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Use of ergogenic aids and nutritional habits among federated athletes in Catalonia, Spain.

Proposta de Treball Final de Màster

Màster d'Alimentació en l'Activitat Física i l'Esport

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Content

Abstract

Sports supplements use has gained popularity among athletes in the past years. The pattern of use and the reasons for consumption seem to be dependent on the sport discipline, sex and competitive level. Most of the studies performed include elite athletes while information about supplement use among amateur athletes is limited. It has been reported that there is a poor level of nutritional education among athletes which results in inappropriate decisions on supplementation and dietary habits which could be improved. To date, studies analysing supplement consumption in Spanish federated athletes are even more scarce. Therefore, the aim of the #EsportFarma study is to understand supplement consumption patterns among federated athletes in Catalonia and analyse the factors that influence their behaviour as well as their dietary habits. The results indicate that the most frequently used supplements among federated athletes in Catalonia are carbohydrates and vitamins and minerals being a health professional and the Internet the general preferred sources of information. The factors that influence consumption are varied and are discussed in the study. In general, federated athletes follow a balanced diet and the figure of a dietician-nutritionist enhances their nutritional habits. Nevertheless, some mismatching between supplement effect and reported reasons for consumption is found as well as an imbalance in the frequency of consumption of certain food groups. Hence, suggestions for improving supplement use and consequently optimising performance and overall athletes' health are given.

Keywords: survey analysis, federated athletes, sport supplements, ergogenic aids, dietary habits.

1. Introduction

Sports supplements can be defined as '*a food, food component, nutrient, or non-food compound that is purposefully ingested in addition to the habitually consumed diet with the aim of achieving a specific health and/or performance benefit*' [1]. They are easily found in the market and include a large variety of products such as energy bars or drinks, protein powder, vitamins and minerals, stimulants, among others. Its use has always been popular among elite athletes with performance-enhancing purposes in order to meet the demanding level of sport competition [1][2][3]. Its popularity has considerably increased worldwide among the general population during the past years: in 1996 supplementation prevalence was around 3.8% [4], 6% in 2009 [5], 13% in 2013 [6], and increasing up to 70% in 2021 [53].

For this reason, in 2009 the AESAN (*Agencia Española de Seguridad Alimentaria y Nutrición,* Spanish Agenfy for Food Safety and Nutrition) designed a regulatory framework to ensure food safety and proper commercialisation of nutritional supplements. With a similar approach, in 2000, the AIS (*Australian Institute of Sport*) created a supplement classification system addressed to athletes in which the different supplements are grouped according to its level of scientific evidence (Table S1) [54].

Because of the increase in the prevalence of supplement use by the general population this has been a topic of interest in several investigations. Several studies suggest that vitamins and minerals are the most consumed supplements in Europe [5] with women being more frequent consumers than men [5][6]. In fact, several studies report that individuals who supplement with vitamins and minerals get a higher amount of micronutrients from their diet than the individuals who do not supplement indicating that supplementation is often unnecessary [7][8].

Among active people and gym users, it is also common the consumption of sports supplements. Men tend to consume more protein and carbohydrates while women consume vitamins and minerals with the purpose of enhancing performance and maintaining good health, respectively [5][6]. The most popular source of information by most supplement-users is the Internet and friends, which can result in supplementation in a misinformed manner [9][10]. In this regard, studies performed in the Spanish population indicate that only 28% of sports supplement-users rely on health professionals from the like doctors, pharmacist, or dieticians-nutritionists for acquiring supplements, while more than 40% follow recommendations from the Internet or friends [53].

When it comes to athletes, a similar tendency has been observed. A meta-analysis from 2016, which includes including studies from a large variety of countries concluded that

elite athletes tend to consume more ergogenic aids than non-elite athletes [2]. Different studies performed in this subgroup suggest that between 48 and 81% of elite athletes consume at least one supplement, with proteins and multivitamins being the most popular [11][12][13][14][15] [16].

Despite the existing controversy regarding if men or women are most frequent consumers, it seems clear that gender is a differentiating aspect of consumption [12][14][15]. What has been consistent among several studies is the fact that men tend to consume proteins and creatine whereas women rely more on multivitamins [13][16].

Sport discipline is another differentiating aspect of the consumption trend: athletes who practise power-sprint disciplines (i.e. bodybuilding, weightlifting) tend to consume creatine, BCAA and protein whereas in endurance disciplines (i.e. cycling, swimming) carbohydrates and isotonic drinks are the most popular [17][2]. Elite athletes mostly rely on dieticians and coaches when deciding on supplementation [2]. Nevertheless, it is also common to self-administrate supplements based on the information found on the Internet and social networks, which increases the risk of undergoing a positive anti-doping test because of unintentional supplement misuse [18].

Ergogenic aids use is not restricted to elite athletes. Although studies performed in amateur athletes are less frequent, they show a similar tendency, with sports drinks, protein and multivitamin are the most consumed supplements, while the Internet and team mates or coaches the principal motivators of consumption [14][19].

Interestingly, among amateur athletes there is a higher tendency of self-organizing supplementation based on the information found on the Internet and social networks [19]. In this regard, it has been reported that there is a general misinformation when it comes to supplement use suggesting that some athletes do not fully understand the function of the different ergogenic aids that they consume, which can be related to a poor nutritional education [20].

It is interesting to note that most of the studies performed to date do not include Spanish athletes. To our knowledge, there are only three published studies performed in elite Spanish athletes, focused on basketball [11], tennis [21] and squash players [22]. Studies that involve federated Spanish athletes are missing. Therefore, the main purpose of the #EsportFarma survey is to understand the patterns of consumption of sports supplements among male and female federated amateur athletes in Catalonia, Spain. The patterns of use and motivators for consumption and choice will also be analysed including

possible differences among the different included sports. Considering that nutritional education among athletes seems to not be optimal the nutritional habits of federated amateur athletes in Catalonia will also be investigated.

The present study is a descriptive study that will eventually help evaluate the need of implementing new recommendations for improving sport supplement use and daily nutrition of amateur federated athletes in Catalonia.

2. Objectives

The main objective of this project is to disclose the ergogenic supplementation tendencies and nutritional habits of amateur federated athletes in Catalonia.

In order to fulfil this purpose there are several secondary objectives:

- To describe the supplementation habits of amateur athletes of Catalan federations.
- To identify and correlate the factors that can influence their consumption tendencies including prescription, reasons and motivators for consumption.
- To detect a possible relation between supplement use and gender, sports discipline and nutritional habits among amateur federated athletes in Catalonia.
- To get insight into the nutritional habits among federated athletes of Catalan federations and understand the factors that modulate them.
- To establish, if necessary, recommendations for optimizing sport supplement use and daily nutrition of amateur federated athletes in Catalonia.

2.1 Research questions

The following questions are the main aspects that motivate the study:

- What are the most common sport supplements used by amateur athletes from Catalan sport federations?
- What are the main information sources and reasons that motivate and influence supplement consumption?
- Is there any correlation between supplement use and gender, sports discipline or nutritional habits?
- What are the tendencies that amateur athletes from Catalonia follow when it comes to their nutritional habits? Is there a good nutritional education among them?
- Are the current nutritional recommendations followed? Does the role of a nutritionist or dietician have an impact on the athlete's nutritional habits?

3. Methods

Participants

One hundred thirteen (54 males and 59 females) athletes volunteered to participate in the #EsportFarma study by filling out an adapted questionnaire about sport habits, use of sport supplements and dietary habits. The athletes were members of Catalan sport federations. Specific information of the sample is indicated in Table 1.

		Total	Frequency (%)		p-value
			Yes	No	
Gender	Male	51.33% (54)	61.1% (33)	38.9% (21)	0.4
	Female	48.67% (59)	67.8% (40)	32.2% (19)	
	Total	113	64.6% (73)	35.4% (40)	
Age Range	< 18	0.88% (1)	0% (0)	100% (1)	0.005 (*)
	18-25	10.60% (12)	83.3 % (10)	16.7% (2)	
	26-34	33.62% (38)	63.2% (24)	36.8% (14)	
	35-44	29.20% (33)	75.8% (25)	24.2% (8)	
	45-54	12.39% (14)	64.3% (9)	35.7% (5)	
	55-64	7.08% (8)	25% (2)	75% (6)	
	≥ 65	6.19% (7)	14.3% (1)	85.7% (6)	
Sport	Hiking	28.3% (32)	65.7% (21)	34.3% (11)	N/A
	Athletics	23.9% (27)	70.4% (19)	29.6% (8)	
	Cycling	15% (17)	88.2% (15)	11.8% (2)	
	Swimming	13.3% (15)	80% (12)	20% (3)	
	Paddle tennis	12.4% (14)	71.4% (10)	28.6% (4)	
	Body-building	10.6% (12)	58.3% (7)	41.7% (5)	
	Gymnastics	9.7% (11)	63.6% (7)	36.4% (4)	
	Football	8.8% (10)	90% (9)	10% (1)	
	Winter Sports	8% (9)	100% (9)	0% (0)	

	Rowing	8% (9)	44.4% (4)	55.6% (5)	
	Basketball	8% (9)	66.7% (6)	33.3% (3)	
	Power-lifting	5.3% (6)	83.3% (5)	16.7% (1)	
	Tennis	4.4% (5)	40% (2)	60% (3)	
	Table tennis	3.5% (4)	0% (0)	100% (4)	
	Sailing	3.5% (4)	75% (3)	25% (1)	
	Triathlon	3.5% (4)	100% (4)	0% (0)	
	Volleyball	3.5% (4)	50% (2)	50% (2)	
Experience	< 5 years	76.9% (87)	63.2% (55)	36.8% (32)	0.03 (*)
	< 5 years	23.1% (26)	69.2% (18)	30.8% (8)	

Table 1. Characteristics of the participants and frequency (%) of consumption of sports supplements. (*) indicates that the difference between groups is significant, with $p < 0.05$.

