



Prevalence, Information & Attitude towards Using Supplements among University Athletes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The purpose of this study was to analyze the prevalence of dietary supplements usage amongst university's players, in addition to their know-how and players towards sports supplementation. Current study check out the extent of knowledge, attitudes, beliefs and practices regarding using dietary supplements of 100 athletes was administered, which included 88 Males and 12 Females, 20 to 27 years of age from the population of university athletes. The comparison was analyzed by chi-square test to observe the importance of distinction amongst respondents' notion about the statements of questionnaires. The results calculated through Statistical Package for Social Sciences (SPSS-25). The outcomes displayed that maximum of the athletes proven the satisfactory knowledge of dietary supplements and the motives for the usage of them; however the outcome of the study suggested that need of inclusive knowledge of players about supplements and under vigilant management showed improvement of University athletes.

Keywords: Supplements; prevalence and chi-square.

1. INTRODUCTION

Athletic dietary supplements are a class of supplements whose motive is to serve as an addition to the everyday diet to enhance fitness, overall performance and be a stronger competitor during competition which is a primary technique to enhance performance is the use of sports supplements [1,2]. The industries which manufacture the sports supplements worth billion dollars which are different in their effects according to the desire of athlete in various dietary supplements. However, all dietary supplements are not always beneficial and they designed to provide a super balanced expanse of vitamins, minerals and other major nutrients to assist the growing muscular tissues and health. Additionally, supplements include amino acids, vitamins, minerals and herbs to offer a balanced quantity of every component which is not included in the daily diet plan [2] that is crucial elements to assist muscle tissues construction, stamina and various attribute which are required to perform on the pinnacle on favored sports activities of collegiate athletes [3]. When athletes incising the sports supplements to take, make sure the product has an appropriate ingredient which you desire to achieve [4]. An innovative exercise methodologies and broadcasting illustration of skilled sports, athletes from a basic formative year elevated the dimensions of competitive aspect with the help of distinctive strategies. Sports diet and training principles supported and revamp the exercise tricks to boost performance and recovery. Dietary supplements are an ergogenic aids which supposed to adopt as a development of athletic whole display, development and quick restoration. [3,5,6]. Due to over loading, colt athletes sometimes lack the supply of instant energy particularly during in-season which resulted in that maximum athletes are not able to construct balance diet alternatives for escalation and muscles expansion which has been taken from sports supplements [3,5,7,8]. The utilization of supplements has unexpectedly accelerated in the past ten years the availability of production in the market cannot be accompanied through a suitable scientifically-based research regarding their protection, worth and efficacy [9]. Moreover, the growing social popularity of intake of supplements might also provide an extra explanation of this phenomenon [10]. With the elevating intake of diet supplements here is also a requirement for significant information about those supplements [3]. The exploit of nutritional supplements is such a threat which might

purpose an inadvertent doping because of the contamination in their ingredients. Another issue that is worth considering is their effectiveness that is controversial [6]. Although various studies explored that the athletes have self-reported expertise about the use of supplements. The distinct method used in this research is checking out the information of university players regarding the uses and causes of dietary supplements and triumphing facts regarding sports supplements. In this research, the researcher has tried to investigate the motives of the prevalence of supplements amongst university athletes which inspects their knowledge and attitude towards dietary supplements. Unfortunately, athletes who are not fond of exploring the data from acquainted resources of enumerated dietitians. Thus, academic plans are not available in such countries, particularly in the developing ones. The players have incorrect information which might be the cause of health issues and it can result in adverse performance [3,7].

2. LITERATURE REVIEW

2.1 What is Supplement?

The food supplements as intense resources of vitamins or different ingredients with a nutritional or biological effect, whose motive is to supplement a routine diet [11]. A food supplement is described as a locally available product that is ingested as an accumulation to balanced diet plan which consists of vitamins, minerals, herbs(botanicals), amino acids and as a whole, lot of new different crops (National Center for Health Statistics, 2012).

