



## Trabajo Original

Epidemiología y dietética

### Sports supplements use in mountain runners: differences by sex and competitive level *Consumo de suplementos deportivos en corredores de montaña: diferencias en función del sexo y del nivel competitivo*

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#### Abstract

**Introduction:** sports supplements (SS) are widely used by all types of athletes to improve their performance. These SS are classified according to the ABCD system of the Australian Institute of Sports (AIS) from higher to lower scientific evidence. In mountain runners, their use could be necessary due to the physiological demands required by this sport. However, the literature on the use of SS by mountain runners is scarce.

**Objective:** to analyze the pattern of SS consumption in mountain runners by studying differences according to sex and competitive level (regional vs national).

**Methodology:** this was a descriptive and cross-sectional study on the consumption and use of SS by mountain runners participating in the Alcoy Solidarity Trail. Data were collected through a validated questionnaire based on content, applicability, structure, and presentation. This questionnaire was completed online by the athletes, who could fill it out voluntarily and at their convenience, as well as anonymously.

**Results:** the results showed that 87.5 % of participants reported consuming SS, with no significant differences observed with respect to competitive level, although differences were found with respect to sex (92.7 % in men vs 70.6 % in women;  $p = 0.029$ ), with a higher consumption found in men compared to women. The most consumed SS were sports bars (81.9 %), sports drinks (75.0 %), caffeine (48.6 %), magnesium (38.9 %), and electrolytes (27.8 %).

**Conclusions:** among mountain runners consumption of SS is high, and 4 of the 5 most habitually consumed SS belong in the category of greater scientific evidence.

#### Keywords:

Sports supplements.  
Mountain runners. Sport.  
Nutrition. Scientific  
evidence.

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## Resumen

**Introducción:** los suplementos deportivos (SS) son muy utilizados por todo tipo de deportistas para mejorar su rendimiento. Estos SS se clasifican según el sistema ABCD del Australian Institute of Sports (AIS) de mayor a menor evidencia científica. En corredores de montaña, su uso podría ser necesario debido a las exigencias fisiológicas de este deporte. Sin embargo, la literatura sobre el uso de SS por corredores de montaña es escasa.

**Objetivo:** analizar el patrón de consumo de SS en corredores de montaña, estudiando las diferencias según el sexo y el nivel competitivo (autónómico vs. nacional).

**Metodología:** se trata de un estudio descriptivo y transversal sobre el consumo y uso de SS por parte de los corredores de montaña participantes en el Trail Solidario de Alcoy. Los datos fueron recolectados a través de un cuestionario validado en base al contenido, la aplicabilidad, la estructura y la presentación. El cuestionario fue completado de manera *online* por los atletas que pudieron rellenarlo voluntariamente y a conveniencia, y de manera anónima.

**Resultados:** los resultados mostraron que el 87,5 % de los participantes reportaron consumir SS, no observándose diferencias significativas con respecto al nivel competitivo, aunque sí se encontraron diferencias con respecto al sexo (92,7 % en hombres y 70,6 % en mujeres;  $p = 0,029$ ), donde los hombres tenían un mayor consumo en comparación con las mujeres. Los SS más consumidos fueron las barras deportivas (81,9 %), las bebidas deportivas (75,0 %), la cafeína (48,6 %), el magnesio (38,9 %) y los electrolitos (27,8 %).

**Conclusiones:** entre los corredores de montaña, el consumo de SS es alto y 4 de los 5 SS más consumidos pertenecen a la categoría de mayor evidencia científica.

### Palabras clave:

Suplementos deportivos.  
Corredores de montaña.  
Deporte. Nutrición.  
Evidencia científica.

## INTRODUCTION

Mountain races are currently part of trail running, defined as a pedestrian competition open to all, which takes place in a natural environment with the least possible amount of paved roads (20 % maximum) (1). Mountains or forests, fields or deserts, this endurance race takes place on naturally variable terrain (1).

Mountain races involve different physiological, biomechanical and muscular demands, determined by the irregular characteristics of the terrain and the enormous positive and negative elevation changes of the terrain (2). Considering the multifactorial demands and challenges of this type of racing, a wide range of factors support the performance results in mountain racing. The physiological and psychophysiological characteristics that are important for success may include: aerobic capacity and lactate clearance capacity; career economy; skills characteristic of the mountain race (going up, going down, handling obstacles...); pacing strategies; exogenous and endogenous energy substrate availability and utilization kinetics; thermoregulatory response; gastrointestinal integrity; and functional responses (2,3).

