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Dietary Habits and Fluid Intake of a Group of Elite Spanish Basketball Players: A Need for Professional Advice?

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The aim of the present study was to analyse dietary habits and fluid intake of professional basketball players with consideration of dietary guidelines and sport nutrition recommendations. A dietary habit questionnaire including a 24 h recall was recorded by 55 elite basketball players of the first Spanish Basketball League. Energy consumption among these athletes was high 17.7 ± 0.9 MJ · day^{-1} in comparison to other elite team sport athletes. Furthermore intakes of protein, fat, saturated fatty acids mineral and most vitamins exceed the current Daily Recommended Intakes (DRI's) for these macronutrients whereas, intakes of carbohydrate and vitamin E failed to meet the guidelines. Daily fluid intake was 3126 ± 1226ml. Water was the preferred beverage (1688±1032 ml), followed by milk (445 ± 521 ml), commercial sport drinks (377 ± 520 ml), carbonated beverages (307 ± 492 ml), juices (150 ± 208 ml), beer (67 ± 189 ml), non-alcoholic (beer 49 ± 158 ml) and wine (43 ± 218 ml). Sixty-six percent of the participants reported to consume particular foods before competition and 10% stated to do this after competition. On average athletes consumed 646 ± 352 ml · h^{-1} and 882 ± 486 ml of liquids during training and competition session, respectively. Furthermore, 44 % of the participants recorded not to drink before getting thirsty and 3 athletes stated never to drink during training and 2 did so during competition. Results of the present study underline the need for professional advice from sport nutritionists for elite basketball players.

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Key words: dietary habits, hydration, basketball, nutrient intake, sport

Key points:

1. The dietary habits of elite Spanish basketball players was characterised by a high daily energy intake.
2. This high energy consumption was accompanied by an excessive dietary intake of protein, total fat, saturated fat and cholesterol.
3. Fluid intake, particularly during training and competition, was not adequate for an important part of the study population.
4. Professional dietary advice would be desirable for this group of athletes to improve dietary habits and fluid intake, essential for optimal health and physical performance.

Introduction/Objectives

Basketball is one of the most popular sports in the western world (3). Professional basketball players of the first Spanish basketball league (ACB) compete at high level. The completion season of the Spanish basketball league start around the beginning of October and end in April or May. Basketball players of the ACB train twice a day and compete at least once a weak. The average duration of a training session is between 90 and 120 minutes and a match consists of four quarters each for 10 minutes. Specific physical performance demands for the athletes in this stop and go sport are high and characterized by intermittent bouts of high intensity exercise over a relatively long duration. A heart rate response of greater than 85% of maximum heart rate during 61.8% of exercise time has been reported by Beam and Merrill (2) in female collegiate basketball players. A high intensity run every 21 seconds and a heart rate of 169 beats $\cdot$ min^{-1} during live time in male elite basketball has been observed in elite male basketball players (29). Furthermore, Rodriguez-Alonso and colleagues (39) observed significant differences of heart rates between all positions (e.g. guard 185 beats $\cdot$ min^{-1} and center 185 beats $\cdot$ min^{-1}) of elite female basketball players. Moreover, game intensity increased according to the level of competition (39).

The physiological requirements of elite basketball are high and glycolysis makes an important contribution to the energy requirements of these athletes (29). The degree of energy demand of the athlete is directly influenced by the duration, frequency and intensity of training and competition. Energy demands of an 90 kg weight basketball player are around 4100 kcal (37). However, numeric guidelines for energy intake can only provide a crude approximation of energy needs of an individual athlete. Therefore, the consumption of a well-balanced, nutritionally adequate diet that meets the additional energy and nutrient demands imposed by training and high level competition is crucial for competing successfully in professional sport. An adequate diet should be cover carbohydrate and protein needs (7-8g carbohydrates per kg of body weight and 1.2-1.7g protein per kg of body weight) of the athlete and should be moderate in fat content (20-25%) (37) Athletes have to be well-hydrated before exercise, and should be drink enough fluid during and after training or competition (37). An inadequate nutrient intake could affect the physical health of the athlete and possibly contribute to sports injuries (1,4). Hence, professional advice from sport nutritionists could help to avoid adverse effects of an inadequate diet on health and sports performance. However, actually, there is no

expert in sport nutrition incorporated in the medical service of a Spanish professional team sport club (personal observation).

