EFFECTS OF TRAINING VOLUME IN FINAL RACE TIME AND NEUROMUSCULAR FUNCTION IN ULTRATRAIL RUNNERS

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ORIGINAL SCIENTIFIC ARTICLE

Abstract: The increasing status of ultratrail races due to the growth in number of races and participants in this kind of events has caught the attention and interest of the scientific community. The present study was carried out in an ultra-trail race (108km distance and 5800m of accumulated slope). The participants were divided into amateur level competitors (n=10; 43.30±4.52 years) or high-level competitors (n=10; 41.40±6.19 years). Neuromuscular response (squat jump, countermovement jump and Abalakov jump) was evaluated before and after the race. A questionary was passed to all participants before the race to determine the experience, the basal parameters and the training volume. The aim of this study is to a) determine the influence of the training volume expressed in hours per week (HS) and elevation gain (D) in the final race time; b) determine the influence of the training volume in the lower body strength loss after an ultratrail race. We establish the hypothesis that those runners who present a lower training volume spend a longer time in finishing the race and that they have a greater loss of lower body strength. Final race time and lower body strength loss were both minor in high level group. Although no significant results ($p<0.05$) were found out.

Keywords: trail running; training-volume; neuromuscular, final-race-time, jump.

INTRODUCTION

In recent years, ultra-trail races have grown not only in number of events but also in number of participants (Martínez-Navarro et al., 2020). Events such as the Ultra Trail du Mont Blanc (UTMB), Sables Marathon or Western States Endurance Run are clear example of this boom (Scheer, 2019). The increasing status of this kind of races has aroused the attention and interest of the scientific community which aims to analyse the physical effort and its potential several consequences in health (Scheer et al., 2020). Furthermore, the search for variables that can determine a better performance is another reason for analysis ((Balducci, Clémençon, Trama, Blache, & Hautier, 2017). Along these lines, finding a way to quantify the load accurately is presented as the way to follow when controlling the training process (Borresen & Lambert, 2008).

An ultra-marathon race is one that exceeds 42,192km in distance (Wardenaar et al., 2018) regardless of the terrain on which it is carried out (Scheer et al., 2020). Insofar as there are several variables that influence the performance of an ultra-

distance runner such as Maximum Aerobic Speed (MAS), Maximum Sustainable Power or the strength of the lower body extensors, the decrease in these values is the subject of study and analysis (Balducci et al., 2017). In addition, there seems to be no established standard regarding the ideal volume of training (Hoffman & Fogard, 2011) to minimize the losses.

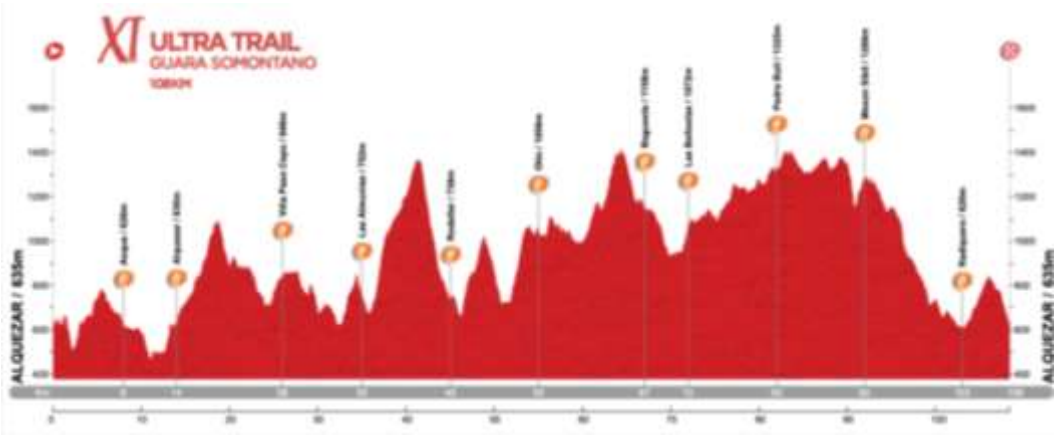
Additionally, trail races also take place in a natural environment which can be very changeable and that has a low percentage of paved roads (World Athletics, 2020). Therefore, high Maximum Aerobic Power (MAP) and high values of eccentric strength of the lower body muscles are shown to be highly necessary to successfully face this type of race characterized by the presence of significant slopes, both in ascent and descent (Rojas-Valverde et al., 2019). Indeed, various studies report the loss of lower body strength after the completion of an ultra-distance race (Balducci et al., 2017; Martínez-Navarro et al., 2020).