The high physiological demands in trail running, as well as the possibility to obtain a real improvement in the performance and competition results, encourages athletes to consider the use of tools and strategies like the use of SS (4). SS can be defined as a food, component, nutrient or non-food component that is purposely ingested within the normal diet with the aim of obtaining a specific effect on health or performance (5). The Australian Institute of Sport classifies SS into 4 different groups (ABCD) according to the degree of evidence; this classification is widely used by health and sports professionals to advise athletes (6). Currently, both elite athletes and amateur athletes consume SS to improve their sports performance (5). However, many athletes make use of SS without knowing the information about its correct consumption and they are not aware of the real effect of the supplements or the side-effect, which can cause health problems and a decrease in sports performance (7).

The use of SS has become increasingly widespread among all type of athletes, and current studies place it between 30 % and

95 % (8-10). In order of prevalence, the most commonly used supplements are: protein powder or protein bars (66 %), sports isotonic drinks (49 %), creatine (38 %), recuperative drinks (35 %), multivitamins (31 %) and vitamin C (25 %) (11). Regarding the consumption of SS according to the level of competition of the athletes, several recent studies on Spanish athletes determined that the use of SS was greater in professional or elite athletes (8-10). One recent study of 337 Spanish athletes indicated that proteins were the most consumed supplement (41 %) followed by amino acids (37 %) (9). According to the sex of the athletes, several studies concluded that consumption was higher in men than in women, and in addition, differences were observed with respect to the type of SS consumed (8-10,12). Regarding endurance sports, the bibliography suggests that the most consumed SS in this type of sports is caffeine, with performance benefits (5-7). In addition, sports drinks have shown benefits in physical performance by compensating for the loss of fluids and nutrients during training or competition (7,13). Likewise, a large number of athletes use sports gels and carbohydrate drinks during competition, as their consumption increases endurance capacity (14).

Although many studies on the prevalence and consumption pattern of SS can be found in endurance and ultra-endurance races (7,13,15-17), as well as about diet, drug use or use of food supplements on trails (18-20), to date no research has been exclusively carried out on mountain runners to study the SS prevalence and consumption patterns. Thus, the objective of this work was to analyze the pattern of SS consumption of mountain runners, by studying the differences based on sex and competitive level (regional vs. national level).

## MATERIALS AND METHODS

### TYPE OF STUDY

This was a descriptive and cross-sectional study that assessed SS consumption in mountain runners that participated in the Alcoy 2019 Solidarity Trail, Spain.

## PARTICIPANTS

The subjects were 72 athletes, associated members of Spanish sports federations (55 men and 17 women), of legal age, who ran the Alcoy 2019 Solidarity Trail race. The competitive level of the participants differed between regional (22 athletes that compete at the provincial and regional level) and national (50 athletes that compete all over the country). The athletes performed a minimum of 3 training sessions per week lasting 60-90 minutes per session. Table I describes the age, basic anthropometric characteristics and years of sporting experience of the study sample.

## INSTRUMENTS

The chosen supplement consumption questionnaire used was validated based on content, applicability, structure, and presentation (4). The questionnaire contains three sections: the first collects the anthropometric, personal and social data; the second encompasses the practice of sports activity and its context; and the last and most extensive is related to the consumption of SS. This part includes, among other questions: what supplements they take, why do they take them, who advises them, where do they buy them, or when do they take them. This questionnaire has been used in previous researches with this aim (8,10,21,22). This questionnaire was developed by a group of three experienced sport scientists and a total of 25 experts in sport sciences, sports medicine, nutrition, chemistry and pharmacology verified its construct validity. In fact, in a review conducted by Knapik et al. (15), that assessed the quality of questionnaires aiming to determine the prevalence in the use of SS by athletes; this questionnaire achieved a 54 % methodological quality and was one of the 57 questionnaires reviewed (out of 164) that were considered suitable to obtain accurate information on the SS used by athletes.

