Is ultradistance sport healthy? A descriptive observational study of a cohort of ultradistance runners

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Running. Resistance training. Athletic injuries. Electrocardiography. Sports medicine.

Summary

Objective: To describe the physical and physiological characteristics of a group formed by ultra-distance runners, to compare their training habits with the guidelines established by the WHO and to study the possible harmful consequences of the high volume of physical activity performed.
Material and method: The sample was formed by runners who repeated their participation in the "Ehunmilak" ultra-distance race in 2017 and 2018. Data collected through the medical certificates of the race and an own questionnaire were analyzed. For the analysis of variables, the Mann-Whitney U and Chi-square tests were used, with a 95% confidence interval. A value of $p < 0.05$ was considered statistically significant.
Results: A low prevalence of several well known risk factors was observed (HT 1.8%, DM 0%, dyslipidemia 0-1.8%, smoking 5.3-10.5%, overweight 17.5%). During the last two years, 0% suffered cardiovascular injuries and 52.6% suffered musculoskeletal injuries. Medical examinations were performed frequently, each year by 91.2%. 72% complied with the latest WHO recommendations regarding volume of physical activity. Finally, no relationship was found between the parameters that indicate a high volume of physical exercise and the ECG result. The same occurred with musculoskeletal injuries, although in this case significant relationships were observed with BMI ($p = 0.004$) and training intensity ($p = 0.009$).
Conclusions: It was observed that the group of runners studied is in good health and that their training habits are correct, according to the latest WHO recommendations. In addition, their characteristics and training habits did not show a relationship with the risk of developing a pathological ECG or suffering musculoskeletal injuries, except for the significant relationship that BMI and training intensity showed with the latter.

¿Es la ultradistancia saludable? estudio descriptivo observacional de una cohorte de corredores de ultradistancia

Palabras clave:
Correr. Entrenamiento de resistencia. Lesiones deportivas. Electrocardiografía. Medicina deportiva.

Resumen

Objetivo: Describir las características físicas y fisiológicas de un grupo de corredores de ultradistancia, comparar sus hábitos de entrenamiento con las directrices establecidas por la OMS y estudiar las posibles consecuencias lesivas del alto volumen de ejercicio físico realizado.
Material y método: Muestra compuesta por corredores que repitieron participación en las carreras de ultradistancia Ehunmilak de 2017 y 2018. Se analizaron datos recogidos mediante los informes médicos de la carrera y un cuestionario creado específicamente para este estudio. Para el análisis de variables, se utilizaron las pruebas de U de Mann-Whitney y Chi-cuadrado, con un intervalo de confianza del 95%. Un valor de $p < 0{,}05$ fue considerado estadísticamente significativo.
Resultados: Se observó baja prevalencia de varios factores de riesgo conocidos (HTA 1,8%, DM 0%, dislipemia 0-1,8%, tabaquismo 5,3-10,5%, sobrepeso 17,5%). Durante los dos últimos años, el 0% sufrió lesiones cardiovasculares y el 52,6% lesiones musculoesqueléticas. Los exámenes médicos son realizados con frecuencia, cada año por el 91,2%. El 72% cumplió con las últimas recomendaciones de la OMS en cuanto a volumen de ejercicio físico. Por último, no se encontró relación entre los parámetros que indican gran volumen de ejercicio físico y el resultado del ECG. Lo mismo ocurrió con las lesiones musculoesqueléticas, aunque en este caso se observaron relaciones significativas con el IMC ($p=0{,}004$) y la intensidad del entrenamiento ($p=0{,}009$).
Conclusiones: Se observó que el grupo de corredores estudiado goza de buena salud y que sus hábitos de entrenamiento son correctos, acorde a las últimas recomendaciones de la OMS. Además, sus características y hábitos de entrenamiento no mostraron relación con el riesgo de desarrollar un ECG patológico o de sufrir lesiones musculoesqueléticas, exceptuando la relación significativa que mostraron el IMC y la intensidad del entrenamiento con estas últimas.