Several studies have analysed nutrient intakes of elite competitors in individual sports such as long distance running (32), cycling (11), track and field (49), and swimming (51). However, limited data exists on dietary habits and fluid intake of elite game players, especially in basketball, despite the worldwide popularity of this sport. Two studies have assessed nutrient intake in college (34) and university (44) and one study has analysed energy and macronutrient intake in a small group of unspecified basketball players (13). Furthermore, none of these studies have been taken into consideration the evaluation of dietary habits and fluid intake during training and competition.

Therefore, the aim of the present study was to evaluate whether dietary habits and fluid intake, during training and competition in elite Spanish basketball players were in line with current dietary guidelines.

Materials and Methods

Subjects

With the permission of the respective team physicians of seven first League Spanish Basketball teams, a dietary habit questionnaire including a 24 h recall was administrated to the players (n=77). Fifty-five players answered the questionnaire, corresponding to a compliance of 71%. Participants were informed about procedures before giving their voluntary consent to participate. The protocol was approved by the institutional review board. Subjects completed eight to ten training sessions a week, and competed one to two times a week. They also performed international competitions. Age, weight, height, body mass index (BMI) and duration of performed training time were recorded (Table 1).

Dietary assessment

A particular objective of this study was to analyse the average nutrient intake of the study population. A dietary habit questionnaire composed of a 24h dietary recall and

Table 1 Characteristics of Participants

Characteristics	Mean	Standard deviation
Age (years)	25.1	(4.0)
Height (cm)	197.0	(9.0)
Weight (kg)	93.0	(11.0)
Body mass index (Unit)	24.0	(1.5)
Training session per day	2	
Training load per week (hours)	15.5	(2.0)
Frequency of competition	1-2	

specific questions on dietary habits and fluid intake of habitual training and competition was administered to the players. The questionnaire was administrated through the respective team physician. Values of daily average energy, carbohydrate, protein, fat, vitamin and mineral intake were calculated from a structured 24h dietary recall. This questionnaire included a food list of 154 items, and recommendations on how to describe the type, dressing and quantity of each dish. Type and amount of beverages consumed the day before were also recorded. Players were instructed to report food intake in household measures (glass, teaspoon, etc) and for some foods like meat, if possible, in the absolute amount (grams). If players were not aware of the absolute food amount they described the portion size in he following manner e.g. a small steak, two slices of salami, one egg etc. Reported information on food intake was converted into nutritional data using the Diet Analysis Nutritionist IV software (N Squared Computing, San Bruno, SA). The food database of this program was increased by adding food items from Spanish food composition tables (18,22,31).

Different methods have been designed to assess alimentation pattern and nutrient intakes. Each of these methods has its strength and weakness (40,50). The 24-hour recall is one of the most widely used dietary assessment methods that attempt to define and quantify food intake during the day just before the interview. This dietary assessment method is valid to analyse the average intake of groups and does not modify the usual dietary habits (53). Gersovitz and colleagues (12) concluded that the 24-hour recall and the 7-day dietary record provide about equally accurate estimates of the average intake. 24-hour recalls have limitations in the individual assessment of dietary intake, due to attenuation from daily variation in nutrient intake (15). Ideally 24-hour recalls should be administer several times during an entire competition season, in studies analysing dietary habits in professional team sport athletes, to reduce intra-individual variability of food intake and hence, give more reliable data of habitual food consumption. However, the purpose of this study was not to analyse individual nutrient intake, but to assess average group intake. Questions about eating and drinking habits were recorded separately and data were analysed from those players who correctly completed the 24-h dietary recall (n=50). Participants answered the following questions (see Table 2).

