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Nutrition, hydration and ergogenic aids strategies in ultraendurance mountain events

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Abstract:

BACKGROUND: The purpose of the present research was to analyze nutrition, hydration and ergogenic aids strategies in ultraendurance mountain events. METHODS: A total of 386 ultraendurance mountain races finishers were analyzed. They were divided into three groups according to their race distance: G1: distance less than 45 km (n: 250); G2 distances between 45 and 90 km (n: 71); G3 distances longer than 90 km (n: 65). The ergogenic, nutritional and hydration strategies were quantified after each race by a questionnaire. RESULTS: We found a higher ingestion of (0.56 ± 0.95), caffeine (G3 M±SD; 203.8±211.5 mg), water (G3 M±SD; 7.1±3.7 l) and Portion of Sandwich (nutrition 5.3±7.4) NSAID in longer distance probes. Higher performance runners in low and medium distances consumed a significantly (p>0.05) lower quantity of gels (higher 0.76±0.98 vs lower 1.38±1.38), and muesli bar (higher 1.09±1.13 vs lower 2.04±1.94), and in long distances Higher performance consumed more water (M±SD; higher 8.23±3.92 vs lower 6.12±3.28) than lower performance ones. They also could maintain a higher rated of perceived exertion than lower performance (G3 M±SD; higher 16.7±2.28 vs lower 18.2±1.71). CONCLUSIONS: Higher distance presented higher nutritional, caffeine and NSAIDs ingestion than lower distances, also, higher performance athletes of higher distance presenter higher water and nutritional ingestion than lower performance ones. In Lower distance probes, higher performance athletes presented lower hydration and nutritional ingestion than lower performance athletes.

Keywords: performance, NSAIDs, hydration, running.

INTRODUCTION

Ultraendurance mountain events are increasing their popularity and the number of runners in the last years [1]. Previous researches focused in these population have found that low body fat was a performance key factor [2], increases in protein catabolism and muscle breakdown [3,4], a blood lactate below the anaerobic threshold [5], the maintenance of hemoglobin values due to increased erythropoiesis to compensate for exercise-induced hemolysis [6], increases in triglycerides consumption as energetic substrate [7], and a normal renal function [8]. Another studies analyzed athletes heart rate (HR) response during a 21-hour ultraendurance event, measuring how the race was performed at 71% of maximum heart rate (HRmax) [9], founding other author a high sympathetic modulation in a mountain ultraendurance probe [10].

An important factor to highlight in ultraendurance events is the use of nonsteroidal anti-inflammatory drugs (NSAIDs), since there increases the risk of hyponatremia associated with exercise, as well as rhabdomyolysis [11]. Also, the risk of acute renal failure, endotoxemia, acute cerebral edema and inflammation was increased with the use of NSAIDs, not reducing muscle damage and pain [11]. Another important factor is the sodium consumption to maintain proper hydration, even it has been proven that the use of sodium supplements or drinking beyond thirst is not required to maintain hydration during ultraendurance events with high thermal stress [12]. By contrary, other researcher recommend an extra sodium supplementation in ultraendurance events and consider adding caffeine before or during the race [13]. However, the predominant mechanism of the ergogenic benefits of caffeine is still unknown [13]. In this line, normally ultraendurance athletes do not adjust their fluid necessities during competitions [14], by contrary, successful athletes in several days ultraendurance probe drank their fluid necessities [14]. In addition, an appropriate fueling is essential for optimal performance since extreme negative energy balance were assessed in previous ultraendurance mountain events [10]. A low carbohydrates (CHO) intake during races are associated with lower performance, varying CHO intake rates considerably among events and athletes [13]. But this high CHO intake is associated with nausea and flatulence [15]. Regarding dietary strategies, previous studies showed in a 160 km ultraendurance race an ingestion of 6047 kcal, 18 L of fluid, and 12 g of sodium [16], and specifically in mountain marathon that 1/3 of runners drank 600 ml or more fluids, the 52% consumed less than 30 g of carbohydrates, and the 95% consumed less than 500 mg of sodium [17]. Despite the considerable number of studies in the literature on the nutrition strategies in ultraendurance races, there is still a shortage of studies conducted in environments that reproduce the competitive situation [18].

Even previous literature has shown a higher performance in ultraendurance athletes who have an adequate use of ergogenic aids, hydration and nutrition, the strategies more efficient are still poor known, especially in the different distance mountain events. For this reason, we proposed the present research with the aim of to analyze nutrition, hydration and ergogenic aids strategies in different distance ultraendurance mountain events.