2.2 Categories

Sports supplements had been described and classified in lots of ways. Though, not a single definition classified completely. Now widespread, categories consist of sports foods (gels, bars, drinks and protein powders), vitamins and minerals, herbals, botanicals and ergogenic dietary supplements. Moreover, there is a class which incorporates for weight loss, extended libido and there are also gluten-free, lactose-free, allergen-free and other functional foods, which is another source of energy. The food which consisted of natural, organic and superb (foods) segments which may be described as dietary supplements (meals) which are in

particular tough because of the complex mixtures and the anti homogeneous contents material of natural ingredients. However, this class has advanced speedily in recent years, ambitious in component through ordinary notion that natural equal health [12]. Furthermore, it has been observed that natural food put less risk for utilizers resulted negative to dope test. The finding supported the user for taking herbs regularly for better results and brought consciousness for patrons (Avelar-Escobar *et al.*, 2012).

2.3 Prevalence of Supplement use

Surveys concerning that utilizing the herbal supplements among the general population have constantly proven, the supplements that are used by a big population which is substantiated consumed through by huge industry [13]. A comprehensive survey of the overall residents in United States identified forty percent of the colts were habitual of utilized supplements (1988–1994), this had spread over one-half during (2003 to 2006) centers for disease Control and Prevention till 2011. The board is responsible of nutrition with an annual survey taken 2007 samples of mature people extracted with 18 years age adults living in USA. The latest survey concluded that 71% of US adults (greater than one hundred and seventy millions adults) utilized supplements to get energy and maintain overall health. An increasing effect after 2015 stated that 68% dietary supplements utilized were vitamin and minerals. Their usage is however increased for the last five years in the age group of 18 to 34 years. In addition survey statistics of 2016 showed interest of teenagers which have been grown day by day, use of dietary supplements for the hypertrophy of muscles and optimal performance in different life activities [14].

2.4 Supplement use and Training Load

The researcher which determined the association between supplement and training intensity by Lim *et al.* [15], consents with the review by Knapik *et al.* [16] and with latest reviews by Heikkinen *et al.* [17], who concluded that sports professionals consumed a huge amount of supplements than non-professionals and it became as an essential part of meals. Further, numerous researches predicted that players from aerobic sports activities use dietary supplements greater than other sports [3,15,18].

2.5 Prevalence of Supplements Gender Wise

Sobal and Marquart (1994) investigated that female athletes utilized 10% natural supplements more than male athletes, Similarly, Nieper [19] depicted the usage of dietary supplements with a precise sample of thirty two track and field athletes competing at the World Junior Championships during 2004 which resulted 62% athletes used supplements. The trend depicted about 20% higher in female's athletes as compared with male. However, Karimian and Esfahani [20] deprived that 77% more usage in male as compared with female athletes as they had taken a survey of 500 athletes. As, numerous research had no longer locate any distinction among male and female athletes [21-23] stated a negative sex-related aspect highlighted in use of supplements, however they discovered that male athletes have keen interest to devour protein powder and ergogenic supplements, commonly related to enhanced muscle mass and strong sexual relation, while female addicted to take vitamin and mineral supplements, usually related to increase health and recover nutritional deficiencies.

2.6 Prevalence of Supplement age Wise

The consumption of supplements noticed to be endemic and famous in young colts. Braun *et al.* [24] investigated that an age group of (10 to 25) German athletes, utilized herbal supplements envisioned at 80% along with high rated German athletes Nutritional Survey (GANS-II) which resulted that 16–19% of all German mature athletes of age (14–18) utilized nutritional supplements (Federal Research Center for Nutrition 2008). They also deprived different in various ages and performance as well: at the age of 18 years, competing globally stated use more than players at state level. A number of systematic researchers resulted that supplements used by adolescent athletes, depend upon types, different sports, categories and range of dietary supplements which enhanced in growing age exercise hours [7, 25-29].

2.7 Remuneration of Supplements Utilized by Athletes

However, nutrition (dietary supplements) can be crucial at a specific periodic span of sports or

sometimes with nutritional challenges especially for those, who like to eat vegetable along with a particular medical condition. In Nordic, the official organization follow a legit rules for concerning particular dietary supplements, including every day consumption of omega-3, fatty acids and vitamin D (NNR, 2014). They allowed the barricade of particular food with vital nutrients. When it comes to the athletes, the official guidelines were nevertheless applied [28]. Otherwise, the players would to take advantages from dietary supplements. Such circumstances might be useful to adopt a specific technique of supplementation utilization to achieve optimum fitness and performance.