Design of the survey

The survey was divided in three parts:

- **Part 1: Participant information, sport habits and supplementation:** gender, age, level of studies, smoking habits, diseases and prescribed medication. Sport discipline(s), experience (years) in the practised sport, number of competitions per year, daily activity, training hours and intensity, type of training followed (individual, team, personal trainer, internet), specific diet(s), presence of a dietitian/nutritionist. Type of supplements consumed (sports drinks, carbohydrates, proteins, branched chain aminoacids, vitamins and minerals, antioxidants, condroprotectors, collagen, caffeine, creatine, glutamine, carnitine, bromelain, ginseng and probiotics), frequency of use, dose, place of purchase, prescription and purpose of consumption. The questions were adapted from [55]. Information about supplements effect was given to the participants (Table S1).

- **Part 2: Hydration habits:** type of drink before, during and after training and frequency of drinking. The questions were based on recommendations of the ACSM (American College Sport of Medicine) [25] and served as a reference for the FEMEDE (Federación Española de Medicina del Deporte).

- **Part 3: Nutritional habits** (optional, N = 66). Consumption frequency of the different food groups (vegetables, fruit, eggs, dairy, meat, fish, nuts and oil) and meal frequency was asked following the Frequency of Consumption questions from the SENC2015 (*Sociedad Española de Nutrición Comunitaria)*, adapted from [23][24]. Each answer was related to a higher or lower frequency of consumption and the most similar one to the WHO recommendations was given the highest punctuation resulting in a final score that allowed for the grouping of the sample (Table 1).

SCORE	
0-18	You should improve your nutritional habits.
19-36	Your nutritional habits can be improved.
37-55	You follow a balanced diet.

Table 1. Scores and corresponding adherence to the Mediterranean Diet.

In order to create the spider charts, each frequency of consumption within each food group was assigned a punctuation giving the maximal punctuation to the highest frequency of consumption included in the questionnaire (Table 2). For example, for eggs consumption the questionnaire offered 4 possible answers being (1) never or less than once per week, (2) one or two times a week, (3) three or four times a week and (4) more than 4 times a week. Since the WHO recommends consuming eggs three or four times a week a punctuation closer to 3 indicates a more adequate consumption of this food group.

Food group	WHO Recommendation	Corresponding punctuation
Fruits	3 times a day	5
Vegetables	2 or more times a day	5
Beans	2-4 times a week	5
Grains	3-5 times per day	3
Dairy	2-4 times per day	3
Fish	3 or more times a week	5
Meat	3-4 times a week	3
Eggs	3-4 times a week	3
Nuts	3-7 times a week	5

Table 2. WHO recommendations for consumption of each of the food groups and its corresponding punctuation for generating the spider charts.

Data collection

The data was collected through an anonymous and auto-administered online survey. The answers were collected using the Typeform application ensuring anonymity by multiple levels of encryption and access controls using TLS secure cryptographic protocols.

A link to the survey (https://cofb.typeform.com/to/ZY9P6q?typeform-source=mail.google.com) was distributed by email to the different Catalan sport federations in order to reach the athletes. The main objective of the survey was described in the email, in order to inform and attract more participants. The participation was voluntary and totally anonymous including the approval of an informed consent before its realization. The duration of the data collection process was extended as necessary (from 2017 to 2021) in order to obtain answers from at least 100 participants. The study was aproved by the Ethic Comitee of UOC (Universitat Oberta de Catalunya).

Statistical analysis

The data was collected in a Microsoft Excel file, which was the main tool for performing the analysis. The participation of 113 federated athletes was recorded. In order to facilitate the study and interpret the data the entire sample was divided in a variety of subgroups (Table S1, S2, S3) which were independently compared. Participants and quantitative data of sport supplementation and frequency of consumption are expressed by percentages and frequencies. The qualitative data (i.e. supplement consumption between subgroups) was analysed with the Chi Square test and t-student test was used for analysing the quantitative data (i.e. score of the Mediterranean Diet Questionnaire between subgroups). The significant level was set at $p < 0.05$.

4. Results

4.1 General sample

The average age of the participants was 38.62 years old from which 51.33% were males and 48.6% were females. The older age groups included more males than females (Figure 1A). Among all the participants there were 17 different practised sports all of them with a different number of participants but a similar proportion of genders (Figure 1B).

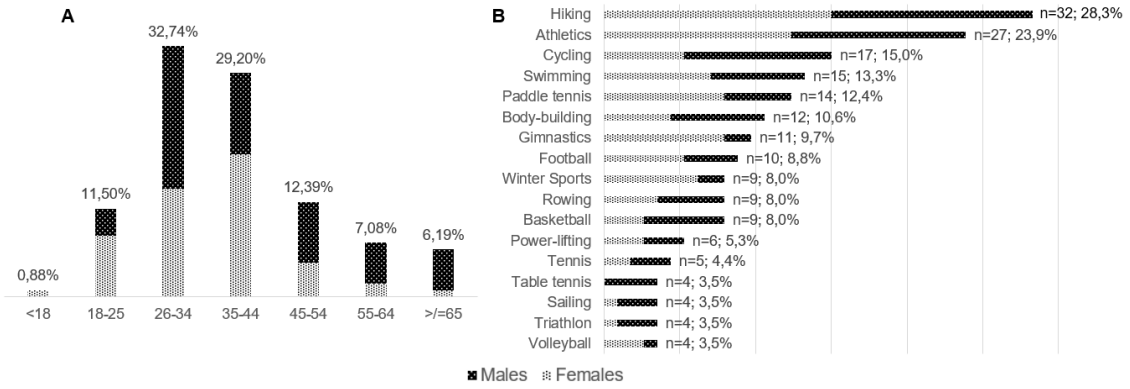

Figure 1. Distribution of the simple according to (A) age and gender and (B) practised sport.

77% of the sample has been practising their sport for more than 5 years (Figure 2A). More than half of the sample (65.5%) has participated in less than 5 competitions during the last year and only 9.73% of the sample has engaged in more than 20 (Figure 2B). 41% of the sample reported not following any specific training, 9.5% reported taking trainings from the internet, 37% trained in team and 12.6% had a personal trainer (Figure 2C).

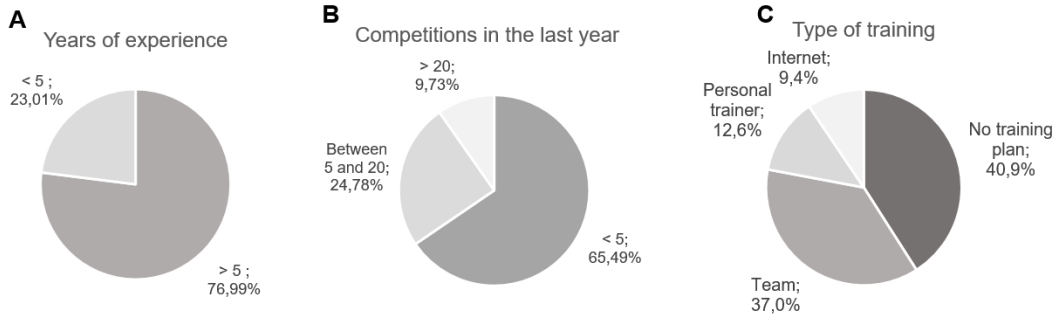

Figure 2. Distribution of the sample regrading (A) experience in the sport, (B) engagement in competitions in the last year and (C) type of training followed.

4.2 Supplementation habits

4.2.1 General sample and gender differences

From the total sample, 64.5 % of the participants consumed supplements in a regular manner. The youngest age-group (18-25 years old) were the most frequent consumers (80%) whereas participants above 55 years old reported the lowest use of supplements

(35%). Overall, the most consumed supplements were carbohydrates (26.5%) and vitamins and minerals (23.9%). Only 0.9% of the participants consumed bromelain and glutamine and ginseng were also poorly consumed (3.5%) (Figure 3).

Female athletes reported a higher supplement use than males (67.8 % vs 61%, respectively, $p = 0.4$). Female athletes presented a higher consumption of vitamins and minerals (34%) whereas carbohydrates were the most common among male athletes (33%). Antioxidants, caffeine, creatine, carnitine and ginseng were consumed at least two times more frequently in males than in females. The opposite was found with vitamins and minerals and probiotics, which were at least twice as frequently consumed by females (Figure 3).