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Introduction

Inactivity, a sedentary lifestyle and poor physical shape are considered independent high-risk factors for mortality due to any cause, cardiovascular pathology or cancer, this can present estimated risks similar to other well-defined entities such as smoking, arterial hypertension (AHT), hyperglycaemia on an empty stomach or a high body mass index (BMI).[1,2]

Consequently, physical activity provides undeniable health benefits: it reduces mortality for any reason, the lethality and incidence of cardiovascular diseases and many cancers, also AHT and diabetes mellitus (DM).[2-7] Benefits have also been demonstrated for mental health, reducing anxiety and depression, improving cognitive function and the risk of suffering dementia.[3,8,9]

However, some sports such as ultramarathons, demonstrate the need to investigate the limits of excessive physical exercise. The ultramarathon, a race that exceeds the 42 km marathon, is a discipline that has seen a boom in events, and so also participants, over the last few years.[10] As one example, 2 of these races were run in North America 1979 and more than 50 in 2008.

Various studies endorse the concept that individuals capable of completing this calibre of race are healthier than the general population and have less need for medical attention. Apart from asthma and allergies, they suffer from fewer chronic diseases (cancer, coronary diseases, heart attacks, DM and AIDS among others), they have lower absenteeism, and they require less use of the health system.[10-12]

Nevertheless, this extreme sport also carries some risks. In the short term, the stress that the body suffers during the race leads to an acute phase reaction,[13] although most changes are transitory.[14] Musculoskeletal,[15-17] digestive[18-22] and dermatological[22,23] disorders are usual; although cardiovascular,[24,25] renal,[15,26] hepatic[27,28] or blood[29,30] anomalies also appear.

Even so, the anomalies that cause the most concern are possible long term damage, where once again the musculoskeletal system is one of the most affected due to the great stress on bones and joints, increasing the risk of osteoarthritis[31-33] or stress fractures among others.[33] A special mention should also go to the "triad of the female athlete",3[4,35] asthma[36] and allergies.[37] However, the greatest interest has been aroused by cardiovascular injuries, given that recently a U-shaped dose-response relationship has been suggested between the intensity of physical exercise and cardiovascular morbidity.[38] One of the most accepted theories is a direct association between extreme physical exercise and atrial fibrillation (AF),[39-41] although other studies have also proposed a J-shaped relationship between the volume of the physical activity and the risk of AF.[42,43] On the other hand, it has been described that athletes doing resilience sports for many years have a greater prevalence for arteriosclerosis plaque in their arteries, although they have a lower risk profile.[44,45]

In this respect, given the growing importance of this sporting discipline and the need to continue researching it, this study proposes to describe the physical and physiological characteristics of a group of ultradistance runners, determine if their training habits can be considered healthy and finally study the possible harmful consequences of this high volume of physical exercise.

The latest WHO recommendations will be taken, published in late 2020,[3] to work out if these training habits are healthy. In the case of healthy adults (18-64 years old), they recommend a minimum of 150-300 minutes of moderate aerobic physical activity, a minimum of 75-150 minutes of intense aerobic physical activity or an equivalent combination of the two each week. Even so, the same recommendations have observed a drop in mortality due to any cause with moderate-intense physical activity of up to 750 minutes per week, a limit that was considered to determine whether the training volume remains healthy.

Material and method

This is a descriptive observational study of a cohort of ultradistance runners The sample comprises individuals who had taken part for two consecutive years (2017-2018) in the *Ehunmilak Ultra Trail* race. This is an ultradistance mountain race that takes place around towns in Gipuzkoa, with a circular route of 172 Km, climbing 11.000 m in total. The sample size was 57 participants, with an alpha level defined as 0.05 and a statistical power of 95%.

The inclusion criteria for the sample selection were as follows: having taken part in the Ehunmilak race in both 2017 and 2018; presenting the race's medical report signed by a doctor as suitable to compete and a 12-lead electrocardiogram (ECG) at rest; having signed the relevant permission to send data to the race organisation for research and having properly filled in the questionnaire received by mail.

The work was accepted by the research ethics committee from Donostia Hospital and met the current data protection law. Study participants remained anonymous at all times during the data transfer from the Ehunmilak ultradistance race organisation, identified only by alphanumerical codes.

The medical report consists of a printed form with various sections to be filled out. In addition to the relevant administrative data, they must provide information on the following parameters: allergies, AHT, DM, dyslipidaemia, smoking habits, weight, height, family history of ischemic heart disease, history of syncope due to physical exercise, usual treatment, resting heart rate and blood pressure. Furthermore, it is optional but recommended to provide information on completing an echocardiogram and stress test. This report must come with a 12-lead ECG carried out at rest.