The objective of this study is to determine the influence of the volume of training expressed in hours (HS) and accumulated slope (D) in the finishing time involved in the completion of an ultra-distance race. Our hypothesis establishes that runners who present a lower volume of training and cumulative slope during the season take a longer to complete the test and present a greater decrease in the strength levels of the lower body.

MATERIALS AND METHODS

The race

The study was carried out in the Ultra-Trail® Guara Somontano HG. This race is framed in the city of Alquézar (Huesca) and consists of 108km of distance and a positive slope of 5800 meters. Time-wise, participants had a time limit of 24h to complete it. The mean temperature was 14±4.4ºC and the relative humidity was 57±16.1% (Figure 1).



Note: obtained from organizer´s official website.

Figure 1: Race profile.

Participants

A sample of 20 experienced male trail runners participated in the study (age: 42.35 ± 5.36 years), all of whom participated voluntarily. The research was approved by the Ethics Committee of the Government of Aragon (CEICA) under Act No. 16/2017.

Participants completed an ad hoc survey of their pre-test training parameters, which included information regarding training volume in hours per week (HS), amount of elevation gain per season (D) in metres, and their previous experience in long-distance sports, in general, and trail running.

The sample was divided into two subgroups based on training volume: the Amateur group, formed by subjects who trained less than 8 hours per week and less than 50,000m positive per year; and the High group, made up of subjects whose training volume was greater than 8 hours per week and more than 50,000 accumulated positive slope per year.

The study carried out is a longitudinal correlational study in which the results obtained in the periods before (PRE) and after (POST) the race have been measured and compared.

Measurements and evaluation

Strength assessment was carried out using the Bosco test. Squat jumps at 90º (SJ), Abalakov (ABK) and counter movement (CMJ) jumps were also analysed. All jumps were performed before (PRE) and immediately after finishing the race (POST). In each of the jumps, the height of the flight was measured in centimetres and the difference in the absolute value of each of the PRE and POST jumps was evaluated. At the same time, the percentage variation (%) between PRE and POST was calculated for each of the jumps.

Previously, all the athletes performed a kinanthropometric analysis, a maximum incremental effort test on a treadmill to determine Maximum Oxygen Consumption (VO2max), Maximum Heart Rate (HRmax) and Maximum Aerobic Speed (MAS). All these tests were carried out by specialists in sports medicine at the Aragonese Centre for Sports Medicine of the Government of Aragon (Spain).

Statistical analysis

A descriptive analysis of the variables was performed based on the mean and the standard deviation (SD). The Shapiro-Wilk test was performed to analyse the normality of the distribution and the Levene test to determine homogeneity. Student's t was applied in order to determine the differences between groups.

RESULTS

The descriptive analysis of the characteristics of the sample indicates that the High group trained an average of 11.05±2.95 hours per week compared to 6.5±0.71 hours for the Amateur group (Table 1). In this sense, the High group was the one that gained the most positive slope throughout the season. However, it was the Amateur group which scored as the most experienced in both long-distance races and mountain races.

Table 1. Descriptive analysis of the groups. Mean and SD of training volume and experience.

Group	Weekly volume (h)	Seasonal levation gain (m)	Experience in endurance sports	Experience in trail-running (years)
Amateur	6.5 (± .71)	33716.7 (±14001.75)	8.30 (±3.59)	5.8 (±2.53)
High	11.05 (±2.95)	56426.6 (±8184.58)	7.1 (±2.64)	4.6 (±1.26)

The mean age of the subjects who participated in the study was 42.3±5.36 years (Table 2), with the Amateur group being slightly older (43.3±4.52 years versus 41.4±6.19 years). The youngest participant in the Amateur group was 35 years old and the oldest was 50, while in High group the age gap was 18 years (the youngest being 32 years and the oldest 50 years).

Table 2. Descriptive analysis of the groups. Ages.

Group	Mean age	Máx.	Min.	Range
Amateur	43.30 (± 4.52)	50	35	15
High	41.40 (± 6.19)	50	32	18
Total	42.35 (± 5.36)	50	32	18

Final race time

The mean and SD of times needed to complete the race can be seen in Table 3.

Table 3. Descriptive analysis. Mean and SD of the final race time.

