Mal J Nutr 23(3): 409 - 423, 2017

Knowledge and Attitude Related to Nutritional Supplements and Risk of Doping among National Elite Athletes in Malaysia

Balaravi B [1], Chin MQ[1], Karppaya H[2], Chai WJ[2], Samantha Quah LW[1] & Ramadas A[1]

[1] *Jeffrey Cheah School of Medicine and Health Sciences, Monash University Malaysia, Jalan Lagoon Selatan, 47500 Bandar Sunway, Malaysia*
[2] *National Sports Institute, National Sports Complex, Bukit Jalil, 57000 Kuala Lumpur, Malaysia*

ABSTRACT

Introduction: Often considered a legitimate strategy to enhance health and performance, the consumption of nutritional supplements (NS) has become a common practice which frequently results in unintentional doping among athletes. Despite a probable association between NS and doping, there are limited studies on this topic in developing countries such as Malaysia. Thus, this study aimed to identify the prevalence of NS usage among national elite athletes and assess their knowledge and attitude regarding its use and doping. **Methods:** This was a cross-sectional study conducted at the Malaysian National Sports Institute among national elite athletes (n=50) recruited via convenience sampling. The athletes completed a self-administered questionnaire documenting their demographic characteristics, training information, NS consumption, knowledge and attitude related to supplement-doping. The total knowledge and attitude scores were compared according to demography, training information, and NS consumption. **Results:** The prevalence of NS use among the athletes was 72%. NS usage was significantly associated with training duration (p=0.029), source of nutrition information (p=0.047) and self-exploration on supplements (p=0.045). Supplement-doping knowledge was significantly higher among athletes with tertiary level education (p=0.027), NS users (p=0.044), those obtaining information from nutritionists (p=0.048) and those who had attended nutrition workshops (p<0.001). The attitude score was significantly higher among males (p=0.021), professional athletes (p=0.041), athletes with lower training hours (p=0.010), those obtaining information from nutritionists (p=0.035) and those who had attended nutrition workshops (p=0.005). **Conclusion:** A demographic- and training-specific education on NS should be provided by qualified nutritionists to reduce the risk of doping amongst athletes.

Key words: Athletes, attitude, doping, knowledge, nutritional supplements

Correspondence: Amutha Ramadas; Email: *amutha.ramadas@monash.edu*

INTRODUCTION

Consumption of nutritional supplements (NS) among athletes is a common practice as part of their regular training routine. Athletes are often regarded to be among the heaviest users of NS (Nichols & Harrigan, 2006; Maughan, Depiessen& Geyer, 2007). A recent study established the prevalence of supplementation to be as high as 97.2% among athletes with 84.7% of them having used NS within the last four weeks (Wardenaar *et al.,* 2017). The use of NS has become a legitimate part of the strategy employed by many athletes in the pursuit of sport achievements, and NS may be used without consideration of possible negative consequences such as doping.

Doping refers to the usage of prohibited methods or substances in athletes in order to improve performance (Lun *et al.,* 2012). The World Anti-Doping Agency (WADA), under the leadership of the International Olympic Committee (IOC), was established to fight doping in sports at an international level. WADA reviews the prohibited substance list annually, ensuring that it is updated with the latest trends of illegal performance-enhancing methods. The use of NS, however, has been a grey area. As more drugs are included on the list of prohibited substances, NS has gained popularity to enhance performance "legally". Unfortunately, most athletes rely on information given through product pamphlets or sales agents on the effectiveness of NS without being aware that some of the NS can be contaminated with doping substances on the list of banned substances by the IOC. Studies have shown that at least 25% of marketed NS is contaminated with prohibited substances or harmful ingredients (Geyer *et al.,* 2008).

Athlete awareness of the contents of NS and their potential effects on doping is often questionable. Regarded as food rather than medicine, the inadequacies of current NS regulations prevent athletes from knowing the actual nature and quantity of the contents of the product. This practice of consuming NS without knowledge of its contents puts athletes at a high risk of doping. More than half of the athletes interviewed by Somerville *et al.* (2005) admitted to consuming NS, but only four athletes admitted to the unintentional consumption of banned substances. While this may be a reason to rejoice, this could also mean that some athletes are consuming NS that can potentially lead to doping without even realising it. Often, athletes rely on dietary products with presumed ergogenic properties as an alternative to prohibited performance enhancement drugs (PEDs) (Petroczi *et al.,* 2007). As such, it is believed that whilst athletes may not have the intention to cheat, human factors like poor knowledge of NS, the desire to improve training performance, and learning difficulties may be the main contributors to the accidental intake of such banned substances.