The questionnaire sent to the participants requested information on their sporting experience (when they first took part in an ultramarathon, number of events in total, how many of them were completed and if they are currently doing physical exercise), training habits (weeks of rest per year, total training hours per week, hours of purely aerobic training per week, proportion of weekly training carried out over the anaerobic threshold, complementary strength training or other type, stretches and physiotherapy), medical examinations (frequency of medical check-ups, resting ECG, stress ECG and echocardiogram) and musculoskeletal and cardiovascular injuries suffered over the last two years (2019-2020).

The statistical analysis on the data uses the SPSS Statistics computer program, version 25. To analyse the numerical variables, descriptive statistics procedures were used (calculation of central trend and dispersion measurements and frequency calculations). Subsequently, the quantitative variables and their association were analysed using the Mann-Whitney U test and the categorical variables and their association using Chi-squared. A value of $p<0.05$ was considered statistically significant for all the analyses.

Results

113 patients were recruited who met the criteria to receive the questionnaire by mail. 68 sent their questionnaire back and 11 were excluded because it was not properly filled out. Finally, 57 patients were included in the study, of which 53 were men and 4 were women. The average sample member had the profile of a healthy runner described in other works:[10-12] 43.96 years old, normal weight with a Body Mass Index (BMI) of 23.31, 53 bpm and blood pressure of 120/70. Table 1 shows the distribution of the numerical variables in the study sample.

Table 2 presents the categorical variables, comparing them in 2017 and 2018, and shows the results from the questionnaire carried out in 2020. Regarding the medical report data, little variability was observed from one year to another, with small changes in the prevalence of allergies, smoking, dyslipidaemia and excess weight among others. The training habits showed that most athletes rest for ≤4 weeks a year (56.1%) and train between 8-13 hours a week (59.7%), and that cross training was usual (56.1% cycling, 63.2% strength and 61.4% stretching). Furthermore, a great tendency was observed to get medical check-ups, as the majority underwent a medical examination (91.2%), resting ECG (70.2%) and stress test (70.2%) every year.

No member of the sample mentioned that they had suffered cardiovascular injuries over the previous two years. Consequently, electrocardiographs were used to study the relationship of the different variables with possible cardiac damage. Although the changes in the ECG were initially compiled in three categories (normal, physiological alterations caused by the physical exercise and pathological), they were cut back to two categories to make the associations (normal and pathological). To identify pathological ECGs, guidelines were followed that were proposed by international consensus on interpreting the athlete's ECG, as a result of the consensus of experts in cardiology and sports medicine who met in Seattle (USA) in 2015.[46] In this way, as compiled in Table 3, using the Mann-Whitney U test, no relationship was observed between the different variables and the ECG. However, the relationship between the number of participants in ultramarathons and ECG was very close to the proposed level of statistical signification ($p=0.053$); given that the number of participations in the normal ECG group was 4.75±3.16, compared to 7.80±3.49 from the group with a pathological ECG.

Table 1. Distribution of the numerical variables in the study sample.

Medical certificate						
Variables	**N**	**N***	**Mean±SD**	**Median**	**Min.**	**Max..**
Current age (years)	57	0	43.96±8.63	44	29	67
Weight (Kg)	57	0	71.18±8.4	73	47	86
Height (cm)	57	0	174.6±7.59	174	155	193
BMI (Kg/m2)	57	0	23.31±2.04	22.91	18.94	29.41
Resting HR (bpm)	57	0	53.72±9.67	53	32	78
SBP (mmHg)	57	0	120.14±11.24	120	90	155
DBP (mmHg)	57	0	71.86±8.61	70	55	90
Questionnaire						
Variables	**N**	**N***	**Mean±SD**	**Median**	**Min.**	**Max.**
First participation	57	0	2015±2.43	2016	2010	2017
Participations in UM	57	0	5.02±3.28	4	0	14
No. of UM completed	57	0	3.46±3.34	2	0	13
Rest (weeks/year)	55	2	5.44±4.73	4	0	20
Weekly training over the AT (%)	48	9	14.88±10.63	11	0	50
Rest due to musculoskeletal injuries (weeks/year)	32	25	3.87±5.51	2	0	20
Rest due to cardiovascular injuries (weeks/year)	57	0	0±0	0	0	0

BMI: Body Mass Index; HR: Heart rate; SBP: Systolic blood pressure;
DBP: Diastolic blood pressure; UM: Ultramarathon; AT: anaerobic threshold; N: valid cases;
N*: non valid cases; SD: standard deviation

Table 2. Distribution of the qualitative variables (2017-2018) and questionnaire results (2020).