Statistical analysis

Analysis of frequency was used to examine means ± standard deviation of the variables. Pearson correlations were calculated between energy consumption and

Table 2 Questions Concerning Eating and Drinking Habits of the Athletes

Do you regularly drink during training? Please record amount (ml)
Do you regularly drink during competition? Please record amount ml)
Do you start drinking before getting thirsty during training and competition?
Do you eat a particular food before training? Please specify food
Do you eat a particular food after training? Please specify food
When do you eat your last meal before competition?
When do you eat your first meal after competition?

nutrient intake. Statistical analysis was performed with the SPSS/PC+ package (SPSS Inc., Chicago).

Table 3 Energy and Macronutrient Intake of 50 Elite Spanish Basketball Players

	Unit	Mean	Standard deviation
Energy	$MJ \cdot day^{-1}$	17.7	0.9
	$kj \cdot kg^{-1}$ body weight	191.8	68.6
Carbohydrate	$g \cdot day^{-1}$	424.2	165.9
	$g \cdot kg^{-1}$ body weight	4.6	1.7
	% of energy	40.3	7.7
Protein	$g \cdot day^{-1}$	211.3	99.5
	$g \cdot kg^{-1}$ body weight	2.3	1.0
	% of energy	19.7	4.9
Total fat	$g \cdot day^{-1}$	185.3	78.6
	$g \cdot kg^{-1}$ body weight	2.1	0.92
	% of energy	39.0	7.7

Table 4 Fatty Acid, Cholesterol and Fibre Intake of 50 Elite Spanish Basketball Players.

	Unit	Mean	Standard deviation
Saturated fatty acids	$g \cdot day^{-1}$	57.7	28.3
	% of energy	13.6	
Monounsaturated fatty acids	$g \cdot day^{-1}$	82.6	36.6
	% of energy	19.5	
Polyunsaturated fatty acids	$g \cdot day^{-1}$	24.7	16.5
	% of energy	5.8	
Cholesterol	$mg \cdot day^{-1}$	737.2	391.2
Fibre	$g \cdot day^{-1}$	35.2	18.6

Results

Fifty basketball players of the First Spanish Division (ACB) completed the questionnaires corresponding to a compliance of 71%. Average daily energy intake of elite Spanish basketball players was 17.7 ± 0.9 MJ · day^{-1} (Table 1). Consumption of carbohydrate and protein were 4.6 ± 1.7 and 2.3 ± 1.0 g · kg^{-1} body weight, respectively. Dietary fat intake provided 39% of total energy intake. Basketball players consumed on average 783mg of cholesterol and 13.6 % of saturated fat, expressed in percentage of total energy consumption (Tables 3 and 4). Mean vitamin and mineral

Table 5 Vitamin Intake of 50 Elite Spanish Basketball Players

	Units	Mean	*SD*	DRI/RDA*	%DRI/RDA
Thiamine	mg	3.6	1.1	1.2	300
Riboflavine	mg	4.3	1.7	1.3	330
Niacin	mg	61.5	19.5	16	384
Pyridoxine	mg	4.2	1.1	1.3	323
Cyanocobalamine	mg	12.2	10.2	2.4	508
Ascorbic acid	mg	307	184	90	341
Vitamin E	mg	10.9	8.1	15	73
Folate	mg	570	290	400	143

*DRI: Dietary reference intake (refs. 45-48).
*RDA: Recommended dietary allowance (ref. 9).

Table 6 Mineral Intake of 50 Elite Spanish Basketball Players

Units	Mean	*SD*	DRI/RDA*	%DRI/RDA	
Sodium	mg	4337	2404	2300	189
Potassium	mg	6498	2262	3190	204
Magnesium	mg	612	240	400	153
Calcium	mg	2059	1093	1000	206
Iron	mg	28.4	13.6	8	355
Zinc	mg	21.3	8.9	11	194
Selenium	mg	148	73	55	269

*DRI: Dietary reference intake (refs. 45-48).
*RDA: Recommended dietary allowance (ref. 9).

intakes are shown in table 5 and 6 with respect to the daily reference intake (DRI) for healthy men ages 20-59 or recommended dietary allowance (RDA) (9, 45-49). The average intake for most vitamins and minerals was between 143-508% above the corresponding DRI's/RDA's, with the exception for vitamin E (73% of the DRI). Pearson correlation coefficients between energy consumption and nutrient intake were statistically significant $p<0.0001$, range ($r=0.51$-0.88), with the exceptions of vitamin C and β-carotene.