2.8 Pattern and Reasoning for use among Athletes

Sport-precise motives for consumption consisted of extreme pressure training/competition cannot be achieved with food alone as supplements provided a particular benefit in both practicing and competition. Another cognizance is that performed athletes are the consumers of dietary supplements, and its usage is frequently encouraged or endorsed by senior athlete's circle consisted of coaches, parents & colleagues [29]. Among athletes and physiologically active people, there are numerous problems associated particularly to the psychological and physiological factors of overall performance. In-fact, athletes like to enjoy healthy sports life with efficient training and lacreative performance is viable if fitness is compromised. Injury and rehabilitation that needs intervals of time out from training can damage periodization and even at successful competitions it can breakdown the athlete's competitive season. The sports essential elements which boost up restoration, from injury/illness retraining are manifestly well known among athletes and they used them frequently with combination other necessary diet [17]. Major effects of dietary supplements are

- Athletes have extra necessities as compared with sedentary population
- Low performance in competitive era
- Vitamins are conquering stress, lost by vigorous exercise and its replacement is replenished during exercise.

2.9 Dietary Counseling Effect on Supplement use

A recent investigation of Netherlands assessed the impact of nutritional therapy on supplement

discovered that players have advised to utilize greater amount of supplements as compared with others [28]. They also observed the high dose of supplement was specifically due to an accelerated use of vitamins, mirror guidelines to the players got by advisers, resulted that the data collected from the counselor (advisers) might have a tremendous impact its research layout restricted the results which has been drawn from the research.

2.10 Supplements can Confer Health Benefits

Marik and Flemmer [30], and Rock [31] stated the athletes who utilized nutritional supplements diet are usually investigated above than average nutrients intakes along with healthy food. The research conducted by Nieper [19] at countrywide (track and field) athletes revealed that approximately eighty three percent players showed optimistic results as they did not use it while 42% used supplement with less performance. Further, the athletes who used sports supplements with workout enhances the performance and obligation of sports supplements [19] a deficit in nutrition provokes the need of supplementation is unlikely to enhance wellbeing physical condition. Actually it has an adverse impact both on performance and posture, through absorption of an ordinary training [32], In addition, through extended chance to cut off from sports [33]. Moreover, athletes performed in competition followed an anti-doping code which need to understand that supplement consumed exposed them to a hazard for a optimistic attitude towards doping test [34].

2.11 Influence of Supplements on Exercise Performance

There is growing interest in inspecting the feasible impact of sports supplements on exercise performance, specifically endurance performance. It is obvious that overall performance in many sports activities additionally includes high-intensity exercise which includes instantly decision making and skill accuracy. Motor control, making decision, coordination, reflexes, and other cognitive tasks can be important at some point of numerous sports, which include team sports. Sports performance relies upon the interplay of the mind with the periphery. However, peripheral level fatigue does not only occur, however "central" fatigue or "intellectual" fatigue exist,

concerning mind mechanisms. Cognitive characteristic performs a critical function in athletic overall performance, and evidently mind functioning can be motivated via way of means of nutrition [1,7]

2.12 Important Supplements for Competition

The dietary supplements which enhance the exercise and athletic recital, in the market comprise more than one substance. Therefore, one cannot understand or expect the outcomes and secure of mixtures in these supplements except medical trials have investigated that specific combination. Additionally, the quantities of those elements range extensively among the products. Following are the few supplements, majorly used by new generation for the enhancement of their body and performance.

Protein: An essential part of body is protein to develop, preserve and reload muscle. Exercise enhanced the load of protein oxidation and crashes as the myofibrillar protein formation increases up to a certain level [35]. Amino acids are mainly essential to maximize the training response and restoration after workout [5,36]. Regular resistance training consequences in the accumulation of myofibril (protein) and hence increment in human muscle size or skeletal muscles. A low impact exercise results in moderate protein accumulate in operating fibers mostly in mitochondria, which increases the oxidative capability for upcoming exercise plans [35] Cermak *et al.*, [37]. Sports persons want to get necessary building blocks of proteins through food or from supplementation to help in muscle hypertrophy, maintenance growth and replenish it [35]. The nine essential amino acids with names are (Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, and Valine) has great importance in the performance of athletes, not only growth but also for the competitive environment. The major essential proteins are comprised of 40% important amino acids. As a meal with 25 g overall protein offers 10 g essentials amino acids (EAAs). Dietary protein intake enhances the assimilation of essential proteins in the blood and muscle cells. Amino acids are mainly essential to maximize the training response and restoration after workout [5] Jager *et al.*, [38].