	Medical certificate				Questionnaire		
Año	**2017**		**2018**			**2020**	
Variables	**N**	**%**	**N**	**%**	**Variables**	**N**	**%**
Gender					**Participations**		
Male	53	93	53	93	1-4	32	56.1
Female	4	7	4	7	5-9	19	33.3
Age groups					≥10	6	10.5
<30	3	5.3	0	0	**Currently doing sport**		
30-39	16	28.1	17	29.8	Yes	57	100.0
40-49	26	45.6	24	42.1	No	0	0.0
50-59	9	15.8	13	22.8	**Reduction due to health**		
≥60	3	5.3	3	5.3	Yes	4	7.0
Allergies					No	53	93.0
Yes	3	5.3	6	10.5	**Weeks of rest/year**		
No	54	94.7	51	89.5	0-4	32	56.1
AHT					5-9	11	19.3
Yes	1	1.8	1	1.8	10-14	9	15.8
No	56	98.2	56	98.2	≥15	3	5.3
DM					**Total training/week**		
Yes	0	0.0	0	0.0	5-7	7	12.3
No	57	100	57	100	8-10	20	35.1
Dyslipidaemia					11-13	14	24.6
Yes	1	1.8	0	0.0	14-16	11	19.3
No	56	98.2	57	100	17-19	3	5.3
Smoking					≥20	2	3.5
Yes	6	10.5	3	5.3	**Aerobic training/week**		
No	51	89.5	54	94.7	5-7	15	26,3
BMI				8-10	20	35.1	
Low (<18.5)	0	0	0	0,0	11-13	13	22.8
Normal (18.5-24.9)	47	82.5	44	77.2	14-16	7	12.3
Overweight (24.9-29.9)	10	17.5	13	22.8	17-19	2	3.5
FHIHD					≥20	0	0.0
Yes	1	1.8	2	3.5	**Over aerobic threshold/week**		
No	56	98.2	55	96.5	0-5	9	15.8
FHSD					6-10	14	24.6
Yes	1	1.8	1	1.8	11-15	5	8.8
No	56	98.2	56	98.2	16-20	12	21.1
Syncope					21-25	4	7.0
Yes	0	0.0	0	0.0	26-50	4	7.0
No	57	100	57	100	**Cross training**		
MH					Static bike/strider	32	56.1
Yes	5	8.8	3	5.3	Strength	36	63.2
No	52	91.2	54	94.7	Stretching	35	61.4
Treatment					Others	8	14.0
Yes	6	10.5	4	7.0	Physiotherapy		
No	51	89.5	53	93.0	Normally no	24	42.1
Heart murmurs					Due to discomfort	17	29.8
Yes	0	0.0	0	0.0	Yes	16	28.1
No	57	100	57	100	**Frequency of medical checks**		
Echocardiogram					1year	52	91.2
Normal	48	84.2	42	73.7	2 years	2	3.5
PCDE	9	15.8	9	15.8	3 years	1	1.8
Pathological	0	0	0	0	≥ 4years	2	3.5
Stress test					**Frequency of resting ECG**		
Normal	13	22.8	11	19.3	No	2	3.5
PCDE	41	71.9	41	71.9	1 year	40	70.2
Pathological	0	0	0	0.0	2 years	6	10.5
ECG					3 years	0	0.0
Normal	15	26.3	18	31.6	≥ 4 years	9	15.8
CFIE	38	64.9	34	59.6	**Frequency of stress ECG**		
Patológico	5	8.8	5	8.8	No	7	12.3

(continúa)

Table 2. Distribution of the qualitative variables (2017-2018) and questionnaire results (2020) *(continue)*.