## PROCEDURE

To select the study sample, we contacted the Alcoy Solidarity Trail race organizers via email to inform them about the characteristics of the study and request their collaboration. After ac-

cepting to participate, the competition organizers sent an e-mail containing the link to the questionnaire to all the participants so that the athletes could fill it out voluntarily and at their convenience, electronically and anonymously. An explanatory video on the questionnaire and the characteristics of the study, and an informed consent form prior to conducting the survey was attached to the e-mail. The protocol complied with the Declaration of Helsinki for research in humans and was approved by the Ethics Committee of the University of Alicante (File UA-2020-03-28).

## STATISTICAL ANALYSIS

A Kolmogorov-Smirnov test was applied to verify if the variables had a normal distribution, while Levene's test was used to check for homoscedasticity. For the analysis of the differences in total SS consumption, as well as the total SS consumed in the different categories established by the Australian Institute of Sport (AIS) (6), a two-way ANOVA was applied for the sex factor (male vs female) and level of competition (regional vs national), and the interaction sex  $\times$  level of competition. For the variables in which statistically significant differences were detected, a Bonferroni *post-hoc* test was applied. As for the analysis of those athletes who consumed SS, the reason for which they consumed them, place of purchase and advisor, a chi-square test was applied to verify differences between athletes of different sex and level of competition ( $\chi^2$ ). As for the SS consumed by more than 10 % of the sample, a  $\chi^2$  test was carried out to check for possible differences based on sex or level of competition, while the odds ratio (OR) was calculated with a 95 % confidence interval to analyze the relative risk of consuming SS when being an athlete at a national level with respect to the regional level, and being a man with respect to a woman. The level of statistical significance was set as  $p < 0.05$ . All statistical treatments were carried out with the SPSS software v.20 (IBM, Armonk, NY, USA).

## RESULTS

From the total sample, 87.5 % declared consuming SS, without differences observed based on competitive level (92 % national lev-

**Table I.** Descriptive data of mountain runners at the regional and national level

Competition level	Sex	Age (years)	Height (cm)*	Weight (kg)*	BMI (kg/m <sup>2</sup> )*	Experience (years)
National (n = 50)	Men	43.44 $\pm$ 7.01	176.93 $\pm$ 6.59	74.95 $\pm$ 9.27	24.05 $\pm$ 2.25	4.38 $\pm$ 3.33
	Women	36.78 $\pm$ 14.82	162.2 $\pm$ 6.36	59.1 $\pm$ 5.47	22.51 $\pm$ 2.24	3.9 $\pm$ 3.48
Regional (n = 22)	Men	46.47 $\pm$ 13.6	175.33 $\pm$ 6.48	72.6 $\pm$ 7.24	23.65 $\pm$ 2.45	5.2 $\pm$ 3.71
	Women	39.51 $\pm$ 9.13	165.29 $\pm$ 8.96	56.14 $\pm$ 9.32	20.41 $\pm$ 1.8	3.29 $\pm$ 3.25

\*Self-reported height and weight. BMI calculated from self-reported height and weight.

el vs 77.3 % regional level;  $p = 0.121$ ), although differences were found according to sex ( $p = 0.029$ ), with a higher consumption of SS in men as compared to women (92.7 % vs 70.6 %; OR = 1.31 [0.95-1.81]). The main reasons for SS consumption were improvement of performance (52.4 %) followed by taking care of health (9.5 %), and both (9.5 %); the rest of the responses referred were due to necessity (8.33 %), to improve physical appearance (6.95 %) or to alleviate any deficit in the diet (5.55 %). Regarding the person who motivated SS consumption, no differences were observed either for sex ( $p = 0.213$ ) or for level of performance ( $p = 0.109$ ), with the main motivator being a dietitian-nutritionist (20.7 %), followed by a trainer (17.4 %), teammates (17.4 %), or friends (12.0 %). Concerning the place of purchase, it was found that athletes mostly bought in specialized stores (27.4 %), followed by the pharmacy (17.9 %), internet (16.8 %), shopping centers (11.6 %), the dietitian-nutritionist office (10.5 %), or a herbalist (10.5 %). The participants indicated that the moment in which they take the SS were: training and competition days (44.4 %), followed by competition days (37.5 %) and daily consumption (8.3%).

Table II shows the number of SS consumed in the different categories established by the AIS (6). Regarding the total consumption of SS, no differences were observed between athletes based on sex ( $F = 1.710$ ;  $p = 0.195$ ), level of competition ( $F = 0.379$ ;  $p = 0.540$ ), or interaction sex  $\times$  level of competition ( $F = 0.068$ ;  $p = 0.794$ ), with a mean consumption of  $6.64 \pm 6.84$  supplements.