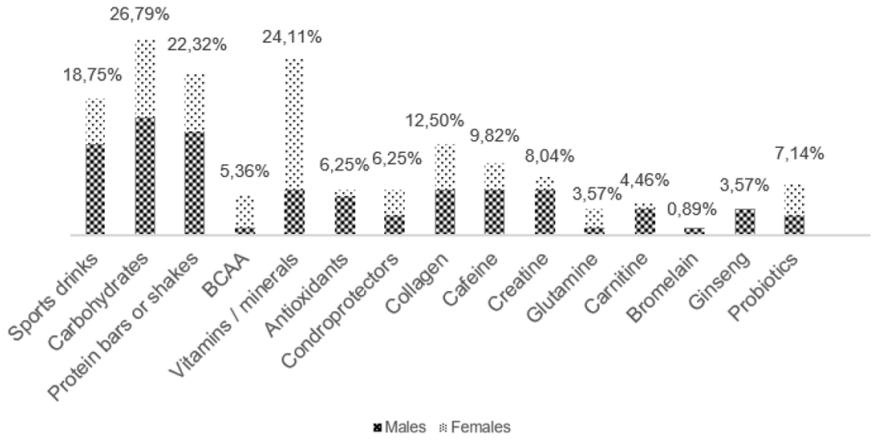

Figure 3. Supplement use of the total sample distinguished by gender.

On average, each participant tended to consume between 1 and 2 supplements (CC = 1.58). Triathletes and swimmers presented the highest supplement use per individual (CC of 4 and 3.2, respectively) while table-tennis and volleyball had the lowest coefficient of consumption (CC <0.5) (Figure 4).

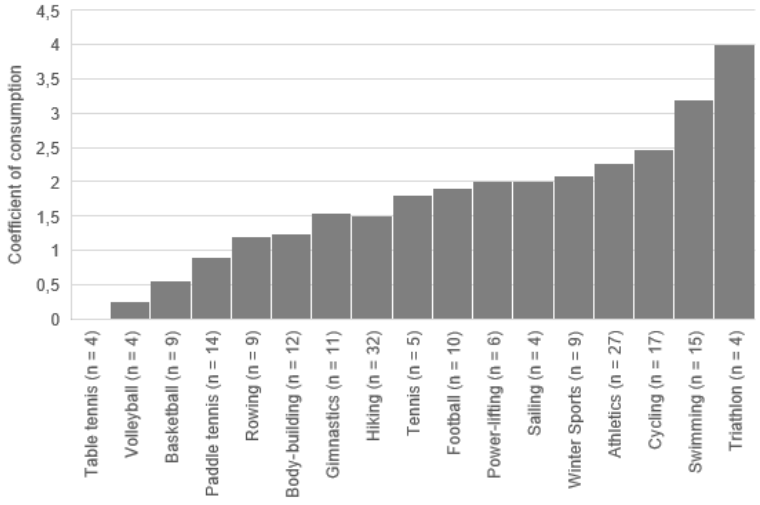

Figure 4. Coefficient of consumption of the different sports included in the survey.

The most common reasons for supplementing were to maintain good health (14%) and improve sports performance (12.9%). Only females reported using supplements for lowering stress or gaining muscle mass and most males used supplements for preventing or treating injuries (Figure 5A). Almost a quarter of supplement-users did not justify their consumption. The most common sources of information when deciding on supplementation were health professionals (38.55%) and the Internet (34.20%) with the first one being preferred by females and the second one by males.

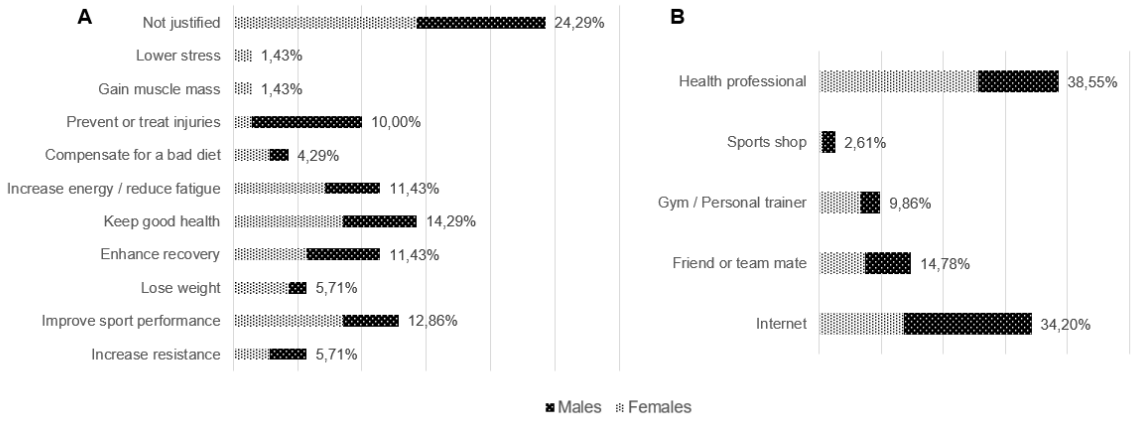

Figure 5. (A) Reasons and (B) motivators for consumption within the general sample.

4.2.2 Type of sport discipline

The 17 sports were divided in two groups depending on type of discipline (Table S2). Supplement use was significantly more common in endurance (75.2%) than in power disciplines (59%) ($p = 0.01$). A highest supplement use per individual was found in the first group ($2.27 < CC < 4$) compared to the latter ($0 < CC < 0.9$) (Figure 6).

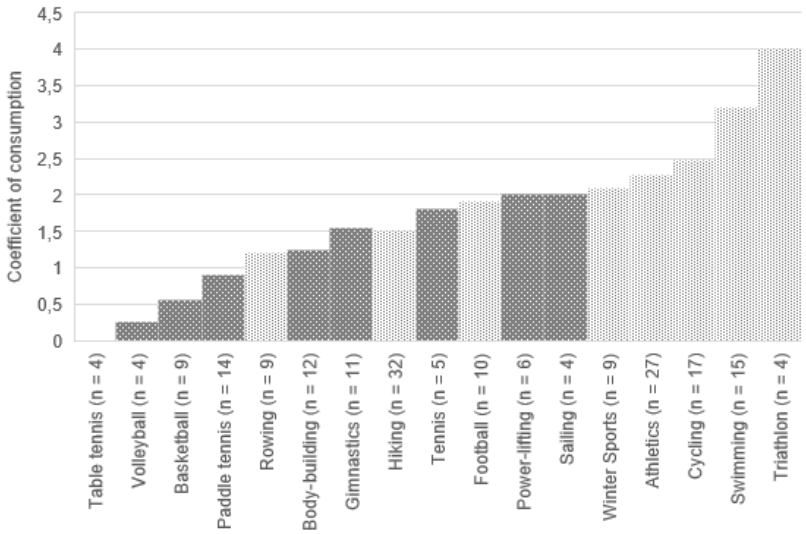

Figure 6. Coefficient of consumption of the different sports included in the survey, distinguished by endurance (light pattern) and power (dark pattern) disciplines.

Among endurance disciplines carbohydrates were the most common supplement (44%) whereas in power disciplines participants tended to consume mostly vitamins and minerals (21.5%). Glutamine, bromelain and ginseng were only consumed by endurance athletes. However, they were consumed by less than 5% of the sample. The biggest difference in consumption between groups was found in antioxidants, which were consumed more than six times more frequently in endurance disciplines compared to power disciplines (9.45% vs 1.54%), followed by carbohydrates, the consumption of which was four times higher in endurance disciplines (44% vs 10.7%). Creatine and caffeine were the only supplements that were more frequently consumed in power disciplines compared to endurance disciplines (9.45% vs 15.38% and 7.87% vs 10.77%, respectively) (Figure 7).

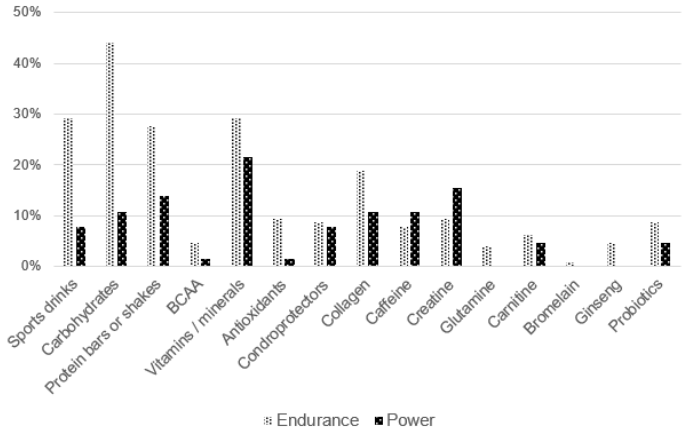

Figure 7. Supplement consumption among athletes participating in endurance and power disciplines.

The more popular reasons behind supplementation in endurance sports were increasing energy and reducing fatigue (19.7%) whereas power disciplines athletes tended to prioritise maintaining a good health (20.5%). Endurance athletes reported using supplements for enhancing recovery around two times more than power athletes (10.9% vs 5.1%). Athletes who participated in power disciplines reported taking supplements for losing weight around 9 times more than endurance disciplines (1.1% vs 10.2%). Similarly, power athletes reported using supplements for compensating for a bad diet almost 5 times more than endurance athletes (2.2% vs 10.2%). Moreover, only participants from the aforementioned subgroup used supplements for lowering stress or gaining muscle mass (2.5%, Figure 8A). In both subgroups, a health professional was the preferred source of supplement information for more than a third of the participants being the Internet the second option (Figure 8B).