Creatine: Creatine is one of the most thoroughly studied and extensively used nutritional

supplements to increase exercise and sports performance [39]. Creatine is produced endogenously and received from the diet in small quantities. It facilitates to generate ATP and thereby provides the muscle tissues with energy, especially for short-time period events (Salomons *et al.*, 2010). Creatine may enhance muscle overall performance in four ways: by increasing storage of phosphocreatine used to generate adenosine tri phosphate (ATP) at the start of intense workouts, accelerating the re-synthesis of phosphocreatine after exercise, suppressing the degradation of adenine nucleotides and lactate accumulation, and/or improving glycogen stores in skeletal muscular tissues (Salomons *et al.*, 2010).

The Beta Alanine: Beta-alanine is naturally occurring as beta amino acid, which is an amino acid group is attached to the β -carbon instead of the more usual α -carbon for alanine in 3-aminopropanoic acid. It is a non-essential amino acid that is produced naturally in the body. It aids in the production of carnosine. The compound plays a role in muscle endurance in high intensity exercise [40] Harris *et al.* [41]. It has been important factor to take it on regular basis as regarding on training schedule, because Beta-alanine works by increasing muscles concentration of carnosine. It does not need to be taken around a training session to produce results. Its supplementation currently appears to be safe in healthy populations at recommendation doses. The only reported side effect is parenthesis (i.e. tingling) but studies indicate that it can be attenuated by using divided lower doses (1.6 g) or using a sustained release formula [40].

Glutamine: The large number of amino acid in muscle, blood and in body's free protein is glutamine. The Branch chain amino acids (BCAAs) material first and foremost build glutamine by the body, additionally, a mature person consumes about three to six gram per day in protein-containing foods [41]. This is one of the vital molecules in energy formation and it helps out nitrogen for a lot of vital biochemical retort [43].

Antioxidants (vitamin C, vitamin E, and coenzyme Q₁₀): Through physical activities and training an athlete elevates the utilization of oxygen of body and creates oxidative stress, which leads to formation of oxygen and nitrogen

reaction along with production of more oxidized molecules in different tissues, as well as muscular tissues theoretically, free radicals could impair exercise performance by delaying ability of muscles to create power thus, increasing fiber fatigue injury by producing inflammation and soreness (Konig *et al.*, 2001; Fisher-Wellman *et al.* [44] [45]. Numerous scholars have recommended that supplements having antioxidants, such as vitamins C and E and coenzyme Q10 (CoQ10), might decrease this free-radical pattern, so minimize skeletal fibers injury, tiredness and enhancing improvement in muscles [46].

Caffeine: Caffeine is naturally found as a methylated xanthine in variable amounts in coffee, tea, cacao pods (the source of chocolate); and other herbal/botanical sources [47] Gill *et al.*, 2020). Caffeine stimulates the central nervous system, muscles and other organs, such as the heart by binding to adenosine receptors on cells, thereby blocking the activity of adenosine, a neuro modulator with sedative-like properties [48] Gill *et al.*, 2020) thus, caffeine enhances arousal, increases enthusiasm and cut off fatigue [49] Gill *et al.*, 2020) and reduce perceived pain and exertion [50]. In the starting plans of longer duration exercises caffeine might activate fats as a release of power and muscle glycogen [51] Gill *et al.*, 2020).

Purpose of the Study: To check the prevalence and utilization of supplements in assessing the beliefs & attitudes of athletes regarding the supplements used in sports.

2.13 Research Questions

- The prevalence level of sports supplements among university's athletes?
- The perception & reasons of sports supplements used by the university's athletes?

3. METHODOLOGY

The cross sectional survey study is quantitative in which information was gathered in numeric format and the way it was analyzed through Statistical Package for Social Sciences (SPSS-25). The student of University of the Punjab, University of central Punjab & Govt College University (GCU) athletes was the population of this research (Lahore Campus). Data was collected from sample of 100 athletes belonging to the University of Punjab. Research tool for the study was a questionnaire designed on a likert scale of five points: strongly disagree, disagree, neutral, agree and strongly agree selected. Chi-square test applied on the statements to view the significant difference among the practice adopted by the significant differences among the practices adopted by the athletes regarding supplements usage.