Within group A, in the category or subgroup of sports foods, differences were observed for the sex factor, with a higher consumption in men as compared to women ( $F = 6.230$ ;  $p = 0.015$ ), with differences between athletes at the national level ( $p = 0.022$ ); but no differences reported for the level of competition ( $F = 0.019$ ;  $p = 0.892$ ) or the interaction sex  $\times$  level of competition ( $F = 0.141$ ;  $p = 0.708$ ). The consumption of medical supplements, also belonging to group A, was  $0.69 \pm 0.98$ , without differences found according to sex ( $F = 0.182$ ;  $p = 0.671$ ), level of competition ( $F = 1.906$ ;  $p = 0.172$ ) or sex-level of competition interaction ( $F = 0.408$ ;  $p = 0.408$ ). The analysis according to categories showed that in the category or subgroup of per-

**Table II.** Consumption of sports supplements in the different categories established by the AIS (6)

Category		Sex	Competition level	
			National	Regional
Total of SS		Male	7.80 $\pm$ 8.37	6.07 $\pm$ 4.01
		Female	4.70 $\pm$ 4.98	4.00 $\pm$ 2.45
		Total	7.18 $\pm$ 7.81	5.41 $\pm$ 3.67
Group A	Sports foods	Male	2.70 $\pm$ 1.57*	2.60 $\pm$ 1.40
		Female	1.50 $\pm$ 1.08*	1.71 $\pm$ 1.11
		Total	2.46 $\pm$ 1.55	2.32 $\pm$ 1.36
	Medical supplements	Male	0.73 $\pm$ 1.09	0.53 $\pm$ 0.74
		Female	1.00 $\pm$ 1.15	0.43 $\pm$ 0.53
		Total	0.78 $\pm$ 1.09	0.50 $\pm$ 0.67
	Performance supplements	Male	0.75 $\pm$ 0.81	0.67 $\pm$ 0.62
		Female	0.30 $\pm$ 0.48	0.14 $\pm$ 0.38
		Total	0.66 $\pm$ 0.77	0.50 $\pm$ 0.60
Group B		Male	0.65 $\pm$ 1.08	0.20 $\pm$ 0.41
		Female	0.30 $\pm$ 0.48	0.29 $\pm$ 0.49
		Total	0.58 $\pm$ 0.99	0.23 $\pm$ 0.43
Group C		Male	2.80 $\pm$ 4.54	2.07 $\pm$ 2.31
		Female	1.40 $\pm$ 1.07	1.43 $\pm$ 1.51
		Total	2.52 $\pm$ 4.19	1.86 $\pm$ 2.08

SS: sports supplements. Data presented as  $M \pm SD$ . \*Statistically significant differences between men and women at the same level of competition ( $p < 0.05$ ).

**Table III.** Most consumed supplements according to sex and competitive level by categories established by the AIS (6)

Category	Supplement	Sex			Competition level			
		Male (n = 55)	Female (n = 17)	p-value	National (n = 50)	Regional (n = 22)	p-value	
Group A	Sports foods	Sport bar	83.6 %	76.5 %	0.490	82.0 %	81.8 %	1.00
		Sports drink	85.5 %	41.2 %	0.001*	74.0 %	77.3 %	1.00
		Electrolytes	30.9 %	17.6 %	0.364	28.0 %	18.2 %	0.556
		Gainers	29.1 %	11.8 %	0.207	28.0 %	27.3 %	1.00
		Whey protein	16.4 %	5.9 %	0.434	14.0 %	13.6 %	1.00
	Medical supplements	Vitamin complex	21.8 %	5.9 %	0.170	18.0 %	18.2 %	1.00
		Iron	7.3 %	29.4 %	0.029*	16.0 %	4.5 %	0.259
		Vitamin D	16.4 %	23.5 %	0.490	18.0 %	18.2 %	1.00
Performance supplements	Caffeine	56.4 %	23.5 %	0.026*	50.0 %	45.5 %	0.801	
Group B	Carnitine	21.8 %	5.9 %	0.170	22.0 %	9.1 %	0.319	
	Vitamin C	14.5 %	23.5 %	0.460	18.0 %	13.6 %	0.744	
Group C	Royal jelly	20.0 %	23.5 %	0.742	18.0 %	27.3 %	0.368	
	Magnesium	43.6 %	23.5 %	0.165	38.0 %	40.9 %	1.00	
	Pollen	14.5 %	-	0.185	8.0 %	18.2 %	0.237	
	Taurine	16.4 %	-	0.104	14.0 %	9.1 %	0.712	
	BCAA	18.2 %	11.8 %	0.719	22.0 %	4.5 %	0.090	
	Vitamin E	12.7 %	11.8 %	1.00	14.0 %	9.1 %	0.712	