	Medical certificate				Questionnaire		
Year	2017		2018			2020	
Variables	N	%	N	%	Variables	N	%
Changes in ECG					1 year	40	70.2
IRBBB	19	33.3	20	35.1	2 years	5	8.8
ER	16	28.1	14	24.6	3 years	1	1.8
T wave alterations	19	33.3	6	10.5	≥ 4 years	7	7.0
LVH	8	14.0	13	22.8	**FFrequency of echocardiogram**		
ST+	4	7.0	0	0	No	29	50.9
BCRD	0	0	0	0	1 year	17	29.8
VC	0	0	0	0	2 years	6	10.5
WPW	1	1.8	1	1.8	3 years	1	1.8
CLBBB	1	1.8	0	0	≥ years	4	7.0
VAV 1º	1	1.8	0	0	**Musculoskeletal injuries**		
					Yes	30	52.6
					No	27	47.4
					Cardiological injuries		
					Yes	0	0.0
					No	57	100.0

N: cases; AHT: arterial hypertension; DM: diabetes mellitus; BMI: Body Mass Index; FHIHD: family history of ischemia heart disease; FHSD: family history of sudden death; MH: medical history; ECG: electrocardiogram; PCDE: physiological changes during exercise; IRBBB: incomplete right bundle branch block; ER: early repolarisation; VC: ventricular contraction; LVH: left ventricle hypertrophy; ST+: rise in the ST segment; WPW=Wolff-Parkinson-White; CLBBB: complete left bundle branch block; VAV 1º: first degree atrioventricular block.

Table 3. Relationship between the variables studied and the ECG.

Variables	Norma ECG n=52	Pathological ECG n=5	P
Age	43.37±8.50	38.80±9.98	0.351
BMI	23.34±2.07	23.01±1.90	0.832
Participations in ultramarathons	4.75±3.16	7.80±3.49	0.053
Ultramarathons completed	3.19±3.16	6.20±4.32	0.081
Weeks of rest/year	5.59±4.76	3.50±4.44	0.310
Total hours of training /week	11.19±3.57	11.80±5.22	0.826
Total hours of aerobic training /week	9.92±3.23	10.20±4.55	0.907
Training over anaerobic threshold(%)	14.98±10.93	13.75±7.50	0.985

52.6% of the sample mentioned that they had suffered a musculoskeletal injury over the previous two years. Using Chi-squared, no relation was observed between the qualitative variables studied and musculoskeletal injuries, as compiled in Table 4. However, as can be seen in Table 5, the Mann-Whitney U test showed a significant relationship between musculoskeletal injuries and two quantitative variables: BMI (p=0.004) and the proportion of weekly training over the anaerobic threshold (p=0.009). On the one hand, the average BMI for the injured group was 22.53±1.75 compared to 24.17±2.02 in the uninjured group.

Table 4. Relationship between the dichotomous qualitative variables and the musculoskeletal injuries.

Variable	Subgroup	Musculo-skeletal injuries Yes n=30	Musculo-skeletal injuries No n=27	P
Static bike/strider	Yes	18	14	0.536
	No	12	13	
Strength	Yes	20	16	0.563
	No	10	11	
Stretching	Yes	19	16	0.752
	No	11	11	
Physiotherapy	Yes	20	13	0.157
	No	10	14	

On the other hand, the average percentage of training carried out over the anaerobic threshold for the injured group was 18.04 ±10.42 compared to 11.71±10.06 in the uninjured group.

Discussion

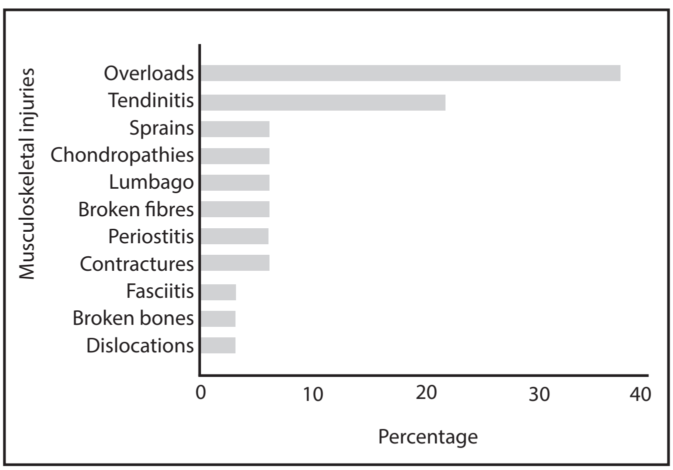
As described in the bibliography[10-12] and in the results section, it was observed that the athletes in the study sample were in good health. The injuries recorded in this cohort were musculoskeletal and mainly not very severe (Figure 1). Cardiovascular injuries were not objectified so ECGs were used to analyse this type of data.