3.1 Data Analysis and Interpretation

Figs. 1 & 2 displayed the age percentage on x-axis (age limits) of male and female athletes while y-axis shows the percentage of total number of athletes in percentage (male & female) which has been shown in Table 1 and Figs 1 & 2 respectively.

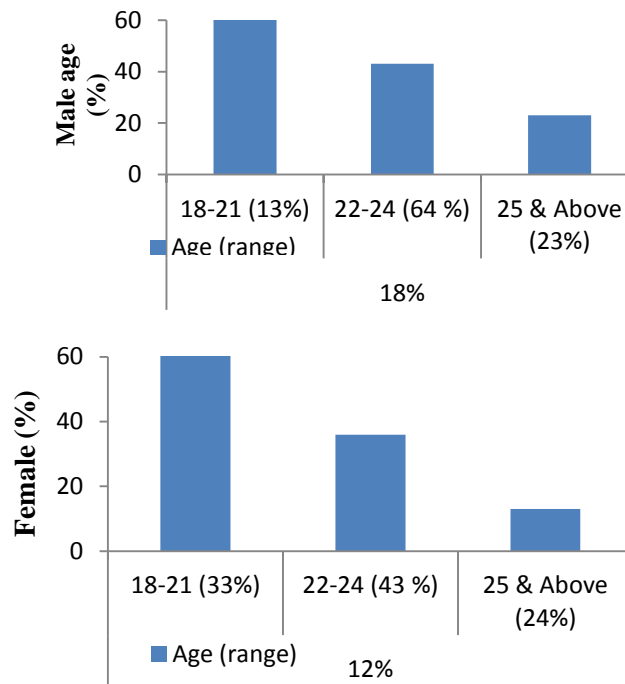
Table 1. Distribution of participants according to demographic variables and supplement usage variables

Variable	Frequency	%
Gender		
Male	88	88
Female	12	12
Age Male & Female %		
18-21	64& 63	64 & 61
22-24	43& 33	43 & 39
25 & above	23& 13	23 & 13
Use Dietary Supplements		
Yes	100	100
Medical condition Restrict food Use		
Yes	0	0
No	100	100

Table 2. Chi-square value of respondent’s perception about “You search information about the supplement prior to buying or choosing it”

Statement	Observed number					X ²	P
	SD	D	N	A	SA		
You search information about the Supplements prior to buying or choosing it?	0	0	3	9	88	135.1	
You look at the nutrition facts label prior to buying or choosing the supplement	0	0	5	16	79	97.7	
To build muscles mass?	0	1	3	24	72	130.8	
To prevent muscle loss?	0	0	4	63	33	52.3	
To enhance physical performance?	0	0	0	23	77	29.2	
To boost energy level	1	0	0	34	65	61.5	
To help weight control	0	0	2	46	52	44.7	
To burn fat and calories faster	0	4	19	57	20	61.1	
As a meal replacement	0	7	23	53	10	47.1	
To help digestion and metabolism	1	2	16	72	9	57.5	
To detoxify the body	1	4	26	62	7	176.3	
To boost immunity	0	2	3	43	52	129.3	
To prevent osteoporosis	0	3	7	57	33	82.7	
The information displayed on dietary supplements is helpful to understand it better and an appropriate for me	0	2	3	43	52	80.2	
The source I receive my information on supplements form is reliable	0	1	0	26	73	74.8	
The supplement that I take are effective for what I am trying to treat, prevent, etc.	0	0	1	28	71	175.8	
I understand which supplements are best suited for my desired healthchanges.	0	1	5	12	82	110.3	
Dietary supplements can have adverse side effects.	5	13	23	39	20	32.2	
Dietary supplements can be used as a substitute for a good diet.	0	4	13	21	62	78.8	
Herbal supplements are safe to take, as they come from“natural rources”	0	10	25	45	20	26.0	***
The more protein supplement you take the more muscle you will build.	0	1	1	3	95	261.5	0.001
FDA regulates the ingredients in dietary supplements.	0	3	23	46	28	37.5	
Dietary supplements including herbs can be dangerous when combined with prescription medications.	0	4	25	53	18	50.9	
Mean ± S.D.	0.35 ±1.07	2.7 ±3.4	10 ± 9.9	38.1 ± 19.1	50.4±27.8		