BCAA: branched-chain amino acid. \*Statistically significant differences between groups ( $p < 0.05$ ).

formance supplements of group A, no differences were observed in the level of competition ( $F = 0.348$ ;  $p = 0.557$ ), or sex  $\times$  level of competition ( $F = 0.033$ ;  $p = 0.857$ ), although differences were found according to sex, with the consumption being higher in men than in women ( $F = 5.705$ ;  $p = 0.020$ ).

The consumption of SS in group B was  $0.47 \pm 0.87$  supplements, with no differences according to sex ( $F = 0.445$ ;  $p = 0.507$ ), level of competition ( $F = 1.807$ ;  $p = 0.183$ ) or the interaction sex  $\times$  level of competition ( $F = 0.089$ ;  $p = 0.766$ ). For group C, mean consumption was  $2.32 \pm 3.67$  supplements, with no differences found for sex ( $F = 0.713$ ;  $p = 0.401$ ), level of competition ( $F = 0.019$ ;  $p = 0.891$ ), or sex  $\times$  level of competition ( $F = 0.220$ ;  $p = 0.641$ ).

Lastly, regarding the most-consumed SS, the one with the highest intake rate were bars (81.9 %), followed by sports drinks (75.0 %), caffeine (48.6 %), magnesium (38.9 %), electrolytes (27.8 %), gainers (25.0 %), royal jelly (20.8 %), vitamin complexes (18.1 %), vitamin D (18.1 %), carnitine (18.1 %), branched-chain amino acids (16.7 %), vitamin C (16.7 %), whey protein (13.9 %), iron (12.5 %),

vitamin E (12.5 %), taurine (12.5 %), and pollen (11.1 %). According to sex, a higher consumption was found in men as compared to women in sports drinks ( $p = 0.001$ ; OR = 2.08 [1.15-3.74]) and caffeine ( $p = 0.026$ ; OR = 2.40 [0.97-5.91]), although they had a lower consumption of iron ( $p = 0.029$ ; OR = 0.25 [0.07-0.84]). The level of competition showed no statistically differences in the consumption of any of the SS considered (Table III).

## DISCUSSION

The objective of this study was to analyze the pattern of SS consumption in mountain runners, including possible differences based on sex and competitive level (regional vs national). Although different studies have analyzed the consumption of supplements and other substances in endurance and ultra-endurance athletes (7,13,15-17), this study is the first to analyze the consumption of SS according to sex and the level of competition exclusively in mountain runners.



The 87.5 % of our athletes reported the use of SS, similar to the results obtained in elite and sub-elite Dutch athletes (84.7 %) (17). However, these data were higher than those reported for North-American ultramarathon runners (75.3 %) (23) and also for elite Spanish athletes from different sports modalities (64 %) (9). It should be noted that, although no differences were found according to the competitive level, the differences found in the consumption of SS according to sex (it being around 20 % higher in men) support the hypothesis that suggests a higher consumption in men compared to women (5). Furthermore, these results were similar to those reported in different studies that detected a higher consumption in men than in women (4,9,12,24).

The main reason for the consumption of SS by the present sample was to improve performance (52.4 %), a result similar to those found in Spanish athletes from different sports disciplines (45-73.2 %) (9,10,21). Although several recent studies reported that the main reasons may be different according to sex or competitive level (4,10), the results obtained did not find differences between them.

The person who determined the use or not of SS is crucial, as this determines a better use of them (17,25,26); the coach, teammates and friends were secondary sources of advice for our sample, with the main motivator being the dietitian-nutritionist (20.7 %), regardless of gender or competitive level. These results differed from recent studies on the consumption of SS in Spanish athletes of different disciplines, in which the advice that determined the consumption of SS was mainly provided by non-expert personnel (4,9,22). In relation to this, it should be noted that athletes who received the advice of a dietitian-nutritionist as the main source of nutritional information had better eating habits, a greater understanding of the periodization of nutrients, and a consumption of SS with a high level of scientific evidence on its performance-enhancing effect (17).