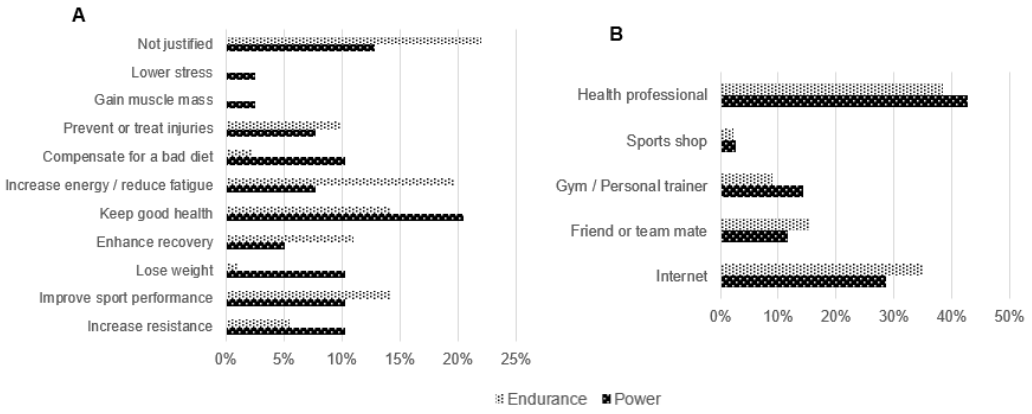

Figure 8. Reasons (A) and motivators (B) of supplementation among athletes participating in endurance and power disciplines.

4.2.3 Individual vs team sports

The 17 sports were divided into the corresponding subgroups (Table S3). Supplement consumption was higher in individual (70.9%) compared to team sports (24%) ($p = 1.15$). In both groups carbohydrates, vitamins and minerals and protein were the most consumed supplements. Creatine was almost 8 times most frequently consumed in individual than in team sports (15.6% vs 2%). In this regard, collagen was consumed 3 times more in individual and in team sports (6% and 2%) (Figure 9).

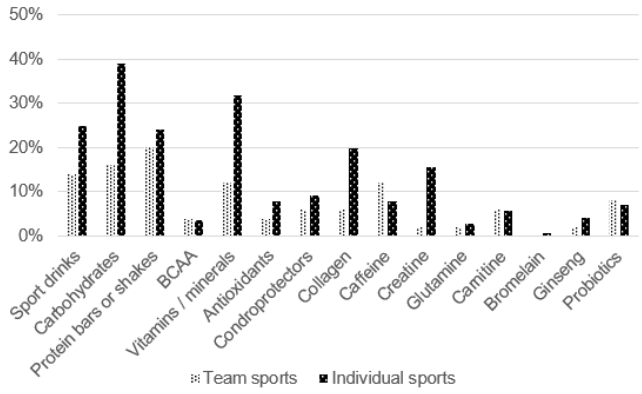

Figure 9. Supplement consumption among athletes participating in individual and team sports.

The most frequently reported reason for supplementing in team sports was for preventing or treating injuries (17%) whereas keeping a good overall health (17%) and increasing energy levels (18%) were the main justifications for participants of individual sports. Losing weight (14.71%), lowering stress (2.94%) and gaining muscle mass (2.94%) were only stated by participants of team sports. Similarly, increasing strength was only reported by individual sports athletes (5%) (Figure 10A). More than 40% of the participants of individual sport disciplines relied on a health professional for deciding on supplementation whereas the same proportion within team sports subgroup relied on the Internet (Figure 10B).

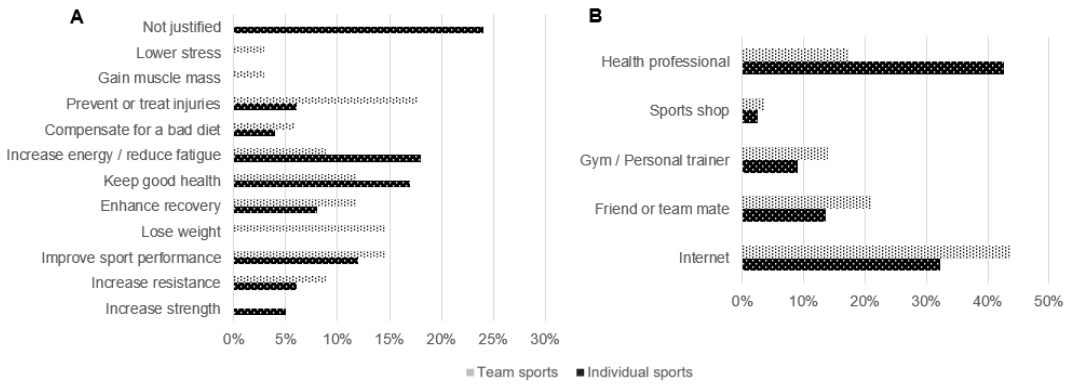

Figure 10. Reasons (A) and motivators (B) of supplementation among athletes participating in individual and team sports.

4.2.4 Intensity level

After classifying the sports according to its intensity level (Table S4) it was found that high intensity sports presented a higher supplement use (74.7%) than moderate intensity sports (65.2%) ($p = 0.16$).

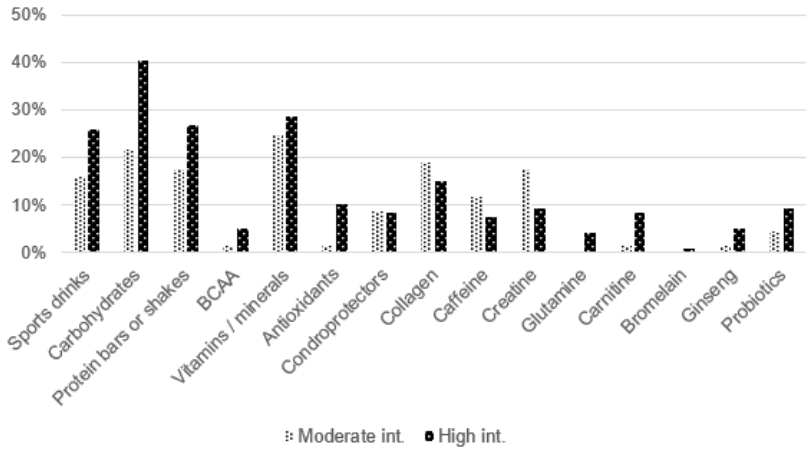

Figure 11. Supplement consumption of athletes participating in moderate and high-intensity sports.

The most common supplement in high intensity sports were carbohydrates which were consumed almost two times more than in moderate intensity sports (40.3% vs 21.7%). The biggest difference was found in antioxidants which were consumed almost 7 times more in high intensity sports (10% vs 1.4%) followed by carnitine which was consumed more than 5 times more in the same group (8.4% vs 1.4%). On the other hand, creatine was 2 times more consumed in moderate intensity sports (9.2% vs 17.3%) and collagen was also more common in this group (15.1% vs 18.8%). Ginseng and probiotics were consumed at least 2 times more in high intensity sports compared to moderate intensity sports (1.4% vs 5% and 4.3% vs 9.2%, respectively) (Figure 11).

The moderate intensity subgroup reported using supplements for keeping a good health (22.2%) whereas the most frequently reported reason for supplementing among high

intensity disciplines athletes was increasing energy and reducing fatigue (16.8%). Increasing strength was 6 times more reported in moderate intensity sports (6.6% vs 1.1%) whereas enhancing recovery was 6 times more reported in high intensity sports (2.2% vs 12.3%). Lowering stress and gaining muscle mass was only reported by individuals of high intensity disciplines (Figure 12A). A health professional was the influence on supplementation for more than half of moderate intensity discipline athletes (56.4%) whereas the Internet was preferred among the high intensity subgroup (38.5%) (Figure 12B).

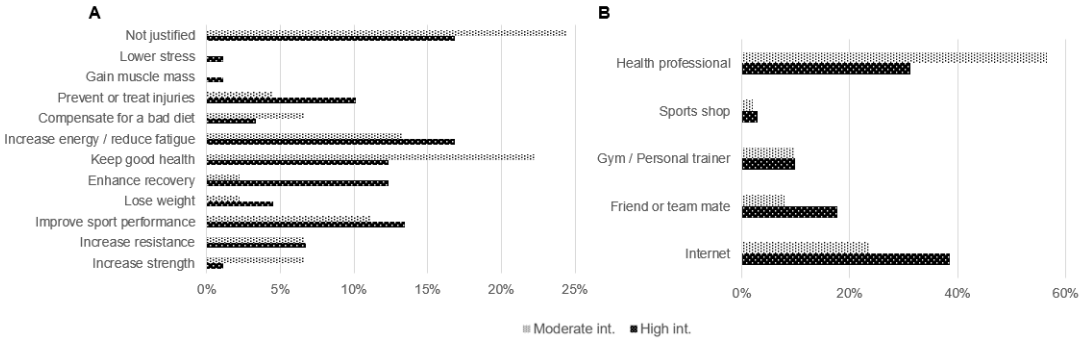

Figure 12. Reasons (A) and motivators (B) of supplementation among athletes participating in moderate and high-intensity sports.