The collected data was analyzed under SPSS-26 which showed all results are highly significant the value of SD, D, N, A & SA are 0.35±1.07, 2.7 ± 3.4, 38.1 ± 19.1 and 50.4 ± 27.8 in Mean ± S.D. respectively. The data compared and evaluated by chi square and was found statistically significant at ***p<0.001 level



Figs. 1 & 2. Male and female age percentage ratio

4. RESULTS

The results shows that the values which are significant at *** $p < 0.001$ so according to our research the utilization of supplements in different games and training has optimistic results in exercises, training, sessions and competitions.

5. CONCLUSION

In this research, the researcher present that dietary supplement use is prevalent among university level athletes. Users of dietary supplements demonstrate the satisfactory knowledge of supplements and the reasons for using them as their enhancement in performance but these findings indicate the necessity of a comprehensive education of all athletes about sports supplements and careful supervision of the athletic development of University athletes. These findings suggest that university athletes perceived dietary supplement effectiveness as favorable among the users, which means supplement users showed positive attitude towards supplements usage. Furthermore, the previous researcher's emphasis on numerous dietary supplements (Protein (Amino Acid), Creatine, Beta Alanine, Glutamine, Antioxidants and Caffeine) which resulted in the enhancement of performance but

our research also suggested that the intake dietary supplements should be according to the game, duration, climate, workout (training) and body demand as well. One more thing was found out that most of the athletes do not know as they have medical complications which restricted their nutritional consumption and cut down their performance graph. The most of the athletes are also well aware of nutrients which they require in the form of supplements (oral & in meals) and the effectiveness of that dietary supplement for the reasons they are using them.

6. RECOMMENDATION

Complete education of all the athletes regarding supplements and vigilant management of the player's progression at the level of school, clubs, colleges and Universities.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Meeusen R. Exercise, nutrition and the brain. *Sports Medicine*. 2014;44(1):47-56.
2. Islam MT, Quispe C, Martorell M, Docea AO, Salehi B, Calina D, Sharifi-Rad J. Dietary supplements, vitamins and minerals as potential interventions against viruses: Perspectives for COVID-19. *International Journal for Vitamin and Nutrition Research*. 2022;92(1):49-66.
3. Jovanov P, Dordic V, Obradovic B, Barak O, Pezo L, Marnic A, Sakac M. Prevalence, knowledge and attitudes towards using sports supplements among young athletes. *Journal of the International Society of Sports Nutrition*. 2019;16(1):1-9.
4. Darvishi L, Askari G, Hariri M. The use of nutritional supplements among male collegiate athletes. 2013;4(1):568-572.
5. Thomas D, Burke Louise, Erdman, Kelly. *Nutrition and Athletic Performance, medicine and science*. 2016;48:543-568.
6. Nabuco HCG, Rodrigues VB, Barros WM, Ravagnani FCP, Espinosa MM, Ravagnani CFC. Use of dietary supplements among Brazilian athletes. 2017;30(2):163-173.
7. McDowall JA. Supplement use by young athletes. *Journal of sports science & medicine*. 2007;6(3):337-342.
8. Smith JW, Holmes ME, McAllister MJ. Nutritional considerations for performance in young athletes. 2015;7:346-349.
9. Torres-Ronda L, i del Alcazar XS. The properties of water and their applications for training. *Journal of human kinetics*. 2014;44:237-248.
10. Dascombe BJ, Karunaratna M, Cartoon J, Fergie B, Goodman C. Nutritional supplementation habits and perceptions of elite athletes within a state-based sporting institute. 2010;13(2): 274–280.
11. EFSA. Dietary Reference Values for nutrients Summary report. EFSA supporting publication. 2017;14(12):121-198.
12. Silano V, Coppens P, Larranaga-Guetaria A, Minghetti P, Roth-Ehrang Rene. Regulations applicable to plant food supplements and related products in the European Union. *Food & function*. 2011;2:710-719.
13. Hameen-Anttila KP, Niskala UR, Siponen SM, Ahonen RS. The use of complementary and alternative medicine products in preceding two days among Finnish parents-a population survey. *BMC complementary and alternative medicine*. 2011;11(1):1-7.
14. Tawfik S, El Koofy N, Moawad EM. Patterns of Nutrition and Dietary Supplements Use in Young Egyptian Athletes: A Community-Based Cross-Sectional Survey. 2016;11(8):1-12.
15. Lim U, Turner SD, Franke AA, Cooney RV, Wilkens LR, Ernst T, Le Marchand L. Predicting total, abdominal, visceral and hepatic adiposity with circulating biomarkers in Caucasian and Japanese American women; 2012.
16. Knapik JJ, Steelman RA, Hoedebecke SS, Austin KG, Farina EK, Lieberman HR. Prevalence of dietary supplement use by athletes: systematic review and meta-analysis. *Sports Medicine*. 2016;46(1): 103-23.
17. Heikkinen A, Alaranta A, Helenius I, Vasankari T. Dietary supplementation habits and perceptions of supplement use among elite Finnish athletes. 2011; 21(4):271-279.
18. Shaw MH, Twilton J, MacMillan DW. Photoredox catalysis in organic chemistry. *The Journal of organic chemistry*. 2016;81(16):6898-6926.
19. Nieper A. Nutritional supplement practices in UK junior national track and field athletes. 2005;39(9):645–659.
20. Karimian J, Esfahani PS. Supplement consumption in body builder athletes. *Journal of research in medical sciences: the official journal of Isfahan University of Medical Sciences*. 2011;16(10):1347.
21. Kim W, Kim HJ, Lee SH, Chang MB, Maeng WJ. Effect of extruded canola seed supplementation on blood metabolites and lactational performance in lactating dairy cows. 2011;43(6):859-872.
22. Wiens K, Erdman KA, Stadnyk M, Parnell JA. Dietary Supplement Usage, Motivation, and Education in Young Canadian Athletes. *International Journal of Sport Nutrition & Exercise Metabolism*. 2014;24(6):613-622.
23. Parnell JA, Wiens K, Erdman KA. Evaluation of congruence among dietary supplement use and motivation for supplementation in young, Canadian athletes. *Journal of the International Society of Sports Nutrition*. 2015;12(1):1-10.
24. Braun MH, Steele SL, Perry SF. The responses of zebrafish (*Danio rerio*) to