METHODS

Participants

A total of 386 finishers of ultraendurance mountain races were analyzed. They were divided into three groups according to their race distance: G1: distance less than 45 km (n: 250); G2 distances between 45 and 90 km (n: 71); G3 distances longer than 90 km (n: 65). We made this distance division since there are the distance classification more used by organization, to run in G3 probes participants must accredit the finalization of a G2 probe, and to run in G2 probe participants must accredit the finalization of a G1 probe. Also, participants were divided in each group in higher and lower performance using percentile 50 in the time probe. All the procedures performed in the present investigation complied with the principles of the Declaration of Helsinki, were approved by the University Etic (CIPI/002/17) and in addition, all the participants signed an informed consent.

Procedure

We contacted all participants of the following probes of the year 2017: Alpinultras race circuit, Peñalara Great Trail, Gruseg Trail, Craft Trail and Extremadura Mountain Federation circuit.

The questionnaires were carried out anonymously and voluntarily without the possibility of being repeated by the same athlete. The participants filled out a questionnaire in the 24 hours after the end of races in which they were asked about: number of NSAIDs taken, quantity of caffeine taken, water and isotonic drinks ingested, number of gels, jelly beans, muesli bars, sandwich portions (80 gr), chocolate ounces and pieces of fruit consumed during the race, the rated of perceived exertion (RPE 6-20 scale) in the probe and leg muscle pain (1-10 scale) after the race. In addition, the final time of each mountain event in min, the total distance in km, the speed (km/h), accumulated positive altitude change (m), the difficulty coefficient (final km x accumulated positive altitude change/1000) and the speed/difficulty coefficient ratio were calculated.

Statistical analysis

Data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 17 (SPSS Inc., Chicago, Ill., USA). The Kolmogorov-Smirnov normality test was used to test the normality and homogeneity of each variable. Then a one factor ANOVA was conducted to check differences between the three distance groups as well as a Student's t-test for paired observations to compare differences between higher and lower performance groups in each distance groups. Finally, a bivariate correlation Pearson analysis was conducted. A significance rate of $p<0.05$ was adopted for all comparisons.

Results

The athletes of G3 performed a distance almost 5 times greater than G1 and almost double than G2. The Speed/Coefficient of difficulty ratio was higher in G1 then G2 and this higher than G3. The consumption of gels, muesli bar or similar, jelly beans, portion of sandwich, pieces of fruit, caffeine and NSAIDs were significantly higher in G3 (Table 1).

TABLE 1 OVER HERE

The G1 higher performance athletes consumed less water and gel than the lower performance. The higher performance G3 athletes consumed more water than lower performance. In G2, higher performance athletes consumed less muesli bar and the higher performance athletes of G1 and G3 had a lower perception of effort than lower performance (Table 2).

TABLE 2 OVER HERE

The consumption of muesli bar in G1 has positive correlation with RPE and in G2 has positive correlation with the test time, it has negative correlation with speed, it has negative correlation with the speed/ difficulty coefficient and has positive correlation with the muscular pain. The consumption of jelly beans in G1 and G2 has positive correlation with the test time, it has negative correlation with the speed and in G1 also has positive correlation with the RPE and muscular pain. It should be noted that the sandwich consumption in G1 presented positive correlation with the speed and with RPE, however in G2 presented a positive correlation with the test time and it has negative correlation with the speed. Finally the consumption of fruit in G1 has positive correlation with RPE and muscle pain and in G2 it produces a positive correlation with in test time and a negative correlation with the speed.

TABLE 3 OVER HERE

Discussion

The objective of this article was to analyze nutrition, hydration and ergogenic aids strategies in different distance ultraendurance mountain events. We found differences depending the distance and performance of athletes analyzed.

Mountain ultraendurance probes significantly increase muscle damage and inflammation markers [(19)]. This fact could explain the high consumption of NSAIDs in ultraendurance events [(11)]. In the present research, we found how in longer distance probes, athletes consumed significantly higher number of NSAIDs. However, it was demonstrated that the 600-1200 mg NSAIDs doses did not provide any benefit for relief muscle damage or soreness [(20)]. This could be especially dangerous when it is combined with a poor hydration strategy, as we found in lower performance runners (G3), since renal damage have been found in similar event by these causes [(21)]. Regarding caffeine intake, each distance group consumed the double quantity than the previous distance group but being these quantities lower than other ultraendurance events as Ironman [(22)]. This increase in caffeine consumption with distance probe could be explained since they consume more gels and isotonic drink with caffeine, and probably they also increase the dose in larger probes for the lipogenic and activating effect of caffeine [(13)].