The inaccurate labelling of product composition serves as another additional contributing factor to doping, since the ingredients on the NS label may not reflect the exact content of NS. For example, caffeine and ephedrine are rarely clearly indicated on the label (Kamber *et al.,* 2001). Caffeine is often marketed as a substance that aids rapid weight loss, fatigue prevention, energy production, and ultimately accentuates endurance performance in athletes. The inter-individual variations in caffeine metabolism, the unknown concentration of caffeine in the supplement and its interactions with other supplements which could interfere with the caffeine metabolism could all lead to elevated levels of caffeine in the urine, and possibly produce a positive test result (Graham, 2001; Pipe & Ayotte, 2002).

Invariably, NS would serve as a safe alternative to doping products, except in a few instances. For an example, there is

a common tendency for athletes to abuse NS by consuming increased dosages or combining different supplements together at one go, a term known as "stacking" (Petroczi *et al.,* 2007). NS use has been implied to be the gateway to doping in the future in that young athletes who are experimenting with NS may be more open (Petroczi, Mazanov & Naughton, 2011) and biased to the concept of consuming prohibited substances (Kandel, 2002; Backhouse, Whitaker & Petróczi, 2013). According to Kandel's gateway theory, there is a sequential relationship between legal and illegal substances because of the positive nature of relationship between these two factors (Kandel, 2002).

The main reason for the usage of NS in athletes differ from that of most people, as their focus centres around performance enhancement, as well as prevention, treatment and rehabilitation from illness or injuries (Lun *et al.,* 2012). Intention to use and the awareness of the risks of NS usage is critical in ensuring effective nutrition education intervention for athletes. Hence, it is important to first establish the current level of knowledge and attitude of athletes towards the supplement-doping relationship. Unfortunately, available data on this topic are limited and there are no published data on Malaysian athletes. Given the absence of such vital baseline information, sports nutritionists and physicians face a major obstacle in designing an appropriate program for this target group. Hence, this study is aimed at determining the knowledge and attitude of national elite athletes of Malaysia with regard to NS and its possible relationship with doping.

METHODS

Study design

We conducted a cross-sectional study among national elite athletes (n=50) who were based at the National Sports Institute, Malaysia. All national athletes training with the National Sports Institute were eligible to participate in this study. The study received ethical approval from the Monash University Human Research Ethics Committee (CF13/3446 – 2013001774) and permission from the National Sports Institute's Research Committee.

Participants

We employed a convenience sampling technique to recruit the study participants. Eligible participants were identified by the sports physician or sports nutritionist during training (South East Asia Games, Asian Games and World Championships) or during routine health check-ups at the clinics in the National Sports Institute. Athletes under 18 years old, those unable to comprehend the study questionnaire or explanation by researchers in English and/or Bahasa Malaysia, and those with incomplete routine anthropometry data were excluded from this study.

A minimum sample size of 49 was required to an estimated prevalence of NS use of 85% (Wardenaar *et al.,* 2017) at 10% precision and 95% confidence level. We identified 64 eligible athletes during the recruitment period and they were given a briefing on the study, accompanied by an explanatory statement and consent form. Athletes who agreed to voluntarily participate in the study were then required to sign and return the consent form to the study researcher. Of the 64 eligible participants identified, 50 athletes agreed to participate in the study.

Study instrument

The questionnaires were made available in two languages, Bahasa Malaysia and English in which the participants either responded to the questions from a list of options or provided an open-ended response. On completion ,the questionnaires were collected immediately.

In addition to demography and training information, the questionnaire

also included a list comprising of eleven types of NS. Athletes were asked to select the NS that they were consuming and to include details of the frequency, duration and rationale of consumption of each NS.

There were sixteen items related to knowledge and eight items related to attitude towards supplement-doping relationship. Every correct response to the knowledge items was awarded one point, while no points were deducted for wrong responses. The attitude items were scored according to a Likert scale ranging from "definitely no" = 1 to "definitely yes" = 5 (5 items), and inverse scoring was imposed for negative statements (3 items). Possible full score for knowledge was 16 and attitude was 40. Higher scores indicate higher inclination towards positive knowledge or attitude concerning supplement-doping.

The language and format of the questionnaire was kept simple for easier understanding. An expert panel comprising of sports nutritionists and physicians determined the content validity, while a group of athletes (n=10) assessed the face validity of the instrument prior to data collection. The internal consistency (Cronbach's alpha) for knowledge and attitude sections was 0.751 and 0.787, respectively.

Statistical analysis

The open-ended responses were summarised descriptively. Frequencies and percentages were used to describe the athletes and their NS usage pattern. The mean supplement-doping related knowledge and attitude scores were normally distributed and were compared across the demography, training information and NS usage using independent *t*-test or one-way ANOVA. Post-hoc Bonferroni was performed when there was a significant difference in mean scores in one-way ANOVA. Statistical analysis was conducted using the IBM® SPSS®Statistics 23.0 and statistical significance was set at $p<0.05$.