Mean daily fluid intake recorded on the 24-hour recall was 3126 ± 1226 ml Fig.1). Water was the main beverage consumed by the athletes (1688 ± 1032 ml), followed by milk (445 ± 521 ml), commercial sport drinks (377 ± 520 ml), carbonated beverages (307 ± 492 ml), juices (150 ± 208 ml), beer (67 ± 189 ml), non-alcoholic beer (49 ± 158 ml) and wine (43 ± 218 ml). Subjects further reported to consume 646 ± 352 ml·h^{-1} and 882 ± 486 ml·h^{-1} of fluid during training and competition respectively. Water was the preferred beverage used by the participants during training (92%) and competition (88%). Forty-four percent of the participants recorded not to drink before getting thirsty and no fluid consumption was reported by 3 and 2 athletes during training and competition respectively.

The participants reported having their last meal 192 ± 55 min before and 120 ± 45 min after competition (Fig. 2). 66% of the participants reported to consume particular foods before competition and 10% stated to do this after competition. The

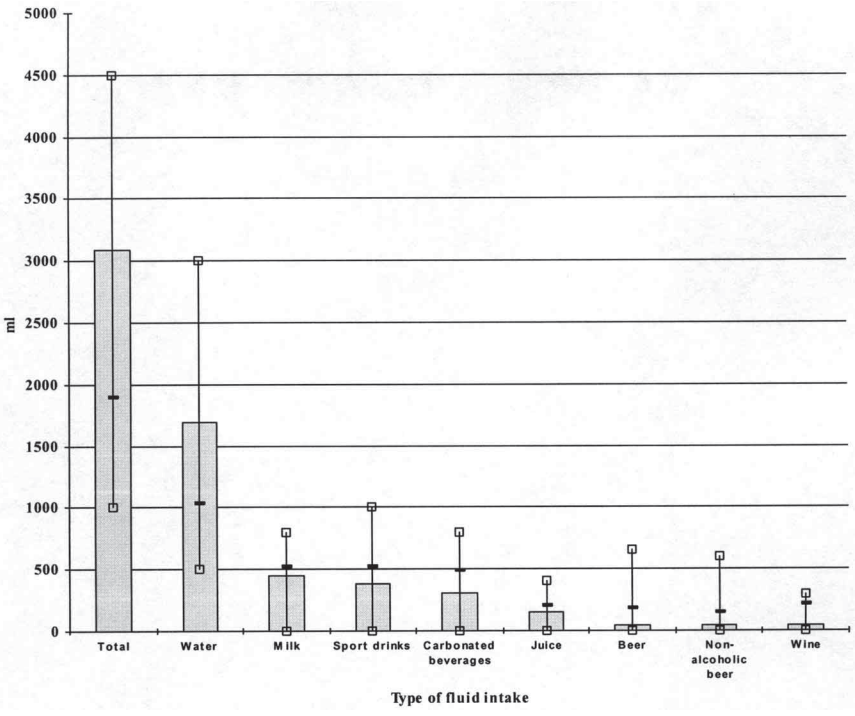

Figure 1 — Amount and type of daily fluid intake of 50 elite basketball player.

