 (75.2)	105 (77.2)	0.21 <sup>*</sup>
Doping education experience per year				
1 time	241 (66.4)	178 (69.0)	63 (60.0)	
2 time	86 (23.7)	58 (22.5)	28 (26.7)	3.20 <sup>*</sup>
over 3 times	36 (9.9)	22 (8.5)	14 (13.3)	
Effective methods in doping education <sup>#</sup>				
Periodical education by anti-doping agency	293 (70.8)	205 (68.1)	88 (77.9)	
Education by coaches immediately before the game	167 (40.3)	126 (41.9)	41 (36.3)	
Periodical education by coaches	137 (33.1)	99 (32.9)	38 (33.6)	
Guideline provided by anti-doping agency	113 (27.3)	74 (24.6)	39 (34.5)	-
Internet	103 (24.9)	81 (26.9)	22 (19.5)	
Professional books	83 (20.0)	57 (18.9)	26 (23.0)	
Others	14 (3.4)	10 (3.3)	4 (3.5)	
Top 4 ranked anti-doping informants (n = 479)				
Periodical education by anti-doping agency	207 (43.2)	138 (40.2)	69 (50.7)	
Coaches	195 (40.7)	144 (42.0)	51 (37.5)	8.11 <sup>*</sup>
Teammates	27 (5.6)	21 (6.1)	6 (4.4)	
Professional books	19 (4.0)	13 (3.8)	6 (4.4)	
Understanding guideline provided by anti-doping agency (mean $\pm$ SD) <sup>†</sup>	5.76 $\pm$ 2.39	5.76 $\pm$ 2.40	5.77 $\pm$ 2.38	-0.035 <sup>**</sup>
Anti-doping knowledge (mean $\pm$ SD) <sup>†</sup>	5.29 $\pm$ 2.58	5.17 $\pm$ 2.66	5.60 $\pm$ 2.34	-1.611 <sup>**</sup>
Importance of anti-doping education (mean $\pm$ SD) <sup>†</sup>	7.13 $\pm$ 2.52	7.08 $\pm$ 2.60	7.25 $\pm$ 2.29	-0.660 <sup>**</sup>

\* No statistical difference between men and women.

<sup>†</sup> 100 mm visual analogue scale (minimum 0 (poor) to maximum 10 cm (excellent) was used.

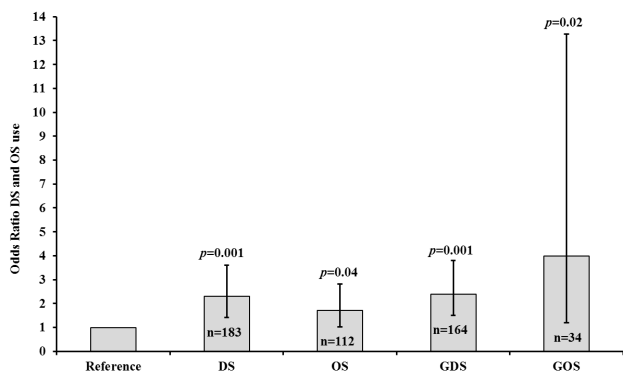
<sup>‡</sup> *t* values based upon gender.

<sup>#</sup> Results are presented as multiple response rates. Response numbers including multiple answers were 414 (male 301, female 113).

(43%) and in coaches (41%), and there was no significant difference according to gender. Understanding of the guidelines provided by the KADA and doping knowledge was above average (over 50 mm) for both genders.

*Relationship in doping education and DS use*

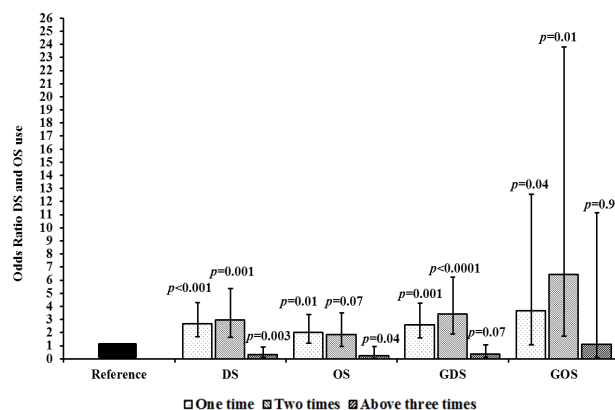
Fig. 1 shows the relationship between doping education and DS and OS use during the training period and before the game.



**Fig. 1.** Odds ratios (OR) with 95% confidence intervals (95% CI) for DS and OS prevalence in anti-doping education, including all participants with all measurements (n = 479). The analysis is adjusted for age, exercise career, exercise time per day, and exercise time per week. Abbreviations: DS, dietary supplements; OS; oriental supplements; GDS, dietary supplements use immediately before the game; oriental supplements use immediately before the game.

In a comparison of doping education between experienced athletes (at least over one time) and non-experienced athletes, DS and OS use during the training period was 2.30 (1.47-3.60) and 1.71 (1.03-2.82), respectively. DS and OS use immediately before the game was 2.38 (1.50-3.80) and 3.99 (1.20-13.28), respectively.

Regarding the rate of doping education, DS use during the



**Fig. 2.** Odds ratios (OR) with 95% confidence intervals (95% CI) for DS and OS prevalence in anti-doping education frequency, including all participants with all measurements (n = 479). The analysis is adjusted for age, exercise career, exercise time per day, and exercise time per week. Non-experienced doping education group was referred, and OR was calculated and divided by 1, 2, and 3 times. Abbreviations: DS, dietary supplements; OS; oriental supplements; GDS, dietary supplements use immediately before the game; oriental supplements use immediately before the game.

training period was as follows: one time 2.67 (1.66-4.29), two times 2.97 (1.64-5.37), and more than three times 0.32 (0.11-0.91). OS use during training was one time 2.0 (1.18-3.38), two times 1.83 (0.96-3.49), and more than three times 0.21 (0.05-0.94).