RESULTS

Thirty three male and 17 female national elite athletes with a median age of 22 (IQR=6) participated in this study. The majority of the participants were professional athletes (56%), had secondary level education (74%), were involved in intermittent sports (46%) such as combat sports and had international exposure (92%). Only 40% of them were at the competition-level training at the time of interview. The majority trained more than 16 hours per week and 48% of them expressed the desire to increase their training hours. This is especially important as current duration of training was significantly associated with the use of NS (p=0.029). Table 1 describes the overall demographic and training characteristics of the athletes.

Current NS usage was recorded in 74% of the respondents (Table 2). Nutritionists were the primary source of information of NS (66%), followed by the physicians (12%) and coaches (12%). There was a significant association between source of information on NS and NS usage (p=0.047). A higher proportion of users (70.3%) received NS information from nutritionists compared to non-users (53.8%). We also noted a higher proportion of non-users receiving NS information from coaches compared to users (30.8% vs. 5.4%). In addition, a significantly higher proportion of users self-explored information on NS compared to non-users (91.9% vs. 69.2%, p=0.045).

Those who consumed NS were grouped into three major categories – dietary/medical, muscle building/repair and performance foods (Table 3). The three most common NS consumed were energy/sports drink (83.8%), protein drink/powder (54.1%) and multivitamin (54.1%). Almost all NS except energy/sports drink, had being consumed for lesser than 6 months albeit with variation in frequency of usage. Nine of eleven NS were said to be consumed for its energy enhancement properties.

Table 1. Demographics and training characteristics of athletes

		Total	*Supplement usage*		*P*
		(n=50)	*Users (n=37)*	*Non-users (n=13)*	
Demography					
Age (years)	Median (IQR)	22.0 (6.0)	23.0 (6.0)	21.0 (4.0)	0.201[a]
Gender	Male	33 (66.0)	27 (73.0)	6 (46.2)	0.099
	Female	17 (34.0)	10 (27.0)	7 (53.8)	
Highest level of education	Secondary	37 (74.0)	25 (67.6)	12 (92.3)	0.141
	Tertiary	13 (26.0)	12 (32.4)	1 (7.7)	
Occupation	Student	22 (44.0)	16 (43.2)	6 (46.2)	0.856
	Professional athlete	28 (56.0)	21 (56.8)	7 (53.8)	
Sports and training information on sports type	Endurance	16 (32.0)	13 (35.1)	3 (23.1)	0.535
	Intermittent	23 (46.0)	15 (40.5)	8 (61.5)	
	Power/ strength	11 (22.0)	9 (24.3)	2 (15.4)	
Current level of training	Preparatory / Training	30 (60.0)	22 (59.5)	8 (61.5)	0.895
	Competition	20 (40.0)	15 (40.5)	5 (38.5)	
Average training duration (hours/week)	<15	6 (12.0)	5 (13.5)	1 (7.7)	0.029*
	16 – 25	21 (42.0)	19 (51.4)	2 (15.4)	
	>25	23 (46.0)	13 (35.1)	10 (76.9)	
Highest level of competition ever participated	National	4 (8.0)	4 (10.8)	0 (0.0)	0.561
	International	46 (92.0)	33 (89.2)	13 (100.0)	
Intention to increase training hours	Yes	24 (48.0)	17 (45.9)	7 (53.8)	0.624
	No	26 (52.0)	20 (54.1)	6 (46.2)	

Data presented as n(%) unless indicated.
Chi square or Fisher's Exact Test was used to test association between all categorical variables and nutritional supplement usage.
[a]Mann Whitney Rank U Test
*significant at $p<0.05$.

Table 4 represents a comparison of mean supplement-doping related knowledge and attitude scores of the study participants. The mean knowledge was significantly higher among athletes with tertiary level education compared to those with secondary-level education (mean Δ=1.495, 95% CI=0.178-2.812, p=0.027). Male athletes had a better attitude score compared to female athletes (mean Δ=2.383, 95% CI=0.383-4.383, p=0.021), while professional athletes had a better attitude score than athletes who were still studying or working full-time elsewhere (mean Δ=1.935, 95% CI=0.005-3.875, p=0.041). Surprisingly, athletes who had intention to increase training hours had a lower attitude score compared to athletes who did not plan to train more (mean Δ=-2.506, 95% CI=-4.376-0.636, p=0.010).