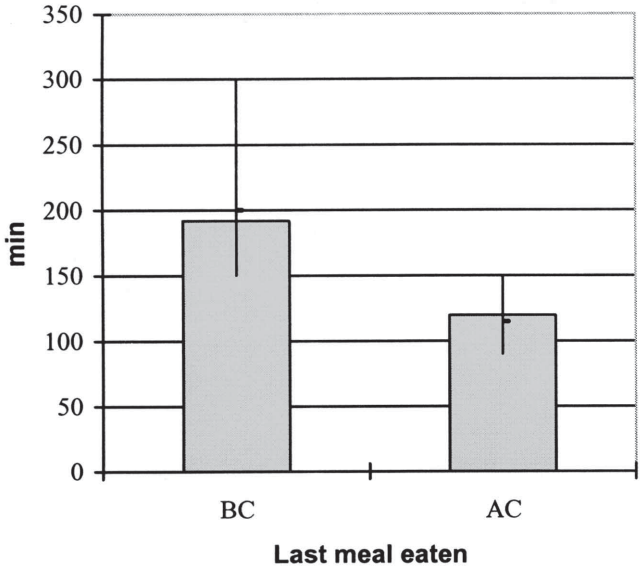

Figure 2 — Last meal eaten min before BC and after competition AC.

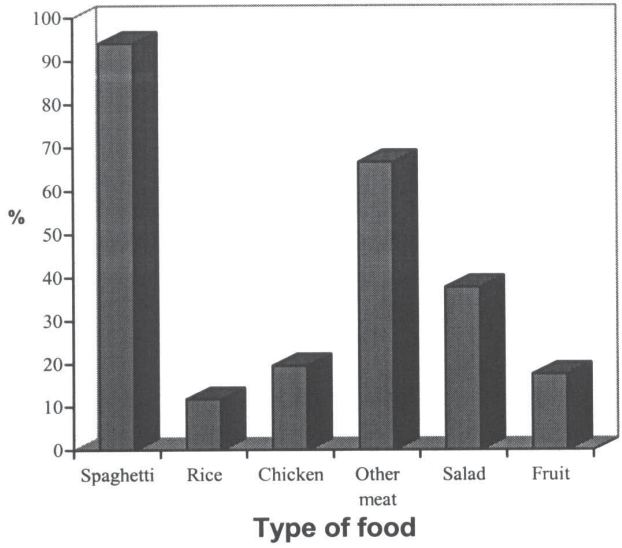

Figure 3 — Type of particular foods consumed before competition by 33 elite basketball players.

special foods consumed before competition consisted of spaghettis and rice (90% and 10% of respondents respectively), accompanied by meat (86.3%), salad (37.8%) and fruit (17.6%) (Fig. 3).

Discussion

This study sought to investigate dietary habits and fluid consumption of a relatively large group of professional basketball players from different Spanish first League Basketball Clubs ACB). High energy consumption accompanied by excessive dietary intakes of protein, total fat, saturated fat and cholesterol and an insufficient vitamin E intake characterized the dietary habits of the study population. Furthermore, fluid intake during training was not adequate.

Adequate dietary habits are essential for good health and physical performance. In contrast, Regular training and competition imposes additional nutritional demands on athletes. Total energy expenditure is increased in proportion to the training load performed and energy intake balanced with energy expenditure is a primary concern for athletes. For elite athletes, high-energy expenditure during training and competition dictates the need for a high-energy diet. Average energy intake (17.7 MJ) of the participants in our study was 53% higher than that of the average Spanish population (30). Furthermore, comparison of energy intakes of different team sport athletes shows that, with the exception for University basketball players, participants in the present study had a higher energy intake than that recorded in other team sport athletes (see Table 7). The reported average energy intake by the athletes of this study expressed as kJ·bodyweight kg)$^{-1}$, was 191.8 kJ·kg^{-1} and nearly reached the general recommendation of energy intake for elite athletes of 209 kJ·kg^{-1} (7).