The place where SS were bought was another determining factor in their proper use (25,26), which may harm the expected sports performance or the athlete's health (9). The present sample, regardless of gender and level of competition, were more likely to buy in specialized stores and pharmacies, although the internet was shown as the third most frequented place for the purchase of SS, which can lead to more professional advice as compared to online shopping. This reduces the chances of buying lower quality or illegal SS, due to the lack of specific legislation in the country of origin, which can even lead to misleading advertising with online purchases (25-27).

The results obtained showed a greater use of SS on competition days as compared to the rest of the options (81.9 %), regardless of gender or level of competition. This may be due to the importance of the availability/use of energy substrates and hydration during competition in this type of competitions, as well as the possibility and variety of existing SS for it, since its alternated consumption is very useful for complying with the carbohydrate, sodium and fluid intake recommendations during competition (7,19,28). Proof of this is observed when verifying that sport bars (81.9 %) and sport drinks (75.0 %) were the two most commonly

consumed SS by the study sample. Both supplements are important for hydration and nutrient replenishment during competitions, for providing energy and nutrients or seeking to counteract the high sweating rates generated by climatic conditions in this type of event (29). Although to a lesser extent, the high use of caffeine and electrolytes by the sample should also be added, as their use during competitions can also be useful in this type of events (5,6,8-10,15).

The results obtained in the analysis of the different SS groups established by the AIS (6) according to the level of scientific evidence, showed that there were no statistically significant differences according to sex, level of competence, or interaction between sex  $\times$  level of competition in general. Similarly, there were no differences for each of the subgroups or categories, except for the sport foods and performance supplements subgroups, both belonging to group A established by the AIS (6). In the sport foods subgroup (group A) there were differences by sex in the total subgroup, with a higher consumption in men as compared to women (men:  $2.65 \pm 0.22$  vs women:  $1.61 \pm 0.36$ ;  $p = 0.015$ ), and by sex for national level athletes ( $p = 0.022$ ). Similarly, in the performance supplements subgroup (group A) differences were found according to sex, with the consumption being higher in men than in women ( $0.71 \pm 0.11$  vs  $0.22 \pm 0.17$ ;  $p = 0.020$ ). These results differed from those found in recent studies, in which differences were obtained according to level of competition of the different subgroups established by the AIS (6), which supported the hypothesis that the level of the athletes was one of the most important variables which determined the consumption of SS according to the level of evidence (4,8). Although the existing evidence considers that the lower AIS levels indicate a worse the source of information (30), the data found in the present study point to dietitian-nutritionist as the main motivator, this reinforces the idea that receiving dietary advice from a qualified professional lead to better use of SS (17).

If the average consumption from each of the categories or groups established by the AIS (6) is considered, we can observe that the average consumption of supplements from group A ( $3.7 \pm 2.44$ ) exceeded that of group B ( $0.94 \pm 1.71$ ) and group C ( $2.00 \pm 3.39$ ), although this is mainly due to the high average consumption of the sport food subgroup as compared to the rest. Regarding the average consumption, it should also be noted that the average consumption of group C supplements (little or no evidence of beneficial effects) was twice that of group B (they need additional research), mainly due to the use of the supplement magnesium. Therefore, it would be important to provide nutrition education approaches that help with the better use of supplementation (25,26), as athletes often use SS without a clear understanding of its effects and risks (26).

The results of the present study show that the three most-consumed SS by the entire sample were sports drinks, sports bars, and caffeine. These findings are in line with the data reported in other studies, in which SS were one of the substances most consumed by elite athletes of various sports modalities (9,10,15). In this regard, it should be noted that the

three SS belonged to Group A, the group with the highest degree of evidence according to the AIS classification (6). When comparing the SS most consumed by the sample according to the competitive level (regional vs national), no statistically significant differences were observed, being these SS the most consumed by both levels.

According to sex, sports drinks, sports bars and caffeine were the most consumed by men, while sports bars, sports drinks and iron by, women respectively. In addition, as can be observed in the results, there were significant differences on the use of iron supplements, with a higher consumption found in women. These findings are similar to those found in a meta-analysis conducted by Knapik et al. (2016), in which iron supplementation was higher in women (15). This could benefit the health and performance of the women in the sample, since the prevalence of iron deficiency is higher in female athletes, due to the increased demand for iron during menstruation (31,32). Iron is an essential component of myoglobin and hemoglobin, which ensure an adequate supply of oxygen to skeletal muscles (33), and a nutritional deficiency can compromise energy metabolism, thus increasing glycolysis and reducing energy efficiency, and performance (31).