- high external ammonia and urea transporter inhibition: nitrogen excretion and expression of rhesus glycoproteins and urea transporter proteins. *Journal of Experimental Biology*. 2009;212(23):3846-56.
25. Tscholl P, Junge A, Dvorak J. The use of medication and nutritional supplements during FIFA World Cups 2002 and 2006. 2008;42(9):725–730.
 26. Dietz P, Ulrich R, Niess A, Best R, Simon P, Striegel H. Prediction profiles for nutritional supplement use among young German elite athletes. *International Journal of Sport Nutrition & Exercise Metabolism*. 2014;24(6):623-631.
 27. Pedrinelli A, Ejnisman L, Fagotti L, Dvorak J, Tscholl PM. Medications and nutritional supplements in athletes during the 2000, 2004, 2008, and 2012 FIFA Futsal World Cups. *BioMed research international*; 2015.
 28. Wardenaar FC, Ceelen IJ, Van Dijk JW, Hangelbroek RW, Van Roy L, et al. Nutritional supplement use by Dutch elite and sub-elite athletes: does receiving dietary counseling make a difference? *International Journal of Sport Nutrition and Exercise Metabolism*. 2017; 27(1):32-42.
 29. Reinert DF, Allen JP. The alcohol use disorders identification test: an update of research findings. *Alcoholism: Clinical and Experimental Research*. 2007;31(2):185-99.
 30. Marik PE, Flemmer M. The immune response to surgery and trauma: Implications for treatment. *Journal of Trauma and Acute Care Surgery*. 2012; 73(4):801-8.
 31. Rock F. *Communicating rights: The language of arrest and detention*. Springer; 2007.
 32. Paulsen G, Hamarstrand H, Cumming KT, Johansen RE, Hulmi J, Borsheim E, Raastad T. Vitamin C and E supplementation alters protein signalling after a strength training session, but not muscle growth during 10 weeks of training. *The Journal of physiology*. 2014;592(24):5391-5408.
 33. Garcia-Cortes M, Robles-Diaz M, Ortega-Alonso A, Medina-Caliz I, Andrade RJ. Hepatotoxicity by dietary supplements: a tabular listing and clinical characteristics. *International Journal of Molecular Sciences*. 2016;17(4):1-23.
 34. Maughan RJ, Depiesse F, Geyer H. International Association of Athletics Federations. *The use of dietary supplements by athletes*; 2013.
 35. Burd NA, Mitchell CJ, Churchward-Venne TA, Phillips SM. Bigger weights may not beget bigger muscles: evidence from acute muscle protein synthetic responses after resistance exercise. 2012;37(3):551-554.
 36. Jäger R, Kerksick CM, Campbell BI, Cribb PJ, Wells SD, Skwiat TM, Purpura M, Ziegenfuss TN, Ferrando AA, Arent SM, Smith-Ryan AE. International society of sports nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*. 2017 Jun 20;14(1):20.
 37. Cermak NM, Gibala MJ, Van Loon LJ. Nitrate supplementation's improvement of 10-km time-trial performance in trained cyclists. *International journal of sport nutrition and exercise metabolism*. 2012; 22(1):64-71.
 38. Jäger R, Kerksick CM, Campbell BI, Cribb PJ, Wells SD, Skwiat TM, Purpura M, Ziegenfuss TN, Ferrando AA, Arent SM, Smith-Ryan AE. International society of sports nutrition position stand: protein and exercise. *Journal of the International Society of Sports Nutrition*. 2017 Jun 20;14(1):20.
 39. Kreider RB, Kalman DS, Antonio J, Ziegenfuss TN, Wildman R, Collins R, et al. International Society of Sports Nutrition position stand: safety and efficacy of creatine supplementation in exercise, sport, and medicine. *Journal of the International Society of Sports Nutrition*. 2017;14(1):1-18.
 40. Hobson RM, Saunders B, Ball G, Harris RC, Sale C. Effects of β -alanine supplementation on exercise performance: a meta- analysis. *Amino acids*. 2012; 43(1):25-37.
 41. Harris A. Distributed leadership: Friend or foe?. *Educational Management Administration & Leadership*. 2013;41 (5):545-54.
 42. Ziegler E, Nelson S, Jeter J. Vitamin D supplementation of breastfed infants: a randomized dose–response trial. 2014;76 (2):177-183.
 43. Abcouwer SF, Lin CM, Wolpert EB, Shanmugam S, Schaefer EW, Freeman WM, Barber AJ, Antonetti DA. Effects of ischemic preconditioning and bevacizumab