Table 2. Self-reported information received on supplements and doping according to nutritional supplement usage

		Total	*Supplement usage*		*P*
		(n=50)	*Users (n=37)*	*Non-users (n=13)*	
Source of information on supplements	Nutritionist	33 (66.0)	26 (70.3)	7 (53.8)	0.047*
	Physician	6 (12.0)	4 (10.8)	2 (15.4)	
	Coach	6 (12.0)	2 (5.4)	4 (30.8)	
	Internet	5 (10.0)	5 (13.5)	0 (0.0)	
Self-exploration on supplements	Yes	43 (86.0)	34 (91.9)	9 (69.2)	0.045*
	No	7 (14.0)	3 (8.1)	4 (30.8)	
Attendance at nutrition workshops	Yes	28 (56.0)	23 (62.2)	5 (38.5)	0.139
	No	22 (44.0)	14 (37.8)	8 (61.5)	
Awareness on possible supplements-doping relationship	Yes	19 (38.0)	15 (40.5)	4 (30.8)	0.610
	No	31 (62.0)	22 (59.5)	9 (69.2)	
Accessibility to WADC[1] 2013 Prohibited list	Yes	20 (40.0)	17 (45.9)	3 (23.1)	0.197
	No	30 (60.0)	20 (54.1)	10 (76.9)	
Awareness of WADA[2] list of banned substances and methods	Yes	31 (62.0)	25 (67.6)	6 (46.2)	0.199
	No	19 (38.0)	12 (32.4)	7 (53.8)	

Data presented as *n* (%).
Chi square or Fisher's Exact Test was used to test association between all categorical variables and supplement usage.
*significant at p<0.05.
[1]WADC – World Anti-Doping Code
[2]WADA – World Anti-Doping Agency

The knowledge and attitude scores were also compared according to NS usage (Table 5). Those who were consuming NS had higher level of knowledge score compared to those who do not consume NS (mean Δ=1.312, 95% CI=0.021-2.645, p=0.044). We also found the mean supplement-doping related knowledge score to be higher among those who did self-exploration on NS (mean Δ=2.260, 95% CI=0.551-3.968, p=0.011). Nutritionists and nutrition education were found to impact the level of knowledge and attitude of the athletes. Post-hoc analysis also revealed the mean knowledge and attitude score to be significantly higher among athletes who received their NS information from a nutritionist, as compared to a coach (mean knowledge Δ=4.015, 95% CI=0.020-8.010, p=0.048 and mean attitude Δ=2.545, 95% CI=0.120-4.970, p=0.035). Those who had attended nutrition workshops also scored significantly higher in both domains as compared to athletes who did not attend a formal workshop (mean knowledge Δ=2.214, 95% CI=1.171-3.258, *p*<0.001 and mean attitude Δ=2.747, 95%CI=0.891-4.602,p=0.005).

DISCUSSION

Almost three-quarter of the study sample were consuming NS at the time of

Table 3. Nutritional supplement usage pattern

Type of supplements	*Usage % of usage*	*Most common response among users*						
		Frequency usage		*Duration for consumption*		*Rationale*		
		times/week		*%*	*months*	*%*	*%*	
Dietary/ medical	Multivitamin	54.1	5 – 6	35.0	<6	40.0	Recovery	35.0
	Ginkgo biloba	24.3	3 – 4	33.4	<6	44.4	Energy	44.4
	Ginseng	16.2	3 – 4	33.3	<6	50.0	Energy	50.0
	Other traditional / herbal	18.9	5 – 6	50.0	<6	50.0	Energy	25.0
Muscle building / repair	Carnitine	18.9	1 – 2	42.9	<6	57.1	Energy	14.3
	Chondrotin sulphate / glucosamine / MSM	16.2	5 – 6	50.0	<6	50.0	Recovery	33.3
	Caffeine	16.0	5 – 6	37.5	<6	50.0	Energy	25.0
Performance foods	Energy / sports drink	83.8	3 – 4	44.4	7 – 12	32.3	Energy	45.2
	Energy / sports bar	43.2	1 – 2	62.5	<6	31.3	Energy	50.0
	Protein drink / powder	54.1	3 – 4	40.0	<6	30.0	Energy	30.0

interview, which is well within the ranges reported by previous studies (55-98%) (Nieper, 2005; Somerville *et al.*, 2005; Wiens *et al.,* 2014).

Among the most used supplements reported were energy/sports drinks (83.8%), protein drinks/powder (54.1%), and multivitamins (54.1%). Energy/sports drinks and protein-based supplements are performance foods, which support the hypothesis that most of these supplements are used to improve the athletes' performance as a substitute to illicit substances. Most of the participants claimed to consume NS as an energy booster, even though the actual contents of the NS taken did not fit this description. While this may point to discrepancies dueto a lack of knowledge about the supplement taken, it could also be due to data collection issues such as differences in terminology used; for instance, taking a protein supplement for "energy purposes" after a workout might have been intended to mean for "recovery purposes" by the athletes, but the student researchers may not have probed further to capture the necessary keywords, resulting in a misrepresentation of the athletes' answers.