Regarding whether the training habits of these runners might be considered healthy, considering the aforementioned recommendations

Table 5. Relationship between different variables and musculoskeletal injuries.

Variable	Musculo-skeletal injuries Yes n=30	Musculo-skeletal injuries No n=27	P
Age	43.83±8.47	42±8.86	0.620
BMI	22.53±1.75	24.17±2.02	0.004
Participations in ultramarathons	5.03±3.34	5±3.27	0.981
Ultramarathons completed	3.2±3.11	3.74±3.61	0.650
Weeks of rest/year	5.20±4.69	5.72±4.86	0.733
Total hours of training /week	11.37±3.81	11.11±3.61	0.817
Total hours of aerobic training /week	10.10±3.39	9.78±3.29	0.690
Training over anaerobic threshold(%)	18.04±10.42	11.71±10.06	0.009

Figure 1. Proportions of the different musculoskeletal injuries among the runners that suffer from them.



and that the sample's runners train for 10-11 hours (~600 minutes) a week on average and 72% of the sample trains between 5 and 13 hours per week (Figure 2), we can say that the training habits could mostly be considered healthy and not excessive.

Although there are opinions to the contrary, some authors have described a U-shaped dose-response relationship between physical exercise and cardiovascular risk.[38] With the ECGs available in this study, no relationship was seen between them and the study variables. In other words, it seems that the parameters that could be associated with excess physical activity (taking part in more races, resting for fewer weeks per year, training for more hours per week, that this training is purely aerobic, or a greater proportion of the training is over the anaerobic threshold) were not related to the risk of suffering cardiovascular

Figure 2. Proportions of the study sample according to the total weekly hours of training.

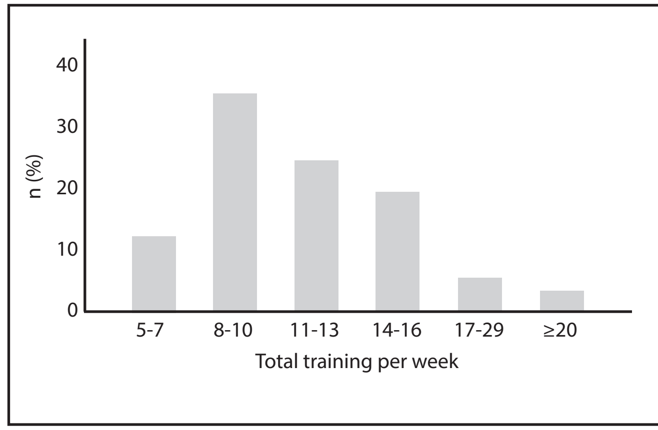


Figure 3. Comparison between the runners with a normal and pathological ECG, regarding the number of ultramarathons run.