Endurance exercise is known to severely deplete muscle glycogen contents after 90-120 min (17) but high intensity, intermittent activity typical for team sports, can reduce muscle glycogen contents by up to 72% in less than 10 min (28). The

Table 7 Comparison of Energy and Macronutrient Intake of Team Sport Athletes

Event	*n*	Energy MJ	CHO %	Protein %	Fat %	Reference
Basketball P	50	17.7	40.3	19.7	39.0	Present study
Basketball NS	11	17.1	44.0	15.0	41.0	Grandjean, 1983 (13)
Basketball C	16	14.9	48.0	17.0	34.0	Nowak et al., 1988 (34)
Basketball U	13	23.2	42.0	15.0	41.0	Short and Short, 1983 (44)
Football P	40	13.3	51.7	18.1	29.2	Schockman et al., 1999 (42)
Soccer P	51	11.9	51.6	15.1	33.3	Maughan, 1997 (27)

Note: P = Professional athletes; NS = Not specified; C = College athletes; U = University athletes.

importance of muscle glycogen concentration and its depletion during exercise for performance of team sport athletes has been demonstrated by several studies and depletion up to 84-90% of intramuscular glycogen stores has been observed in team sport athletes (21,23). Soccer players with low glycogen stores at the start of a match had almost no glycogen left in their working muscle and physical performance of these players decreased in the second half in comparison to those players with higher pre-game and halftime glycogen muscle levels (21). The absolute amount of carbohydrates in the diet may be an important factor for the recovery of muscle and liver glycogen stores after training and competition (6,19). Costill and Miller (5) recommended consuming 9-10g·kg^{-1}·day^{-1} to provide adequate amounts of carbohydrate for complete muscle glycogen replenishment within 24 hours after exhausting exercise. The average amount of carbohydrates consumed by the participants in the present study was 4.6g·kg^{-1}·day^{-1}, which was less than carbohydrate consumption of college non-professional basketball players. Muscle glycogen concentrations declined progressively during 7 days of intense training consuming a diet that contains 3-5 g·kg^{-1}·day^{-1} carbohydrates, whereas 8-10 g·kg^{-1}·day^{-1} prevented muscle glycogen depletion (43). Therefore, the observed average amount of carbohydrates consumed in the present study might not be sufficient for elite basketball players who require rapid recovery from training and competition.

Protein ingestion of the athletes in the present study was 2.3 g·kg^{-1}· day^{-1}, and this is higher than that observed in college basketball players (1.9 g·kg^{-1}· day^{-1}; ref. 34), professional soccer players (1.3 and 1.5 g·kg^{-1}· day^{-1} ref. 27), and professional Australian Football players (1.6 g·kg^{-1}· day^{-1}; ref. 42). In this sense, Lemon (24,25) recommended a daily protein intake of 1.2-1.6 g·kg^{-1}, 1.6-1.7 g·kg^{-1}, and 1.4-1.7 g·kg^{-1} for those athletes involved in endurance training, strength training and soccer, respectively (24,25). In contrast, Renni and Tipton (38) suggested that athletes did not need any further protein supplementation when consuming 12-15% of total energy as protein in an energy balanced diet. Mean protein intake (2.3 g·kg^{-1}· day^{-1}, 19.7% of total energy) of the basketball players in the present study was higher than these recommendations, and it is unlikely that athletes would achieve any further improvements in lean body weight mass or performance with this high protein intake. However, as protein intake under 2.8 g·kg^{-1}· day^{-1} did not appear to impair renal function in well-trained athletes (36) average protein intake reported in this study seems not to have harmful side effects on renal function. On the other hand, proteins in excess of immediate requirements follow degradative pathways. Under certain circumstances this can result in metabolic derangements (20)

It has been recommended that dietary fat should be reduced to about 20% for athletes (37) and certainly to no more than 30% (35) of total energy intake. With regard to these recommendations, the basketball players in the present study consumed on average too much fat. However, this observation was also made by other investigators for team sport-and individual sport athletes (Table 7). Mean saturated fat ingestion, expressed in percentage of total energy consumption, recorded by the basketball players in the present study (13.6% of saturated fat) was clearly above the recommendations (less than 10%, ref. 35). Furthermore, cholesterol consumption (737mg) exceeds more than the twofold the recommended dietary intake (35). These nutrients were significantly correlated to energy consumption of the athletes in the present study (p<0.0001, r= 0.74 and 0.60 for saturated fat and cholesterol respectively). Thus, there appears to be a general problem between the demands to

consume a high-energy intake and to limit saturated fat and cholesterol intakes. The consumption of high energy diets needs a careful food selection to avoid high saturated fat and cholesterol intake, both of which are important risk factors of coronary heart diseases (4).