Analyzing hydration strategies, we found that G1 drank 0.57 l/h between water and isotonic drinks. This was lower than the hydration recommendations [23]. In G2 and G3 we also found a low Na consumption, and in G3 a lower fluid intake than the recommendation too [23]. This lower fluid intake could be related with the decrease in cortical arousal and the fatigue of central nervous system evaluated in previous mountain ultraendurance events, fact that could affect negatively different autoregulation mechanism as hungry, thirsty, or subjective perception of effort, pain, time and memory [10,24,25]. In this line, we found an increased RPE in longer distances, over the value associated to the anaerobic threshold [26], despite the intensity of the 3 study groups were lower than this intensity. Possibly, the increase in inflammatory and muscle destruction parameters could increase the effort perception [27]. In this line, there was a significant higher muscular pain in G1 (shorter distances) than G2 and G3 (longer distances). This maintenance of pain perception independently of the distance of G2 and G3 could be explained since athletes suffer a flow status that inhibit their conscience and perceptions systems [28]. We also found that higher performance athletes presented higher effort and pain toleration, fact related previously with performance in mountain ultraendurance probes [29].

Related to the nutritional strategies, G3 consumed more fruit, gels, jelly beans and portions of sandwich than G2 and G1. Fluid and food intake is essential during these longer events despite the increased nutritional requirements. Therefore, to avoid gastrointestinal problems that impair performance, a delicate balance between the volume and type of feeding and the osmolarity of the liquids in relation to the gastric emptying speed for said foods and liquids is required [11]. It is known that experienced runners known better their personal needs during races [17]. In this line, we found how higher performance G1 athletes presented lower consumption of gel than lower performance, not finding significant differences in longer distances (G2 and G3). We also found a significant lower muesli bar consumption in higher than lower performance G2 athletes. This fact could be explained by two facts: first, athlete presented a more efficient lipid metabolism do not needing to consume high quantities of CHO to get energy, and like intensity performed is low and the main fuel is fat, it would not be necessary to consume so much extra CHO aids [10]; and second, the consumption of gels produces gastrointestinal disturbances that limit performance [11]. In this line we found a positive correlation between the gels, muesli bar and jelly beans intake and probe time, RPE and muscular pain, and negative with speed. These could be related to the high calorie content of these product that can produce gastrointestinal distress [30]. An opposite result was found in sandwich consumption, since positively correlated with speed. This result could be related with the fact that the use of these salty taste foods has been reported by ultraendurance athletes as a psychologically aids since it changes the sweet taste of others typical foods (gel, jelly bean, muesli, chocolate...). Therefore, sandwich could be more recommendable for being more digestive and approaching the upper limit of absorption during the exercise [16].

We found that higher performance G1 athletes drank less water than the lower performance. Contrary than in G3, since higher performance athletes drank more water than lower performance. This lower water consumption during the shorter probes could be explained since short distances athletes (G1) are correctly hydrated at the beginning of the probe and the event is not long enough to decrease the performance due to the dehydration. It is known that when increasing the distance and duration probe, more difficult is the replacement of loosed fluid [31]. For shorter ultraendurance distances (G1 and G2) probably would not be necessary to drink as in longer distances (G3), where hydration is essential to maintain homeostasis, thermoregulation and organic functions [31]. We also found a positive correlation between isotonic drink consumption and muscle pain, possibly because athletes could perform a higher intensity because of the extra energy of the isotonic drink, which increases the intensity of the race and pain [32]. Regarding caffeine consumption, G1 presented a positive correlation between caffeine intake and RPE and muscular pain, probably because athletes could perform higher intensity due to the higher cortical arousal [33], increasing the effort and pain perception [32]. By contrary, we did not find positive correlation between caffeine consumption and performance, in contrast to previous studies that shown improvements in endurance performance [22]. However, it should be noted that any ergogenic benefit of caffeine in this type of events is reached at very specific doses [22], which needs further investigation.