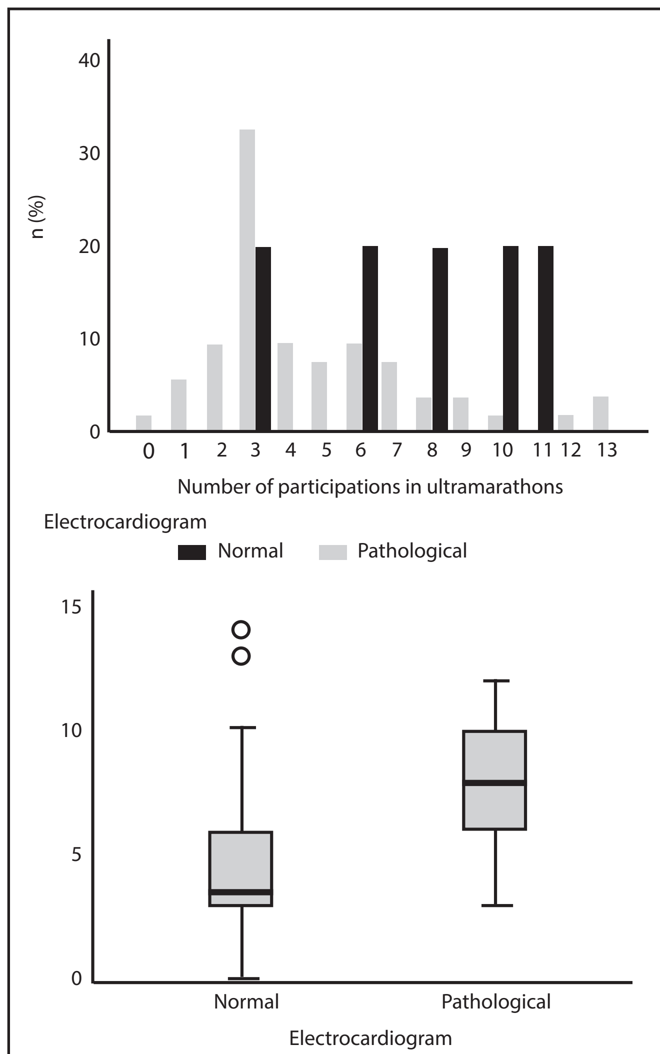


Figure 4. Comparison between the runners who suffer musculoskeletal injuries and those that do not, regarding the percentage of weekly training over the anaerobic threshold.

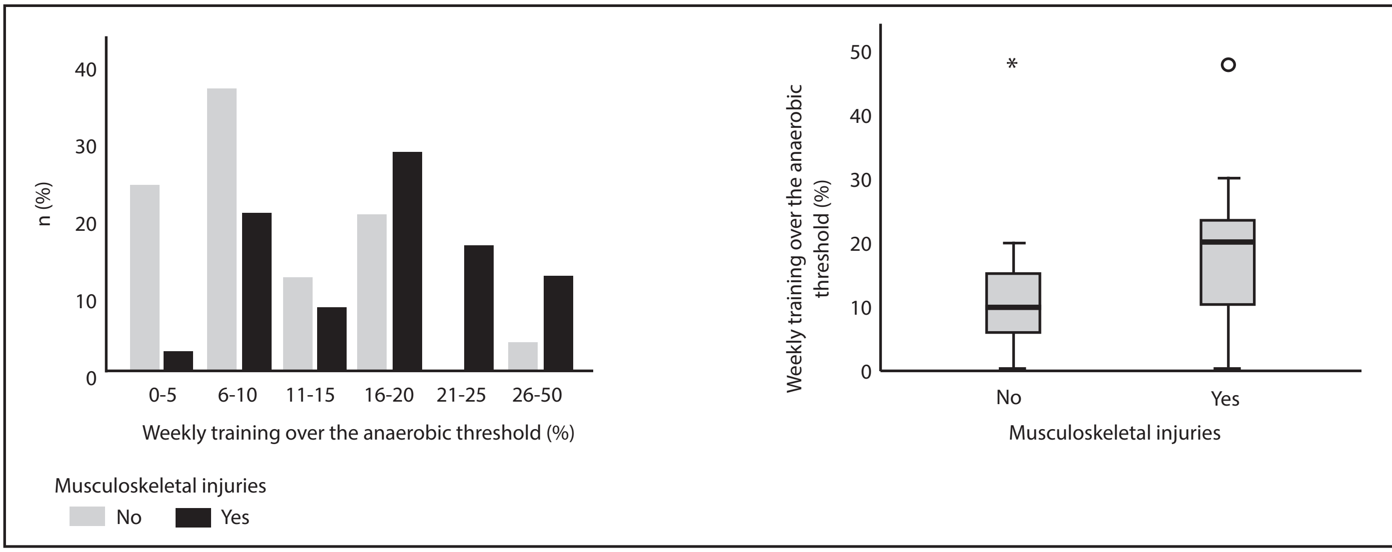
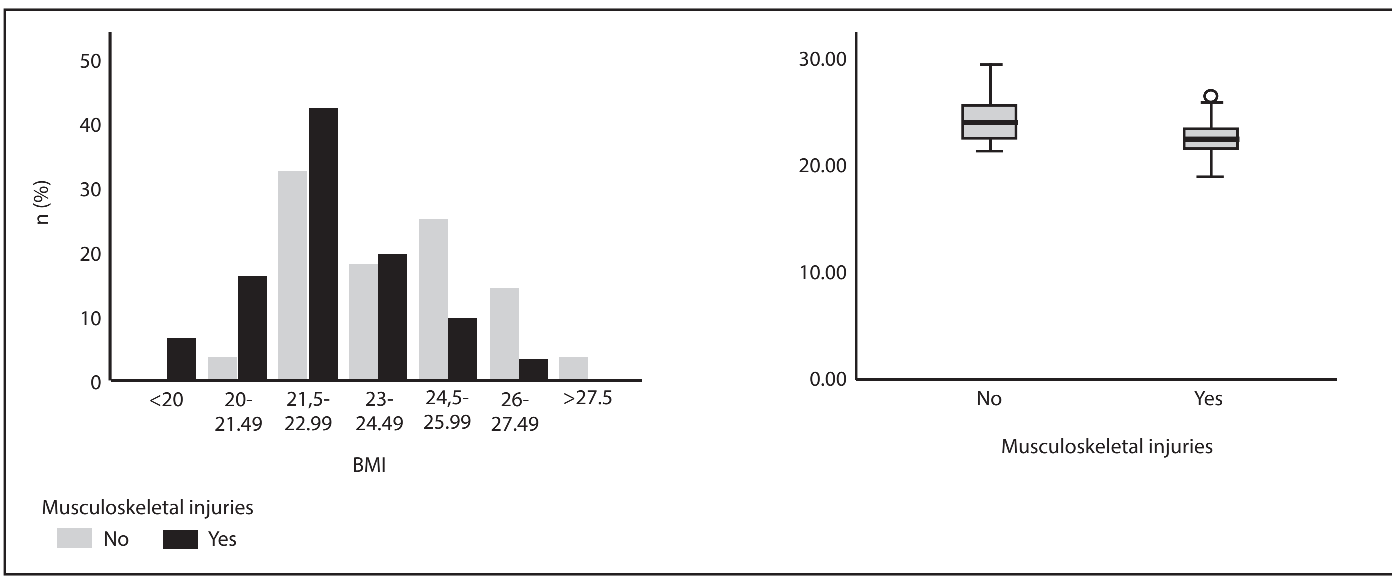