Vitamin and mineral intakes recorded by the participants in the present study were above the DRI's/RDA's with exception of vitamin E. However, it must be taken into account that the current recommendation for vitamin and mineral intake are for the general population and do not make allowance for physical activity. Interestingly, vitamin C and β-carotene intake was not significantly associated with energy consumption indicating a poor fruit and vegetable selection.

A daily fluid intake of 1ml/kcal energy expenditure for individuals living under average conditions of energy expenditure and environmental exposure was proposed by the National Research Council (9). Professional basketball players in this study consumed an average of 3126 ± ml · d^{-1} of liquids. This amount is slightly above the recommendations (2900 ml) given for a 70 kg male consuming a 2900 kcal diet. However, body weight of most professional basketball players exceeds 70 kg and, most importantly, energy expenditure of high intensity training loads increases the requirement of fluid intake. Therefore, it seems unlikely that the recorded average fluid intake of the professional basketball players in the present study is sufficient to maintain an euhydrated state.

A body water deficit of as little as 1-2% of body mass can impair physical performance and mental function (17,52). Average total fluid intake during training and competition of the participants in the present study reached general recommendations for athletes performing continuous prolonged exercise (600-1200 ml · h^{-1} , ref. 1). Failure to replace sweat loss during exercise could lead to a state of chronic hypohydration. Thirst drive is inadequate to promote a rapid or complete replacement of sweat loss during exercise athletes (14). Therefore, the 44% of the participants who recorded not to drink before getting thirsty are more susceptible to involuntary dehydration than those who did. Above all, athletes who never consume beverages during training (6 %) or competition (4%) are at high-risk of hypohydrating.

Fluid intake was self-reported by the athletes and sweat loss during training and competition were not measured. Therefore, a more detailed study is needed to clarify the question whether fluid intake of these athletes is sufficient to achieve fluid balance.

Not only the amount and nutrient content is important in planning a pre-exercise meal, but also the time of ingestion. Consumption of a moderately-high carbohydrate, low fat and low protein meal 3 hours before exercise could improve moderate- to high-intensity exercise compared to a similar meal consumed 6 hours prior to exercise (26). In this regard, 66% of the study population reported to consume a meal ~3 h prior to competition, which was composed mainly of carbohydrate rich foods. In addition, it is important to consume a meal high in carbohydrate within the first two hours after exercise to ensure rapid restoration of muscle glycogen stores (19). However, in the present study, only 10% of the athletes reported to consume particular foods after competition. This revealed that the pre-exercise meal composition received more attention than the post-exercise one by most of the athletes.

Generally, basketball players should follow a carbohydrate-rich and variable diet that covers energy and micronutrient demands. Special attention should be

given to pre- and post event meals. Easy to digest, high-carbohydrate foods should be selected around three hours before the exercise. The consumption of a high carbohydrate-protein meal a soon as possible after exercise is important to ensure rapid muscle glycogen and protein restoration. Furthermore, players should drink whenever possible (time outs etc.), before exercise, during training, and in competition, and recover weight loss with sufficient fluid intake after exercise

In summary, dietary intake of a group of elite basketball players of the first Spanish Basketball League.was characterized by a moderate carbohydrate, high protein and fat consumption. Moreover, average saturated fat and cholesterol intakes were higher than recommended for a healthy diet. Vitamin and mineral intake were equal or above the corresponding RDI's with the exception of vitamin E. The average amount of daily fluid intake was slightly above the recommendation given for a 70 kg male, an amount that might not fulfil the special needs of the studied population group. Furthermore, nearly half of the players stated to drink only when getting thirsty during exercise. These results indicate that more professional advice, ideally by sport nutritionists, would be desirable to improve nutritional habits and drinking behaviours of elite basketball players.

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