4.2.5 Years of experience

The 77% of the sample had been practising their sports for more than 5 years and reported a significantly lower supplement use (63.2%) than the athletes with less than 5 years of experience (69.2%) ($p = 0.03$). The experienced group consumed mostly carbohydrates (27.5%) for improving performance (12.7%) while the non-experienced consumed vitamins and minerals (30.8%) for keeping a good health (22.2%). Caffeine was consumed almost two times more in non-experienced athletes (8% vs 15.4%) whereas the opposite happened with probiotics that were two times more frequently consumed by experienced athletes (8% vs 3.8%). Bromelain and probiotics were only consumed by experienced athletes (Figure 13).

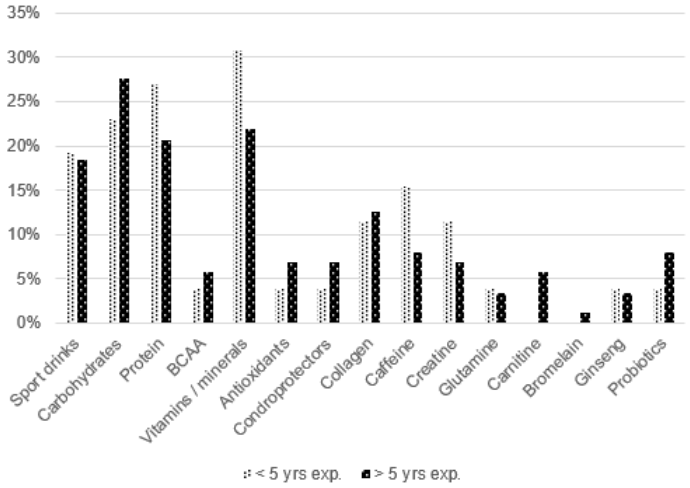

Figure 13. Supplement consumption of athletes with less than 5 years of experience and athletes with more than 5 years of experience.

Keeping a good health was primordial for 22.2% of the non-experienced athletes who supplemented and improving sport performance was the most common reason for supplementing among experienced athletes (12.7%). Only individuals from this group reported using supplements as a way of losing weight (7.27%) whereas gaining muscle mass and lowering stress was only reported by non-experienced athletes (5.56%) (Figure 14A).

More than 40% of individuals of both groups followed recommendations of a professional sanitary but less experienced athletes appeared to rely more in gym members or personal trainer (19%) whereas the Internet was more popular in experienced athletes (27.7%) (Figure 14B).

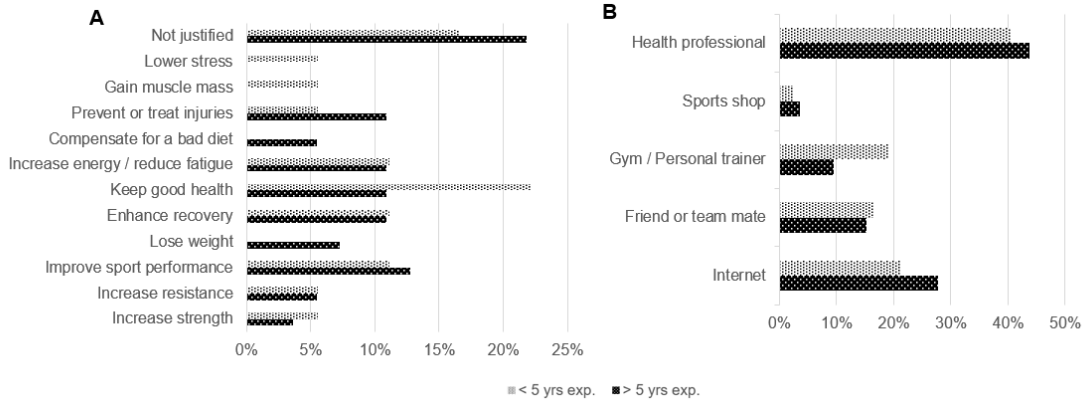

Figure 14. Reasons (A) and motivators (B) of supplement consumption of experienced and non-experienced athletes.

4.3 Nutritional habits

Less than a quarter of the total sample (21.4%) reported following a diet, which included gluten-free (5.31%), dairy-free (4.47%), paleo diet (3.54%), vegetarian (3.54%), high-protein diet (3.54%) and hypocaloric (0,88%).

41.6% of the participants who followed a diet had a personal dietician or nutritionist (D/N), which represented the 15% of the total sample of the study. Within this subgroup, protein and vitamins and minerals were the most frequently consumed supplements (41.5%). Vitamins and minerals were also common (21%) among participants that did not have a D/N along with carbohydrates (24%). Caffeine, creatine, BCAA and probiotics were three-times more consumed among participants that had a D/N. Carnitine and collagen were only consumed by participants who did not have a D/N (Figure 15A).

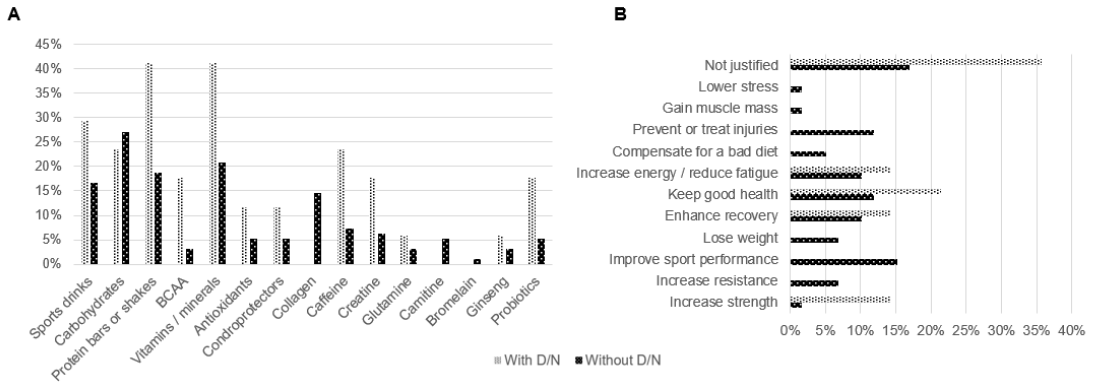

Figure 15. Consumption (A) and reasons for supplementing (B) among individuals with and without a personal dietician-nutritionist (D/N).

Among the participants who did not have a D/N improving sports performance (15.2%) and preventing or treating injuries (12.8%) were the most common reasons for supplementing, which were not reported by any of the individuals who had a D/N. More than 35% of the individuals who had a D/N did not justify their consumption. In this same group, more than 20% reported that keeping good health was their main purpose for supplementing (Figure 15B).

As for their hydration status, 57.5% of the participants drank 1.5L or more per day increasing up to 75% among participants that had a D/N. In both groups, water was the preferred drink before, during and after training. Around 10% of the total sample used isotonic drinks during and after training, 85% of which were from endurance disciplines.

Having a D/N resulted in a higher score (45) in the 'Mediterranean Diet Questionnaire' compared to not having it (41) ($p = 1.68$). The subgroup that had a D/N reported a higher frequency of consumption of vegetables, nuts and fish compared to participants that did not have a D/N; vegetables were consumed 2 times a day and nuts and fish at least 3

times a week among participants that had a D/N whereas participants that did not have a D/N reported consuming vegetables 1 or less times a day, nuts around 2 times a week and fish 1 or 2 days a week (Figure 16).

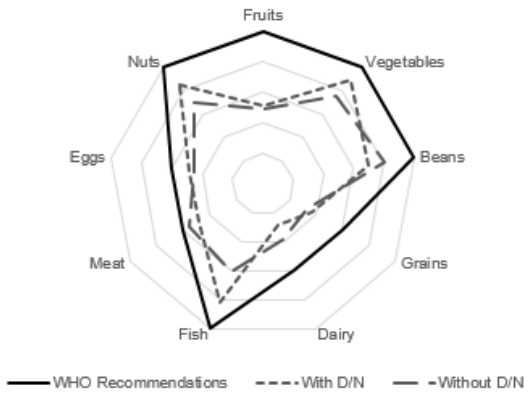

Figure 16. Frequency of consumption of the different subgroups and adequacy according to WHO recommendations.

When analysing the frequency of consumption of the different food groups a similar general tendency was observed in both genders: the consumption of meat and eggs was close to the WHO recommendations but the consumption of fruit and fish was more than 2 points below the recommendations. A difference was observed in the consumption of nuts and grains that were more frequently consumed by men with woman consuming more vegetables and meat (Figure 17).

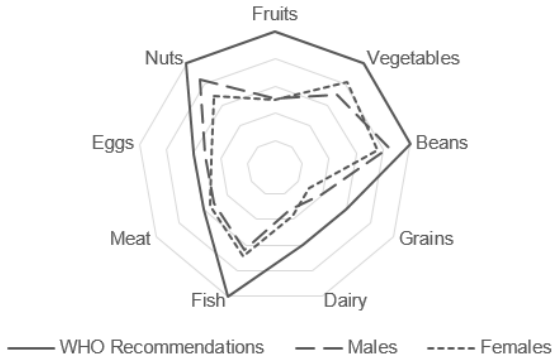

Figure 17. Frequency of consumption of the different subgroups and adequacy according to WHO recommendations distinguishing by gender.