In these types of competitions, there was a large increase in body temperature and sweating rate, and therefore an increased loss of fluids and electrolytes (29). This may justify the high consumption of sport drinks and electrolytes, since an inadequate fluid balance during training or competitions could cause a loss of health and performance (19). Sport foods provide energy and nutrients in a more convenient form than normal foods and can constitute an easy and adequate intake of macronutrients (5). In addition, sport foods are some of the most consumed SS by athletes of different ages, sex, levels, or sports (15). Sports drinks can be a good source of fluid and carbohydrate supplies during and after exercise, aiding in rehydration and refueling (34). It should be noted that the consumption of sports drinks was higher in men than in women, which could be due to a higher rate of sweating in the former (19). On the other hand, sports bars can be useful as a source of carbohydrates during exercise and post-exercise recovery, providing carbohydrates, proteins and micronutrients (5,6,16,19).

Electrolyte supplements can be very useful, together with sport foods since they are closely related to the higher incidence of adverse outcomes in resistance and ultra-resistance sports (35). Given the serious consequences of these outcomes (exercise-associated hyponatremia, exertional heat stroke, dehydration or hypothermia), it is necessary to improve the nutritional information and education of endurance athletes, based on individualized strategies for the consumption of fluids and electrolytes (35).

Caffeine was the third most-used SS in the present sample, showing significant differences as a function of sex, but not in competition level, as found recently in athletes of other sports modalities (9,10,36). Caffeine supplementation has been shown to increase alertness and improve performance, reduce the rate of perceived exertion (RPE), improve cognitive performance, and

improve muscle energy during exercise (36). In addition, the ergogenic effect of caffeine on mood and physical performance is similar in normal and elite athletes (37), making it a suitable supplement for amateur and professional runners. However, the prevalence of caffeine supplementation in this sample was lower than that of Olympic athletes, in which its consumption was detected in 76 % of them (38).

It should be noted that although there was a high consumption of SS found in group A according to the AIS (6), athletes of this type of sports modality could improve their sports performance with other ergogenic aids from this group, which obtained a consumption prevalence of 0 % in the present sample. Thus, in this way, B-alanine (39) and sodium bicarbonate (39) could improve endurance performance and possibly training adaptations during resistance training by affecting the cushioning capacity and allowing a greater training intensity; and beet juice could further increase the adaptation to resistance training, efficiency, delaying fatigue, by reducing effort at submaximal workloads (7,39,40), although more evidence is needed in this regard.

Although the use of SS is widespread and standardized, it is important that both health professionals and athletes know how to perform a cost-benefit analysis on their appropriate and responsible use (26), based on their safety, individual efficacy, and legality (41). In addition, SS should be a complementary part of the athlete's planning, and their use does not compensate for a poor food choice or an inadequate diet (26). It is important to add that the introduction of products or supplements that they have not consumed before into the diet of athletes is advised against, because the unknown side effects that could be triggered (35); and also that a well-designed diet supports the evidence-based benefits of using SS (41).

The present research had several limitations that should be discussed to improve its applicability to real sporting contexts. Although a validated and reliable questionnaire was used to evaluate the use of SS in athletes, this tool collects self-reported information retrospectively, which could have induced some errors in the number and type of SS reported. In addition, the questionnaire was collected at a specific time of the season, which excludes obtaining seasonal variations in the supplements used. Despite the limited sample, this work is one of the few studies on SS consumption in mountain runners.

As main conclusion, in an endurance sport such as trail running, the habitual consumption of SS by athletes is high, being higher in men than in women. The SS of habitual consumption in the mountain runners evaluated were bars, sports drinks, caffeine, electrolytes, and magnesium, with 4 of them belonging to the category with the greatest scientific evidence. In addition, a low percentage, but higher than in similar studies, received advice from a Dietitian-Nutritionist, which could explain the consumption of SS with high scientific evidence. Finally, although there were some differences regarding the percentage or type of SS consumed, the present study obtained similar results to other studies that analyzed supplementation in other athletes.

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