Regarding the rate of doping education, DS use immediately before the game was as follows: one time 2.60 (1.59-4.23), two times 3.42 (1.88-6.23), and more than three times 0.35 (0.11-1.07). OS use immediately before the game was one time 3.66 (1.07-12.56), two times 6.44 (1.74-23.81), and more than three times 1.12 (0.11-11.17) (see Fig. 2).

## Discussion

The data show that DS and OS use by Korean elite university athletes was 46% and 28%, respectively. The data demonstrate that female athletes used DS and OS significantly more compared to males. Seventy-six percent of all participants experienced doping education in the past year, and there were strong associations among doping education and DS and OS use during training and immediately before the game period.

Most previous studies have reported that elite athletes' DS use during training is between 45-95% [1-6]. Sundgot-Borgen *et al.* [4] and Erdman *et al.* [21] reported that no difference in DS use in elite athletes during training period, which is in contrast with our present study. Further, previous studies did not clearly explain the reason for gender differences in DS use, which makes a comparison with our study results impossible. Nevertheless, there were gender differences in reasons for DS use, DS use information, and DS use informants. This finding may imply that gender is the main reason for the differences in DS use. Regarding OS use during the training period, there were no differences in OS use information and informants. However, only the reasons for OS use displayed gender differences. These data suggest that gender primarily affected DS and OS use as opposed to information and informants. Moreover, Kim *et al.* [7] reported that the Korean national team participating at the 29<sup>th</sup> Beijing Olympic games displayed no gender differences in DS and OS use or reasons for DS use during training and immediately before the game period, which was in agreement with our study.

Until now, elite athletes' DS use immediately before and after the game has only been reported in Olympic athletes [1-3,7]. Our data show that DS and OS use by elite university athletes immediately before the game was 41% and 19%, respectively, which is higher than Olympic athletes' DS use (14%) reported by Kim *et al.* [7]. Our study participants' mean age was 20.9 years, which is younger than Olympic athletes' mean age. Younger age might result in higher DS and OS use immediately before the game. In addition, our study results show that DS use immediately before the game was higher in younger age athletes. We also verified DS use time trend, and found that 64% of athletes in this study used DS 30 min after breakfast. However,

we cannot explain this intake trend since there are no similar reports. We generally assumed that the highest DS use trend on game day in the morning might have been due to family recommendation. Previous studies reported that DS use immediately before the game mostly was the result of family as informants [4,6,7]. In accordance with this result, our study found that family was the main reason for DS and OS use by male and female athletes during training period and immediately before the game.

It is considered that DS or OS use immediately before the game might be related to doping. Our data show that understanding of anti-doping with DS use immediately before the game was 59.1 mm while belief in DS efficacy immediately before the game was 69 mm. These results were higher compared to those for belief in DS (58.4 mm) and OS (54.7 mm) during the training period, which ensures that athletes believed in the benefits of DS and OS use. Moreover, satisfaction and importance of DS and OS use during the training period were above average in both males and females with no differences according to gender, which suggests that positive attitudes toward DS and OS use. Consequently, athletes' satisfaction, perceived importance, and belief in efficacy of DS and OS use may be related to the reasons for DS and OS intake. We assumed that no changes in athletes' satisfaction, perceived importance, and belief in efficacy of DS and OS use might cause any gender differences, even though they had different DS and OS use reasons.

The patterns of DS and OS use during the training period were mainly in the forms of multi-vitamin (70%) and red ginseng (70%) both for males and females. Based on previous studies, it was reported that elite athletes mainly consumed DS in the forms of multi-vitamin and vitamin C [2-4,6,7,9,12,17,21]. The importance of vitamin intake was reported to increase athletic performance among DS intake reasons [22]; however, vitamin was not reported in a strict double blinded test concerning practical performance. DS and OS intake patterns during the training period were in accordance with DS and OS intake patterns immediately before the game. Therefore, future study would be needed to examine elite athletes' DS intake for increasing athletic performance.

The interesting finding of this study is that doping education was found to be related to DS and OS use during the training period and immediately before the game. Specially, anti-doping education seemed to increase DS and OS use during the training period and immediately before the game, which proved anti-doping education was directly related to elite athletes' proper DS use. Our data suggest that periodical anti-doping education was the most effective way to prevent doping issues. Further, our data reveal that understanding the guidelines provided by the KADA (57.6 mm), anti-doping knowledge (52.9 mm), and anti-doping education importance (71.3 mm). In agreement with our study, Kim and colleagues [9] reported that doping education caused increased DS intake in junior athletes throughout the training period, and similar results were shown in adult elite

athletes [11]. This result ensures that anti-doping education is important for proper DS use. DS and OS use during training and immediately before the game period increased as anti-doping education frequency was increased; however, we found that elite athletes who experienced anti-doping education more than three times experienced decreased DS and OS intake, which was very unique. This previously unreported result clearly explained the association between anti-doping education and DS use. In Korea, most anti-doping education is conducted before high-level competitions by the KADA. Elite athletes who experienced anti-doping education more than three times mostly participate in high-level competition games. Therefore, they may think of DS and OS intake and this might be a possible reason to decrease DS and OS use. Future studies need to more clearly determine the reasons for DS use and verify the relationship between anti-doping education time, athletes' performance levels, and doping knowledge followed by education, doping awareness, and DS use.

In conclusion, elite athletes' anti-doping education is highly related to increased DS use during the training period and immediately before the game. Korean elite university athletes showed higher OS use compared to Western athletes. Therefore, safe supplement recommendations are needed by athletes.

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