When comparing the adequacy to the Mediterranean Diet similar scores were obtained for men (43) and for women (42) ($p = 1.18$) indicating that both groups follow a healthy diet. When comparing the Healthy Eating Pyramid from Harvard University (Figure 18A) to the pyramids corresponding to male and females diet a low consumption of grains was detected in both genders as well as a high consumption of red meat. Men showed a higher consumption of nuts (Figure 18B) whereas females consumed more fruits and vegetables (Figure 18C).

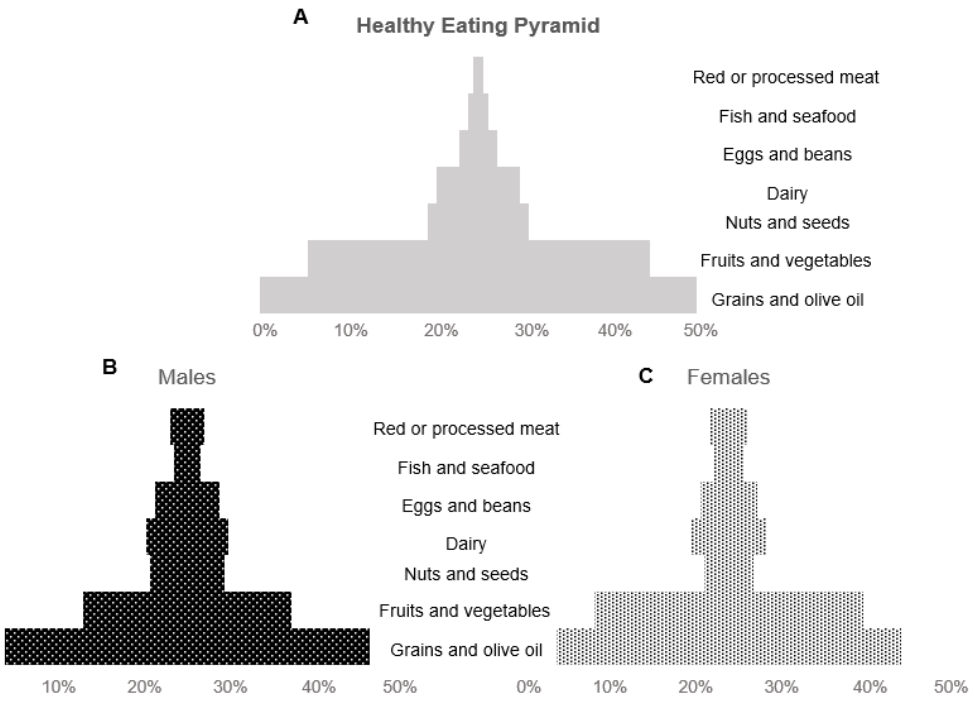

Figure 18. Representation of the dietary habits using the (A) Healthy Eating Pyramid as a reference and comparing (B) males and (C) females.

As for endurance and power disciplines the frequency of consumption of the different food groups between was similar: meat and nuts consumption was close to the WHO recommendations whereas fruits, grains and fish were more than 1 point under the WHO recommendations (Figure S1A). A similar pattern of food group consumption was observed between all the compared subgroups in the study (Figure S1) and all groups were found to follow a balanced diet (Table 3).

Subgroup	**Score**	***p-value***
Endurance	41.4 – Balanced diet	*0.53*
Power	40.6 – Balanced diet	
Individual	40.6 – Balanced diet	*0.73*
Team	41.3 – Balanced diet	
Moderate intensity	41.2 – Balanced diet	*0.66*
High intensity	42.1– Balanced diet	
Less experience	43.8 – Balanced diet	*0.41*
More experience	41.4 – Balanced diet	

Table 3. Summary of the scores obtained in the 'Mediterranean Diet Questionnaire' by each of the analysed subgroups.

5. Discussion

There is a large amount of available articles that study supplement use in athletes. However, most of them are performed in elite athletes and studies focused on federated athletes are scarce. Thus, the ##EsportFarma study can be considered a pioneer in this field and the obtained results are of remarkable interest.

We found that 64.5% of the athletes of Catalan sports federations supplement regularly which is within the range reported by previous studies, being between 48% and 81% [11]–[16]. Interestingly, the majority of the studies available to date report a higher supplement use among females compared to male athletes [2][12][14][15] which is in accordance with the #EsportFarma study results. It is said that females tend to supplement with a health focused mind-set whereas males look for performance improvements [23]. Vitamins and minerals (specifically vitamin E and iron) are the most prevalent among the first whereas proteins, carbohydrates and creatine tend to predominate in the latter [13][16][53]. Our study found that 67.8% of females used supplements regularly whereas it was around 6% less among males. Moreover, vitamins and minerals were the most common supplement among females (34%) and carbohydrates in males (33%). Several studies performed in professional and elite athletes report a high consumption of vitamins and minerals [19][20][23][24].

Considering that vitamins and minerals are not directly related to an increase in performance [22][25] it is worth analysing the sources of information that athletes use for deciding on supplementation. In general, our sample relied on a health professional and the Internet to get information about supplementation. Our study is not the first one to suggest that auto-administration of supplements is done based on the information posted on the Internet [26]–[28]. In fact, one study that includes more than 300 young athletes from different countries concludes that the Internet and coaches were the main sources of information [29]. As for elite Spanish athletes, a study concludes that the Internet and social media are the preferred tools for nutritional education being even more common than the reliance on health professionals [20]. Considering the amount of information readily available online nowadays it is of crucial importance to ensure a proper nutritional education among athletes. Seeing that in our study more than 24% of the supplement-users did not justify the reason of consumption may be indicative of poor information regarding supplement effects. Related to that, collagen is consumed by almost a quarter of the participants increasing up to 20% in endurance disciplines athletes and from individual disciplines. According to the AIS classification of supplements, collagen does not have enough scientific evidence to confirm that it benefits athlete's performance [54]. A simple search on the Internet results in a lot of webpages talking about the benefits of collagen supplementation having effects on the skin, joints and muscle mass suggesting

that it improves overall health. It is therefore necessary to emphasise how the role of health professionals can help athletes make the proper decisions when it comes to choosing supplementation as well as becoming conscious of the importance of nutritional education and how to pinpoint conflicts of interests on the internet. It is interesting that young athletes have been reported to use the Internet as a common tool for getting information on supplementation [29][30]. Contrary to this, in our study participants between 45 and 54 years old tended to use the Internet more than younger age groups, who relied more on gym members or personal trainers (Figure S2). This may explain why the 45-54 years old age group consumed more supplements with low scientific evidence such as collagen (42.9%), carnitine and ginseng (14.3%) (Figure S3).

It is of interest to analyse the correlation between the most popular supplement and the most frequently reported reason for supplementation, since previous studies conclude that there are incongruences between supplement use and the reported purpose of supplementation [12][31]. In the #EsportFarma study, the subgroups that followed the recommendations of a health professional (e.g. females, power athletes, moderate intensity athletes, individual disciplines) reported a higher correlation between the used supplements and the justification for using them (e.g. vitamins and minerals for 'keeping a good health', carbohydrates for 'increasing energy' and 'reducing fatigue'). Interestingly, among team sport participants, the most common supplement was protein and the main reported reason was 'to prevent or treat injuries'. Even if it is true that the ingestion of protein reduces muscle loss and accelerates the healing process during injury [32], regular supplementation with protein is not related to this aspect but to muscle mass maintenance, repair and growth [33]. It is, therefore, not surprising that the main source of information for the participants of this subgroup was the Internet.

When comparing the different subgroups interesting patterns of consumption were found. Some studies suggest that endurance disciplines are related a higher supplement consumption than power disciplines [20][34]. Our results show that endurance discipline athletes consume significantly more supplements than power discipline athletes having different preferences when it comes to choosing the supplement. More specifically, triathlon, swimming and cycling were the sports with the highest supplement use per individual whereas table tennis, volleyball and basketball were the ones with the least consumption per individual. Several studies reported that swimming and cycling are the sports in which supplement use appears to be the highest [19]. A higher training volume is related to a higher supplement use [23] and since endurance disciplines tend to require longer trainings it could be an explanation. Endurance disciplines athletes reported taking supplements for enhancing recovery two times more frequently than power disciplines, which can also be related to a higher training volume. In a similar manner, sports

in which technique is predominant supplementation may be considered less necessary. Endurance discipline athletes tended to consume around 4 times more sport drinks and carbohydrates than power athletes, which is reasonable considering that carbohydrates potentiate performance and recovery in endurance sports and isotonic drinks help in maintaining proper hydration [35]. In a similar manner, creatine and caffeine are recognized to have ergogenic effects in power disciplines [36][37] thus justifying its higher use in power disciplines in our sample. Interestingly, antioxidants and collagen were popular in endurance disciplines (10-20%). These two supplements are related to recovery enhancement and decrease of joint pain but they lack solid scientific evidence regarding its efficacy [22] which can be related to the frequent reliance on the Internet (35%) in this subgroup.