Group	Time (h)
Amateur	19.88 (±1.84)
High	15.32 (±0.82)
Total	17.60 (±2.72)

Strength evaluation

After finishing the test, on average, all the jumps made by both groups underwent a loss in height (Table 4). On the one hand in Amateur group, the CMJ was the jump in which the greatest loss could be seen (9.75±2.23 cm), while in the High group, the greatest loss was in the ABK jump (9.15±6.33cm).

Table 4. Descriptive analysis. Results of the PRE and POST jumps.

Group	Jump	PRE (cm)	POST (cm)	LOSS (cm)
Amateur	SJ	25.5 (± 4.29)	16.74 (± 3.91)	8.76 (± 1.92)
	CMJ	29.86 (± 5.08)	20.11 (± 5.01)	9.75 (± 2.23)
	ABK	34.08 (± 6.45)	24.52 (± 4.88)	9.56 (± 4.30)
High	SJ	27.12 (± 5.29)	19.87 (± 4.31)	7.25 (± 4.14)
	CMJ	31.14 (± 6.33)	23.40 (± 4.65)	7.74 (±5.00)

	ABK	36.66 (±8.94)	27.51 (± 5.25)	9.15 (± 6.33)

Tables 5 and 6 show the correlation between the training volume (expressed in HS and D) and the final time used to complete the test and the height loss of each of the jumps, respectively.

Table 5. Correlational analysis between training volume and final race time.

Group	Paramater	Correlational coefficient	Signification
Amateur	HS	-.059	.871
	D	.447	.195
High	HS	-.416	.232
	D	.034	.926

Table 6. Correlational analysis between training volume and height loss in different jumps.

Group	Jump	Parameter	Correlational coefficient		Signification
			r	rho	
Amateur	SJ	HS	-	-,219	,543
		D	-	0,40	,913
	CMJ	HS	,215	-	,551
		D	-,119	-	,743
	ABK	HS	,153	-	,672
		D	-,575	-	,082
High	SJ	HS	,615	-	,059
		D	,206	-	,569
	CMJ	HS	-	,505	,137
		D	-	-,006	,987
	ABK	HS	,425	-	,221
		D	,436	-	,207

DISCUSSION

The main objective of this study has been to determine the influence of the volume and the accumulated slope of the training in the final time used to complete an ultra-trail race. To do so, our hypothesis suggested that runners who present a lower volume of training and accumulated slope during the season take longer to complete the test and undergo a greater decrease in the strength levels of the lower body.

In this study, as far as the finishing time used is concerned, the results obtained show that those who presented a greater volume of training, expressed both in hours and in seasonal elevation gain, at a general level, obtained a better final time in the race. Despite this, the results obtained do not show a significant difference in that correlation. Other studies, such as that of Citarella et al. (2021), show similar results that support this correlation in a more solid way (p=0.05). However, it should be noted that, in this study, the volume has been expressed in km/week. We also found studies that have obtained opposing results showing an inverse correlation between both parameters (Hoffman & Fogard, 2011). A

significant variation in volume has been seen between the participating subjects both in these studies and in ours, finding differences, for example, of up to 12h/week.

Ultra-trail races are not only long, but also, given the particularity of the terrain over which they are carried out, they imply a great need to maintain the eccentric component of the strength of the lower body which results in the exhaustion of the muscles of the lower body (Giandolini et al., 2016). We have seen that the race reduced neuromuscular function of the runners in both groups (table 4). This result follows the line of other previously published studies which show the loss in neuromotor function caused by a race of these characteristics (Gatterer et al., 2013; Balducci et al., 2017; Martínez-Navarro et al., 2020). Despite this, a significant influence of training volume over the aforementioned, has not been noted.

Furthermore, the great involvement of the eccentric component of the strength of the lower limbs can result in muscle damage as can be seen in studies in which the results obtained in the same race as of this study showed an increase in the concentrations of creatine kinase (CK), alanine aminotransferase (ALT) and bilirubin after performing the test (Pradas et al. 2021).

Finally, this work presents the following limitations: a) the small sample size (n=20); b) only the male gender was valued; c) intake during the test, which has been shown to have a clear influence on the muscles and their function (Urdanpilleta et al., 2020), has not been taken into account; d) the difficult extrapolation to other tests given the wide variety of characteristics that make all mountain tests unique.

CONCLUSIONS

Clearly, the quest for better performance is reason enough for every athlete to dedicate many hours to training. In this sense, there are various ways of quantifying that volume (h/week; km/week; slope/year), however, in ultra-trail races the ideal "dose" does not yet seem to have been established. Despite this, a higher volume is showed to be a better option.

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