The number of training hours appeared to influence the use of NS – there was a proportional association between training hours and use of NS; athletes who trained for longer periods of time had a higher likelihood of using NS(88% of NS users spend more than 15 hours training per week). It is likely that the athletes believed that exercise increased the need for nutritional supplementation. This is in accordance with several studies which demonstrated that athletes participating in sports with high anaerobic demands and high risk of injury are the ones most inclined to engage in doping. These include sports with lots of tackle activity like rugby, and weight lifting, which involves high

Table 4. Mean difference in nutritional supplement-doping knowledge and attitude scores according to athletes 'characteristics

		Knowledge Score				*Attitude Score*			
		Mean(SD) difference	*Mean*	*95% CI*	*P*	*Mean(SD) difference*	*Mean*	*95% CI*	*P*
Demography									
Age (years)	<25	9.40 (2.23)	-1.133	-2.419 -0.153	0.083	27.03 (3.66)	-0.638	-2.818-1.542	0.559
	>25	10.53 (1.64)				27.67 (3.13)			
Gender	Male	10.03 (2.01)	0.854	-0.406 -2.114	0.179	28.03 (3.26)	2.383	0.383-4.383	0.021*
	Female	9.18 (2.27)				25.65 (3.48)			
Highest level of education	Tertiary	10.85 (2.41)	1.495	0.178 -2.812	0.027*	28.23 (4.04)	1.366	-0.885-3.617	0.228
	Secondary	9.35 (1.89)				26.86 (3.26)			
Occupation	Student	9.32 (2.21)	0.753	-0.452 -1.959	0.215	26.14 (4.05) 28.07 (2.76)	1.935	-0.005-3.875	0.041*
	Professional athlete	10.07 (2.02)							
Training information									
Sports type [a]	Endurance Intermittent Power /strength	10.31 (2.50) 9.30 (1.89) 9.82 (1.94)			0.347	28.19 (3.39) 27.26 (3.78) 25.73 (2.65)			0.200
Current level of training	Preparatory /Training	9.60 (2.11)	0.350	-0.889 -1.589	0.572	27.55 (2.69)	0.550	-1.490-2.590	0.590
	Competition	9.95 (2.14)				27.00 (4.00)			
Duration of training (hours/week)[a]	<15 16-25 >25	10.67 (1.86) 9.81 (2.02) 9.43 (2.27)			0.447	28.00 (2.68) 27.52 (3.33) 26.74 (3.86)			0.648

Highest level of competition	National	9.75 (2.22)	0.011	-2.231 -2.253	0.992	28.00 (3.16)	0.848	-2.839-4.535	0.646
	International	9.74 (2.13)				27.15 (3.54)			
Intention to	Yes	9.50 (2.28)	-0.462 -0.748	-1.672	0.447	25.92 (3.83)	-2.506	-4.376-0.636	0.010*
increase training hours	No	9.96 (1.97)				28.42 (2.69)			

Data were normally distributed and analysed with Independent t-test or aone-way ANOVA
*significant at $p<0.05$

Table 5. Mean difference in nutritional supplement-doping knowledge and attitude scores according to current supplement usage

		Knowledge score				*ttitude score*			
		Mean(SD)	*Mean difference*	*95% CI*	*P*	*Mean(SD)*	*Mean difference*	*95% CI*	*P*
Current consumption of supplements	Yes No	10.08 (2.09) 8.77 (1.96)	1.312	-0.021-2.645	0.044*	27.35 (3.75) 26.85 (2.70)	0.505	-1.775-2.786	0.658
Number of supplements consumed	<3 4 – 6 >6	10.04 (1.76) 10.75 (1.98) 9.20 (3.56)			0.435	27.17 (3.83) 28.50 (3.82) 26.40 (3.58)			0.581
Source of information on supplements	Nutritionist Physician Coach Internet	7.67 (1.51) 10.20 (3.70)	10.21 (1.78)[b] 8.83 (1.60)			0.028*	28.18 (3.04)[c] 26.50 (2.81) 24.17 (4.45) 25.40 (3.78)		0.028*
Self-exploration on supplements	Yes No	10.09 (1.89) 7.83 (2.40)	2.260	0.551-3.968	0.011*	27.53 (3.53) 25.17 (2.93)	2.368	-0.673-5.409	0.124
Attendance at nutrition workshops	Yes No	10.71 (1.46) 8.50 (2.20)	2.214	1.171-3.258	<0.001**	28.43 (3.26) 25.68 (3.21)	2.747	0.891-4.602	0.005*

Data were normally distributed and analysed with Independent *t*-test or aone-way ANOVA and post-hoc Bonferroni.

[b]Mean knowledge score was significantly higher in athletes getting information from nutritionists compared to coaches (Mean Δ=4.015, 95%CI=0.020-8.010, p=0.048).

[c]Mean attitude score was significantly higher in athletes information from nutritionists compared to coaches (Mean Δ=2.545, 95% CI=0.120-4.970, p=0.035).