Previous studies report a greater supplement use among individual sports athletes compared to team sports which is related to the higher percentage of doping in the first group (WADA 2017) [19][20][23][25]. This could be due to the greater pressure that an athlete participating in an individual discipline can feel when it comes to performance outcomes, resulting in a higher reliance on supplementation with the aim of achieving the desired goals. The fact that individual athletes tend to compete with a more goal-oriented focus than team sport athletes who look more for enjoyment [38] can help explain the greater supplement use among athletes from individual disciplines. Interestingly, it has been reported that individual athletes are more likely to suffer from anxiety and depression mainly due to the pressure of being exposed alone in a competition and being the only responsible of executing a perfect performance, most of the times under a judge's approval (i.e. gymnastics) [19][38][39]. Team sport athletes may be receiving more support from their colleagues, increasing their self-esteem and consequently feeling more confidence in their capabilities resulting in higher motivation levels and lower sensation of dependence on supplementation for an optimal performance. Most of the published studies suggest a similar supplementation pattern between individual and team sports being protein, BCAA and carbohydrates the most popular supplements. Interestingly, several studies report a higher supplementation of vitamins and minerals in individual compared to team sports [19][23][25], which is in accordance with our results. There is no clear explanation about this but it could be related to the previous point: individual athletes rely more on supplements because of a higher pressure for good performance.

Athletes participating in high-intensity sports presented higher supplement use (74.7%) than moderate intensity sports (65.2%). It is not surprising that athletes who participate in disciplines that imply high intensity movements feel a higher need for supplementation in order to maintain high energy levels and reduce fatigue sensation. From the supplements included in the #EsportFarma study, creatine and caffeine are the ones which

seem to have a more beneficial effects in high intensity disciplines [40][41]. Creatine acts by potentiating the capacity of the phosphate energy system by increasing phosphocreatine availability also having effects on increasing lean body mass [42] while caffeine is thought to act as a central nervous system stimulant, reducing fatigue sensation [43]. Our results show that carbohydrates, vitamins and minerals are the most consumed supplements and that it is in moderate intensity disciplines in which creatine and caffeine are more consumed. In our classification, the moderate intensity subgroup included sports like body-building and power-lifting, disciplines in which creatine and caffeine use is popular [44][45][46][47]. This can explain why these supplements were more common in this subgroup. In a similar way, high-intensity sports included endurance sports such as cycling, swimming and triathlon in which fast-absorbing carbohydrates are common in long trainings and competitions [48]. Therefore, it seems that the supplementation pattern of each subgroup is more related to the type of discipline than to the intensity of it. Actually, some parallelism in the patterns of consumption between endurance and high-intensity athletes as well as between power and moderate-intensity athletes can be observed when comparing figures 7 and 11.

The frequency of supplement consumption was found to be significantly lower in experienced (63.2%) compared to less experienced (69.2%) athletes of Catalan federations. This could be related to older athletes (35%) and, therefore, with more experience, consuming less supplements than younger athletes (80%). Nevertheless, the average age of both subgroups was similar (around 38 years old). Interestingly, 70% of the less experienced participants participated in individual disciplines whereas it was 8% less in the more experienced group. Since individual athletes tend to supplement more than team sport athletes, this could be an explanation for the higher supplementation frequency in the less experienced subgroup. Bromelain and probiotics are supplements whose efficacy lacks strong scientific evidence and deserve further research. Interestingly, they are only consumed by experienced athletes and it is in this subgroup where a dietician-nutritionist is less popular (only 5% of the subgroup) and the Internet has a majoritary role (27.5%) as a source of information for supplementation.

Some subgroups (i.e. power and moderate intensity disciplines athletes, athletes without a dietician-nutritionist) reported using supplements as a resource for ‘compensating for a bad diet’. Previous studies confirm that there is a great tendency on vitamin and mineral supplementation and that it is unnecessary if a proper diet is followed [10]. It is important to reinforce athletes on the idea that supplements should not be taken in a free-will manner since health problems, contaminations or polypharmacy can happen [49]. In our study, the consumption of fruit was found to be lower than WHO recommendations (3 to

5 pieces of fruit and/or vegetables a day) which is probably the reason why supplementation with vitamins and minerals is common. A similar aspect was found with carbohydrates; male athletes tended to supplement with carbohydrate drinks but did not follow a diet rich in carbohydrates. The high carbohydrate supplementation can be related to the use of fast-absorbing carbohydrates during training and/or competition which help athletes maintain energy levels while decreasing the appearance of gastrointestinal discomfort, an aspect that is difficult to find using real food [35]. Nevertheless, considering that carbohydrates are the main energy source they should be abundant in an athlete's diet in order to ensure proper glycogen levels and maintain a good long-term performance [35]. Interestingly, the consumption of this macronutrient among participants of the #EsportFarma study was still lower than the WHO recommendations even for athletes that had a nutritionist. Even if it is true that a dietician-nutritionist seems to help in enhancing proper dietary habits, it seems that the communication between nutritionist and athletes should be improved in order to prioritise consumption of macronutrients and micronutrients within the diet and avoid using supplements as a preventive tool. By observing the general tendency of the diets it seems that male athletes tend to consume more caloric dense foods (i.e. nuts and carbohydrates) than females. Considering that the Internet and social media are a popular tool used on a daily basis caution should be taken for detecting alterations in eating behaviours among athletes, specially of weight-strict disciplines such as body-building and gymnastics. Eating disorders are common in these type of disciplines [34] and the role of a dietician-nutritionist in collaboration with a psychologist can be helpful and used as a preventive tool [50][51]. It is therefore necessary to educate athletes in nutrition in order to promote healthy dietary habits and understand the ultimate role of supplementation, aspects in which a dietician-nutritionist could be helpful.

The #EsportFarma study also had some limitations that should be considered to improve results applicability. First of all, the study included 17 different sports with a different number of participants in each of them, ranging from 4 to 32 participants. Even if grouping the sample is a proper approach for analytical purposes the lack of homogeneity in sample size did not allow for the individual comparison of the different sports and, therefore, the available literature was more limited. Related to that, the reviewed studies used different questionnaires that included different supplements and different approaches for the same question. To enable direct comparisons between studies and facilitate the analysis and interpretation of the results a standardised list of the types of supplements as well as uniformity when it comes to analysing the answers would be necessary. In this regard, a more complete interpretation of supplement use among athletes could be done. As for the reason for supplementation, almost half of the sample, in some cases, did not

justify it. This could be either because the purpose behind supplementation is not fully understood by athletes or because the answer was not included in our questionnaire. For future studies, it would be helpful to add the option 'Others' as well as leave some space to give details about it. Additionally, even if the questionnaire was anonymous it is possible that some athletes intentionally avoided reporting some information, thus altering the results. Finally, only 58.9% (N = 66) of the total sample participated in the last part of the survey corresponding to the nutritional habits. Therefore, the conclusions extracted from this part are not representative of the whole sample and should be interpreted cautiously.

6. Conclusions

In conclusion, the results of the #EsportFarma study suggest an extensive use of ergogenic aids among federated athletes in Catalonia. The most frequently used supplements are carbohydrates and vitamins and minerals. The factors that seem to have more influence on supplement use are related to age, type of discipline and years of experience. The use of the Internet as a source of information about ergogenic aids is popular and results in self-administration of supplements. Health professionals seem to improve supplement election increasing the understanding on supplement functionality. In a similar way, a dietician-nutritionist improves athlete's dietary habits. All in all, there is a need of potentiating nutritional education among federated athletes in Catalonia as well as emphasising the role of health professionals. In this way, sport supplement use will be improved ultimately optimising performance and improving overall athlete's health.

7. Future perspectives

The #EsportFarma study is, to our knowledge, a pioneer study regarding the analysis of supplement use among athletes from Catalan sport federations. Therefore, the obtained results are preliminary and future studies could help in getting a fully understanding on this field. A key aspect would be to obtain a larger and more homogeneous sample allowing an independent comparison of the sports resulting in a more detailed analysis of this population. A bigger sample size would also help in increasing participation in the last part of the survey obtaining more reliable results about their nutritional habits. It is important to maintain the same survey structure including the same list of supplements, reasons for supplementation, supplement prescribers and Mediterranean Diet questionnaire. Moreover, performing the same survey among federated athletes of other Spanish regions would be of interest.