Practical Application

This research provided information to improve nutritional, hydration and ergogenic strategies in ultraendurance mountain races. We do not recommend the use of NSAIDs, and recommend increase hydration in longer races and nutritional and training programs that improve lipolytic metabolism increasing fat consumption and decreasing the nutrients ingestion during the probe, since higher performance athletes in this study tended to have a lower food intake than the slower ones.

Conclusion

Higher distance presented higher nutritional, caffeine and NSAIDs ingestion than lower distances, also, higher performance athletes of higher distance presenter higher water and nutritional ingestion than lower performance ones. In Lower distance probes, higher performance athletes presented lower hydration and nutritional ingestion than lower performance athletes.

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Table 1. Study variables of the three groups analyzed.

Variable	Group 1 M ±SD	Group 2 M ±SD	Group 3 M ±SD	F	P G1 vs G2	P G1 vs G3	P G2 vs G3
NSAIDs	0.05 ± 0.22	0.42 ± 0.68	0.56 ± 0.95	32.968	,000	,000	,304
Caffeine (mg)	64.9 ± 103.0	105.3 ± 120.8	203.8 ± 211.5	29.397	,066	,000	,000
Water Litres	1.0 ± 1.2	3.1 ± 3.7	7.1 ± 3.7	169.933	,000	,000	,000
Isotonic Litres	0.5 ± 0.8	1.5 ± 1.4	3.1 ± 2.9	76.376	,000	,000	,000
Gel (units)	1.0 ± 1.2	1.3 ± 2.6	3.4 ± 4.3	27.271	,944	,000	,000
Muesli bar or similar (units)	0.2 ± 0.6	1.5 ± 1.6	2.5 ± 2.3	90.081	,000	,000	,000
Jelly beans (units)	1.5 ± 3.4	2.6 ± 10.2	6.6 ± 11.9	12.716	,858	,000	,004
Portion of Sandwich (number)	0.2 ± 1.8	0.8 ± 3.8	5.3 ± 7.4	49.536	,622	,000	,000
Ounce of chocolate	0.3 ± 1.2	0.8 ± 2.4	1.6 ± 2.7	12.745	,303	,000	,017
Piece of fruit	1.7 ± 3.2	5.0 ± 5.3	20.6 ± 18.4	133.163	,010	,000	,000
RPE (a.u.)	15.1 ± 2.5	16.1 ± 2.5	17.5 ± 2.1	25.801	,004	,000	,006
Muscular Pain	3.9 ± 2.1	5.2 ± 2.0	5.2 ± 2.6	16.021	,000	,000	1,000
Final Minutes	156.8 ± 67.0	507.6 ± 159.6	1458.0 ± 280.5	2097.751	,000	,000	,000
Distance (km)	21.2 ± 7.3	51.8 ± 4.8	101.6 ± 9.1	3209.204	,000	,000	,000
Speed (km/h)	8.5 ± 1.9	6.3 ± 0.8	4.3 ± 1.0	180.412	,000	,000	,000
Accumulated positive altitude change (m)	1033.1 ± 464.8	2579.1 ± 681.3	7031.0 ± 1601.5	1419.475	,000	,000	,000

Difficulty coefficient (a.u.)	24.6 ± 17.1	136.8 ± 65.9	709.6 ± 167.7	2111.050	,000	,000	,000
Speed / Difficulty Coefficient	0.70 ± 0.84	0.049 ± 0.0097	0.0066 ± 0.0026	42.719	,000	,000	1,000

a.u.: arbitrary unit; RPE: rated of perceived exertion; NSAIDs: nonsteroidal anti-inflammatory drugs; Group 1: (G1) distance less than 45 km (n: 250); Group 2: (G2) distances between 45 and 90 km (n: 71); Group 3: (G3) distances longer than 90 km (n: 65).

Table 2. Results obtained by higher and lower performance subgroups in study variables.