*significant at p<0.05; **significant p<0.001

intensity training, working with heavy workloads (Sekulic *et al.,* 2014).In fact, some of the athletes from this study responded that the usual routine include immediate glucose supply to sustain throughout the training, sports drinks for rehydration and proteins for recovery due to high amounts of energy requirement during intensive training sessions. Intention to increase training hours has also been associated with a poorer supplement-doping attitude. It has been shown that athletes who are dependent on motivation by others, i.e. through the social approval of their peers, and have performance-oriented goals as a display of superiority against other competing athletes, are more prone to accepting the doping culture compared to individuals who are self-motivated, have mastery-oriented goals and focus on personal improvement (Barkoukis *et al.,* 2011). Hence, emphasis should lie on investigating the reasons behind the athlete's increased training hours as it may be a gateway to obtaining performance-enhancing supplements, and ultimately increase doping risk.

Interestingly, this study shows that professional male athletes have a better supplement-doping attitude than females; and this may boil down to the fact that unlike female athletes who consume more general health category supplements such as multivitamins, males are generally more inclined to taking protein supplements and ergogenic aids (i.e.protein, BCAA, creatine, glutamine) which are muscle-bulking agents, and are hence more likely to be aware of the doping issues related to such products. On the contrary, Sas-Nowosielski & Swiatkowska (2008) reported that males were more prone to doping than females, and are generally more approving of the doping culture than females. According to Sekulic *et al.* (2016), the odds of doping behaviour were found to be higher in males who achieved a high sport result, regularly consumed dietary supplements and perceived doping as a common practice among athletes, whereas the decreased likelihood of doping was observed in male athletes who achieved a high competitive result at a senior level. Unlike males, the likelihood of doping is lower in female athletes who were older and have better nutrition knowledge (Sekulic *et al.,* 2016). These gender differences in relation to doping can be explained by two factors, i.e. the self-perception of doping prevalence in sports and hesitation against doping (Rodek *et al.,* 2013; Sajber *et al.,* 2013), with both factors being shown to decrease the likelihood of engaging in doping behaviour. Studies on doping use have shown that the tendency of doping users to "socially project" their choices by overestimating prevalence of doping use in fellow athletes is frequently coupled by their positive expectations towards the outcome of doping (Dunn *et al.,* 2012); Hildebrandt, Seth & Langenbucher, 2012; Backhouse *et al.,* 2013). Accordingly, females were found to be generally less convinced that doping is practised in sports (Sekulic *et al.,* 2016); and were more concerned of the negative consequences of doping such as adverse effects on health and public stigma, compared to male athletes (Zaletel *et al.,* 2015).

Knowledge-wise, it was found that athletes of tertiary education level scored higher than the athletes with lower education background. This could be explained through the understanding that most of the participants with tertiary education were elite athletes with more experience competing at national level. Greater knowledge of NS has been associated with lesser or more controlled use of NS in daily practice (Nieper, 2005). However, the current study shows that NS users were more likely to self-explore and had better knowledge score than non-users. Consequently, educational programs have been shown to reduce the use of NS (DesJardins, 2002). As the majority of Malaysian athletes in this study were of the younger age group,

future educational programs may be best targeted at this group as younger athletes are at higher risk for consumption of NS without proper guidance, especially since these supplements are widely available in the market (Molinero & Marquez, 2009).

More than half of the study participants indicated nutritionists as the main source of information on NS. This is contrary to most studies which reported trainers or coaches to be the primary source of information on NS and influence of sports nutritionists or dietitians was as low as 14% (Burns *et al.,* 2004; Nieper, 2005; Waly, Kilani & Al-Busafi, 2013; Sajber *et al.,* 2013). Burns *et al.* (2004) reported as many as 24% of the student athletes were not aware of availability of dietitians and perceived trainers or coaches to have deeper nutritional knowledge. Nieper (2005) on the other hand, reported that the majority of national athletes used the service of dietitians infrequently despite having accessibility, and in a survey conducted in Oman, as many as 80% of the athletes admitted to consuming NS without supervision by a nutritionist or dietitian (Waly *et al.,* 2013). Nutritionists are able to offer a form of support and information that cannot be obtained from other sources such as education on the exact nutritional needs by sports; specific supplements are specific to training phase, intensity, duration, and the purpose of consuming a type of NS. While a reasonable utilisation of sports nutritionists in the National Sports Institute in our study is commendable, more efforts should be put into marketing their availability to athletes such as through specific nutritional educational programs targeted at athletes and their coaches. Dietary assessment of national athletes, though not compulsory in Malaysia, does provide an opportunity for counselling and nutrition education, whereas routine entry physical examinations may allow sports physicians to open discussions about nutrition and supplements.

None of the study participants admitted to or reported a failed dope test. While this may seem ideal, this may actually be more hazardous as this could also indicate inadvertent doping amongst athletes who are unaware of potential labelling misinformation in supplements, hence giving them false reassurance of the safety of these supplements (Davar, 2012). This is reiterated by Maughan *et al.* (2007) who stated that NS are often used without a full understanding or evaluation of the potential benefits and risks associated with their use, and without consultation with a sports nutritionist.