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1. Supplementary figures

Supplement	Effect / action	Evidence level (AIS)
Caffeine	When consumed before or during exercise it reduces effort perception, improves alert, focus and time of reaction which can benefit performance.	A
Carbohydrate drinks or gels	Its consumption during training or competition in exercise of >1h of duration is related to an increase in performance by maintaining blood glucose levels. Moreover, the ingestion of 30-60 g of carbohydrates per hour seems to lower stress hormones levels and potentiate the immune function.	A
Condroprotectors	Reduction of chondral pain.	A
Creatine	Increase of muscle creatine stores resulting in improved performance in high-intensity short-term (anaerobic) exercise as well as greater gains in lean mass and muscular strength and power. Its consumption is also related to a reduction in DOMS and/or enhanced recovery.	A
Sport drinks	Reposition of fluids and electrolytes. Its consumption during training or competition can increase performance.	A
Protein bars / powder	When ingested with resistance training programmes it potentiates muscle protein synthesis leading to an increase in lean muscle mass. Moreover, it helps in reducing fat mass while maintaining muscle mass.	A
Vitamins and minerals	Its consumption can counteract the increased production of free radicals derived from exercise-related stress. Consumption of vitamin C (200-500mg/day) can improve immune system functionality.	A/B
Antioxidants	They have anti-inflammatory effects potentiating immunity and reducing symptoms from muscle damage (i.e. DOMS), enhancing exercise recovery.	B
Branched chain amino-acids (BCAA)	Leucine, isoleucine and valine. They act as muscle synthesis triggering stimulating muscle repair and growth when combined with resistant training.	B
Bromelain	Prevention of muscular microtear caused by eccentric contractions.	B

Carnitine	Its regular ingestion is related to an increased maximum oxygen consumption and higher power output improving lactate clearance and anaerobic threshold. It is also related to improved recovery after exercise by having an antioxidant effect.	B
Ginseng	Its regular consumption is associated with an increase fatigue resistance, maximal oxygen consumption and a reduction in blood pressure. It can also have effects on the immune system.	B
Glutamine	Its regular consumption enhances muscle recovery and reduces risk of infection serving as substrate for immune cells, particularly lymphocytes.	B
Probiotics	Its oral administration for several weeks is related to increase gut health and immune function. It can also enhance microbiota recovery after antibiotic treatment. They are also related to attenuating upper respiratory tract and gastrointestinal symptoms.	B
Collagen	Increased collagen production and consequent cartilage thickening with decreased joint pain. Its daily consumption can increase tendon, joint and ligaments health.	C

Table S1. Information about the supplements included in the #EsportFarma survey, classified according to the AIS grade of evidence (A, Strong scientific evidence for use in specific situations in sport using evidence-based protocols; B, Emerging scientific support, deserving of further research. Considered for use by athletes under a research protocol or case-managed monitoring situation; C, Scientific evidence not supportive of benefit amongst athletes or no research undertaken to guide an informed opinion; D, Banned or at high risk of contamination with substances that could lead to a positive doping test).

Endurance, n = 127	**Power,** n = 65
Athletics, cycling, football, hiking, rowing, swimming, triathlon, winter sports.	Basketball, body building, gymnastics, paddle tennis, power-lifting, table-tennis, tennis, volleyball.

Table S2. Classification of sports depending on type of discipline and sample size of each group.

Individual sports, n = 141	**Team sports,** n = 50
Athletics, body building, cycling, gymnastics, hiking, power-lifting, swimming, table tennis, tennis, triathlon, winter sports	Basketball, football, paddle tennis, rowing, sailing, volleyball.

Table S3. Classification of disciplines depending on type of sport and sample size of each group.

Moderate intensity (3-6 METs), n = 69	**High intensity** (>g METs), n = 119
Body building, gymnastics, hiking, power-lifting, sailing, table-tennis, volleyball.	Athletics, basketball, cycling, football, paddle, rowing, swimming, tennis, triathlon, winter sports.

Table S4. Classification of disciplines depending on intensity level [52] and sample size of each group.

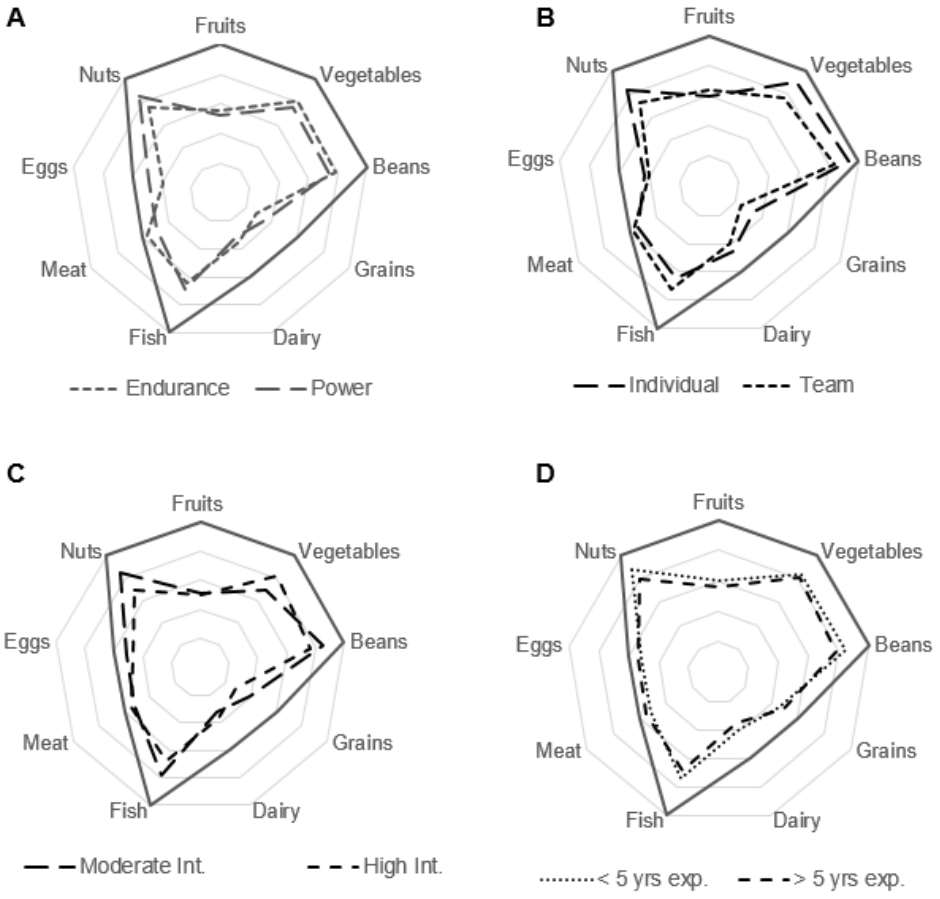

Figure S1. Spider chart representation of the frequency of consumption of each food group comparing (A) endurance and power disciplines, (B) individual and team sports, (C) sports classified by intensity and (D) experience practising the sport and subgroups and the adequacy according to the WHO recommendations (black continuous line).

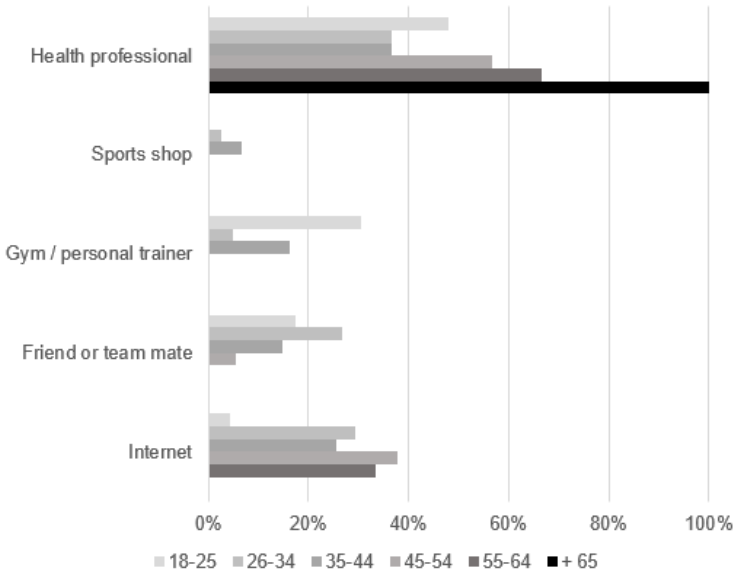

Figure S2. Prescription of supplementation depending on age group.

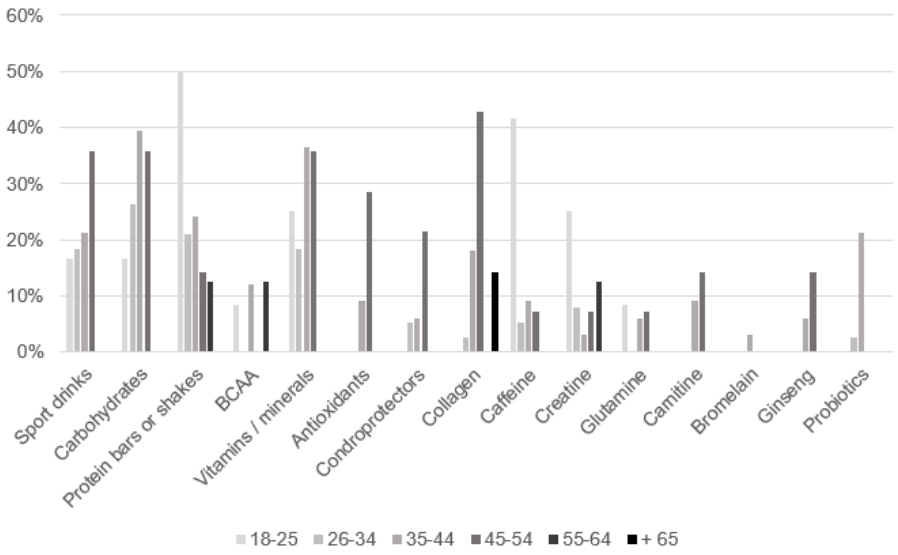

Figure S3. Sport supplement use depending on age group.