- on apoptosis and vascular permeability following retinal ischemia–reperfusion injury. *Investigative ophthalmology & visual science*. 2010;51(11):5920-33.
44. Fisher-Wellman K, Bloomer RJ. Acute exercise and oxidative stress: a 30 year history. *Dynamic medicine*. 2009;8(1):1-25.
 45. de Sousa CV, Sales MM, Rosa TS, Lewis JE, de Andrade RV, Simoes HG. The antioxidant effect of exercise: a systematic review and meta-analysis. *Sports medicine*. 2017;47(2):277-293.
 46. Merry TL, Ristow M. Do antioxidant supplements interfere with skeletal muscle adaptation to exercise training?. *The Journal of physiology*. 2016;594(18):5135-5147.
 47. Brunye TT, Mahoney CR, Lieberman HR, Giles GE, Taylor HA. Acute caffeine consumption enhances the executive control of visual attention in habitual consumers. 2010;74(3):186-92.
 48. Lieberman DE, Venkadesan M, Werbel WA, Daoud AI, D'andrea S, Davis IS, Mang'Eni RO, Pitsiladis Y. Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature*. 2010;463(7280):531-5.
 49. McLellan TM, Caldwell JA, Lieberman HR. A review of caffeine's effects on cognitive, physical and occupational performance. *Neuroscience & Biobehavioral Reviews*. 2016;71:294-312.
 50. Goldstein ER, Ziegenfuss T, Kalman D, Kreider R, Campbell B, Wilborn C, Antonio J. International society of sports nutrition position stand: caffeine and performance. *Journal of the International Society of Sports Nutrition*. 2010;7(1):1-15.
 51. American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. 2009;41(3):687-708.

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