The Anti-Doping Agency of Malaysia (ADAMAS) is the agency under the Ministry of Youth and Sports that carries out doping tests on athletes. ADAMAS also provides education on the nature of doping and its complications, information on the test procedure and the athletes' rights during these tests, as well as the consequences of a positive dope test under the WADA law regulation. In Malaysia, all athletes and coaches under the National Sports Council of Malaysia are required to attend doping education classes, and this may provide a means for athletes to address their concerns regarding the NS that they are consuming.

Athlete nutrition-education programs are usually aimed at correcting dietary inadequacies, promoting optimal health, and improving athletic performance by enriching their knowledge in general and sports nutrition. There are previous recommendations for doping-related interventions to include as much as information as possible on risks and appropriate use of NS (Ntoumanis *et al.,* 2014). The role of the nutritionist is undoubtedly vital in curbing doping behaviour and raising awareness of nutritional supplements with doping ability and the potential complications that come along with it. This study showed that most of the NS users obtained their information

through a nutritionist compared to other sources, i.e. physicians and coaches – and also acquired better knowledge and attitude on the issue of supplement-doping. Hence, formal nutrition workshops run by professional nutritionists is essential in ensuring accurate information regarding nutritional supplements is delivered.

The present study has several limitations, primarily the small sample size. The results therefore lacked the strength to detect differences between the groups. Additionally, convenience sampling of self-selected participants is a limitation to the generalisation of the study's findings and results. With the target population of this study being national elite athletes of Malaysia, this study would benefit from diversifying the sample by recruiting athletes from other sports institutions across Malaysia. A proportion of the study participants were preparing for an upcoming SEA Games at the point of data collection, and may have been consuming more or different types of NS than their usual intake. These factors restricted our analysis as it makes it difficult to draw strong conclusions from the study. Due to the cross-sectional study design, the results of the statistical analyses indicate an association, but causality cannot be determined. In addition, most of the participants were new to the elite sports industry and may not have enough exposure to nutritional counselling or workshops that are being conducted in the institute.

CONCLUSION

Substance abuse in sports has always been a controversial topic in the sports world. However, athletes from all competing sectors, be it at the school level or the Olympics, are at risk of doping, whether intentional or unintentional. This study has shown that the knowledge and attitude of most elite athletes is still at the lower margin of the risks of doping from NS use. However, in general, the awareness of athletes with regard to content of NS and its potential effects on doping is often questionable. The inadequacies of the current national regulation of NS make it difficult for athletes to obtain accurate information about the nature and quantity of the contents of any supplement product. Additionally, the study showed that young athletes seek nutritional advice from the sports nutritionists. However, other parties, i.e. coaches, parents, and physicians, do assert a certain amount of influence on these athletes, and hence play an important part in enhancing nutrition awareness. To ensure a more effective outcome, education on sports doping must be able to offer suggestions, ideas and practical ways of improving knowledge of doping in sports. A demographic- and training-specific education on NS should be provided by qualified nutritionists to reduce the risk of doping amongst athletes. With this information, the sports authority and academic institution can plan and implement activities that could empower athletes to avoid doping practices in their sports career. These findings could also hopefully address some issues to be acknowledged by policy makers in developing or reviewing the guidelines on sport doping.

ACKNOWLEDGEMENT

The authors would like to acknowledge the National Sports Institute for giving permission and support for the study, and all the national elite athletes who had participated in the study. The authors would also like to thank Dr Vinod Kumar Perhakaran for assisting with the recruitment process.

Conflict of interest

The authors have no conflict of interests to declare.

REFERENCES

Backhouse SH, Whitaker L & Petróczi A (2013). Gateway to doping? Supplement use in the context of preferred competitive situations, doping attitude, beliefs, and norms. *Scand J Med Sci Sports* 23(2): 244-252.

Barkoukis V, Lazuras L, Tsorbatzoudis H & Radofinos A (2011). Motivational and sportspersonship profiles of elite athletes in relation to doping behavior. *Psychol Sport Exerc* 12(3): 205–12.

Burns RD, Schiller MR, Merrick MA & Wolf KN (2004). Intercollegiate student athlete use of nutritional supplements and the role of athletic trainers and dietitians in nutrition counselling. *J Am Diet Assoc* 104(2): 246-249.

Davar V (2012). Nutritional knowledge and attitudes towards healthy eating of college-going women hockey players. *J Human Ecol* 37(2): 119-124.

DesJardins M (2002). Supplement use in the adolescent athlete. *Curr Sports Med Rep* 1(6): 369-373.

Dunn M, Thomas JO, Swift W & Burns L (2012). Elite athletes' estimates of prevalence of illicit drug use: evidence for the false consensus effect. *Drug Alcohol Rev* 31: 27–32.