Variable	Performance	Group 1 M ±SD	F	P	Group 2 M ±SD	F	P	Group 3 M ±SD	F	P
NSAIDs (number)	Higher	0.04±0.21	,358	,765	0.44±0.80	,836	,788	0.65±0.97	,260	,472
	lower	0.05±0.23			0.40±0.55 .			0.48±0.93		
Caffeine (mg)	Higher	58.7±105.3	,039	,380	105.5±115.0	,012	,989	221.1±240.0	2,051	,518
	lower	70.3±101.1			105.1±128.2			186.9±181.8		
Water (l)	Higher	0.81±0.90	4,716	,005	2.89±1.74	2,499	,566	8.23±3.92	,248	,022
	lower	1.25±1.45 *(.005)			3.40±5.02			6.12±3.28 *(.022)		
Isotonic drink (l)	Higher	0.54±1.03	,382	,668	1.61±1.64	1,220	,784	3.41±3.36	,496	,431
	lower	0.59±0.56			1.52±1.23			2.83±2.51		
Gel (number)	Higher	0.76±0.98	13,747 ,000		1.27±1.68	,450	,745	3.53±3.91	,038	,877
	lower	1.38±1.38 *(.000)			1.48±3.41			3.36±4.72		
Muesli bar or similar (units)	Higher	0.28±0.64	,059	,981	1.09±1.13	,587	,015	2.32±2.36	,192	,471
	lower	0.27±0.54			2.04±1.94 *(.015)			2.75±2.41		
Jelly beans (number)	Higher	1.34±2.72	5,071	,220	2.33±5.51	,644	,813	4.18±4.85	10,272	,111
	lower	1.88±4.04			2.91±13.5			8.93±15.9		

Portion of Sandwich (number)	Higher	0.21±1.82	,012	,950	0.19±0.70	5,822	,155	4.71±6.60	1,600	,480
	lower	0.20±1.81			1.51±5.45			6.03±8.16		
Ounce of chocolate	Higher	0.35±1.05	1,162	,579	0.72±1.48	,740	,779	1.34±2.30	1,934	,341
	lower	0.43±1.41			0.88±3.14			2.00±3.13		
Piece of fruit (number)	Higher	1.42±3.12	1,008	,123	4.68±4.41	,177	,546	18.9±19.1	,934	,455
	lower	2.07±3.45			5.45±6.25			22.3±17.9		
RPE (6-20)	Higher	14.6±2.54	,471	,002	15.9±2.94	5,561	,447	16.7±2.28	,557	,003
	lower	15.6±2.41 *(.002)			16.4±1.97			18.2±1.71 *(.003)		
Muscular Pain (1-10)	Higher	3.68±2.11	,024	,052	5.08±1.94	,296	,509	5.25±2.75	,735	,899
	lower	4.21±2.11			5.40±2.07			5.33±2.50		

* p< 0.050 between higher and lower performance group. Group 1: (G1) distance less than 45 km (n: 250); Group 2: (G2) distances between 45 and 90 km (n: 71); Group 3: (G3) distances longer than 90 km (n: 65); RPE: rated of perceived exertion; NSAIDs: nonsteroidal anti-inflammatory drugs.

Table 3. Correlation analysis between performance and perceived variables with nutritional, hydration and ergogenic aids in the three-distance analyzed.

	Group 1					Group 2					Group 3				
Variables	Probe time (min)	Speed (km/h)	Speed / Difficulty Coefficient	RPE (a.u.)	Muscular Pain	Probe time (min)	Speed (km/h)	Speed / Difficulty Coefficient	RPE (a.u.)	Muscular Pain	Probe time (min)	Speed (km/h)	Speed / Difficulty Coefficient	RPE (a.u.)	Muscular Pain
NSAIDs															
Caffeine (mg)				.162	.148	.365	-.250	-.345							
				.011	.020	.002	.035	.003							
Water Litres	.154			.272	.158	.709	-.316	-.426	.242		-.299	.349	.425		
	.015			.000	.013	.000	.007	.000	.042		.015	.004	.000		
Isotonic Litres					.178					.260					
					.005					.029					
Gel (units)	.272		-.208	.286	.214	.655	-.311	-.405	.308	.272					
	.000		.001	.000	.001	.000	.008	.000	.009	.022					
Muesli bar or				.156		.422	-.246	-.330		.236					
similar (units)				.014		.000	.039	.005		.048					
Jelly beans	.171	-.146		.160	.217	.453	-.275	-.393							
(units)	.007	.022		0.12	.001	.000	.020	.001							

Portion of	.130	.151		.588	-.373	-.577
Sandwich	.042	.018		.000	.001	.000
(number)						
Ounce of	-.141		.129	.368		-.273
chocolate	.026		.042	.002		.021
Piece of fruit		.215	.187	.249		-.310
		.001	.003	.036		.009

r and p values. a.u.: arbitrary unit; NSAIDs: nonsteroidal anti-inflammatory drugs; G1: distance less than 45 km (n: 250); G2 distances between 45 and 90 km (n: 71); G3 distances longer than 90 km (n: 65)