Graham TE (2001). Caffeine, coffee and ephedrine: impact on exercise performance and metabolism. *Can J Appl Physiol* 26(Suppl): S103-119.

Geyer H, Parr MK, Koehler K, Mareck U,Schanzer W &Thevis M (2008). Nutritional supplements cross-contaminated and faked with doping substances. *J Mass Spectrum* 43: 892–902.

Hildebrandt T, Seth H & Langenbucher JW (2012). Fitness supplements as a gateway substance for anabolic-androgenic steroid use. *Psychol Addict Behav* 26: 955–962.

Kamber M, Baume N, Saugy M & Rivier L (2001). Nutritional supplements as a source for positive doping cases? *Int J Sport NutrExercMetab* 11(2): 258-263.

Kandel DB (2002). Examining the gateway hypothesis stages and pathways of drug involvement. In DB Kandel (Ed.), *Stages and Pathways of Drug Involvement: Examining the Gateway Hypothesis* (pp. 3-15). New York: Cambridge University Press.

Lun V, Erdman KA, Fung TS & Reimer RA (2012). Dietary supplementation practices in Canadian high-performance athletes. *Int J Sport NutrExercMetab* 22(1): 31-37.

Maughan RJ, Depiesse F & Geyer H (2007). The use of dietary supplements by athletes. *J Sports Sci* 25(Suppl 1): S103-113.

Molinero O & Marquez S (2009). Use of nutritional supplements in sports: risks, knowledge, and behavioural-related factors. *Nutr Hosp* 24(2): 128-134.

Nichols AW & Harrigan R (2006). Complementary and alternative medicine usage by intercollegiate athletes. *Clin J Sport Med* 16(3): 232-237.

Nieper A (2005). Nutritional supplement practices in UK junior national track and field athletes. *Br J Sports Med* 39(9): 645-649.

Ntoumanis N, Ng JY, Barkoukis V & Backhouse S (2014). Personal and psychosocial predictors of doping use in physical activity settings: a meta-analysis. *Sports Med* 44(11): 1603-1624.

Petróczi A, Naughton D, Mazanov J, Holloway A & Bingham J (2007). Performance enhancement with supplements: incongruence between rationale and practice. *J Int Soc Sports Nutr* 4: 19.

Petróczi A, Mazanov J & Naughton D (2011). Inside athletes' minds: preliminary results from a pilot study on mental representation of doping and potential implications for anti-doping. *Subst Abuse Treat Prev Policy* 6: 1–8.

Pipe A & Ayotte C (2002). Nutritional supplements and doping. *Clin J Sport Med* 12(4): 245-249.

Rodek J, Idrizovic K, Zenic N, Perasovic B & Kondric M (2013). Differential analysis of the doping behaviour templates in three types of sports. *Coll Antropol* 37(Suppl 2): 211-217.

Sajber D, Rodek J, Escalante Y, Olujic D & Sekulic D (2013). Sport nutrition and doping factors in swimming; parallel analysis among athletes and coaches. *Coll Antropol* 37(Suppl 2): 179-186.

Sas-Nowosielsk K & Swiatkowska L (2008). Goal orientations and attitudes toward doping. *Int J Sports Med* 29 (7): 607-612.

Sekulic D, Bjelanovic L, Pehar M, Pelivan K & Zenic N (2014). Substance use and misuse and potential doping behaviour in rugby union players. *Res Sports Med* 22(3): 226-239.

Sekulic D, Tahiraj E, Zvan M, Zenic N, Uljevic O & Lesnik B (2016). Doping attitudes and covariates of potential doping behaviour in high-level team-sport athletes; Gender specific analysis. *J Sports Sci Med* 15(4): 606-615.

Somerville SJ, Lewis M & Kuipers H (2005). Accidental breaches of the doping regulations in sport: is there a need to improve the education of sportspeople? *Br J Sports Med* 39(8): 512-516.

Waly MI, Kilani HA & Al-Busafi MS (2013). Nutritional practices of athletes in Oman: a descriptive study. *Oman Med J* 28(5): 360-364.

Wardenaar FC, Ceelen IJ, Van Dijk JW, Hangelbroek RW, Van Roy L, Van der Pouw B, De Vries JH, Mensink M & Witkamp RF (2017). Nutritional supplement use by Dutch elite and sub-elite athletes: does receiving dietary counseling make a difference*? Int J Sport Nutr Exerc Metab* 27(1):32-42.

Wiens K, Erdman KA, Stadynk M & Parnell JA (2014). Dietary supplement usage, motivation, and education in young Canadian athletes. *Int J Sport Nutr Exerc Metab* 24(6): 613-622.

Zaletel P, Versic S, Peric M, Zenic N, Sekulic D & Kondric M (2015). Toward (more) effective anti-doping policy in sports: what should we target in anti-doping efforts? *Medicinadello Sport* 68(3):447-460.