Figure 5. Comparison between the runners who suffer musculoskeletal injuries and those that do not, regarding the Body Mass Index.



damage. However, we should mention that, although it did not reach the proposed significance level, the relationship between the number of participations in ultramarathons and a pathological ECG was not far off (p=0.053). This trend might suggest a possible relationship between higher participation in races and developing a pathological ECG (Figure 3). This might be due to the stress represented by these extreme races inducing an acute phase reaction in the body, causing a rise in some biomarkers, among others, that suggest cardiac damage.[24]

The musculoskeletal system receives some of the worst strain in this type of athletes,[15-17,31-33] although the injuries are generally not severe.[47] In the sample used, no association was found between musculoskeletal complaints and most of the variables studied. However, in this case, two significant relationships were found: with the proportion of training over the anaerobic threshold (p=0.009) and with the BMI (p=0.004).

It seems that individuals who train over the anaerobic threshold in a higher proportion were more likely to suffer damage to the musculoskeletal system (Figure 4). In other words, it is possible that doing more high intensity training increases the risk. However, according to several authors, it is not only a higher intensity of physical exercise that increases this risk, but the total volume of physical exercise performed and with this the effect of interaction between the actual intensity, frequency and duration of the training.[48-50] Furthermore, although greater experience has been related to a smaller amount of damage in this type of race,[12,47] it has described that a more professional or competitive profile is more likely to suffer injuries compared to a more recreational profile.[51] Therefore, the participants with more competitive objectives might be the same athletes that train with greater intensity, thereby increasing the risk of a musculoskeletal issue.

Finally, a relationship was seen between the BMI and musculoskeletal injuries. Initially, it could be interpreted that it is logical for a higher BMI to increase the risk of damage to the musculoskeletal system and a lighter weight should act as a protective factor.[52-54] However, in the study cohort, the runners with lower BMI suffered more damage (Figure 5). This trend has also been described in other studies: a systematic review showed that there was some evidence to suggest that higher weight and a BMI > 26 could act as a protective factor against pathologies in the lower limbs in long distance runners.[55] It proposed that this relationship could be due to less activity during the training in the overweight group. Another study observed a different distribution of the musculoskeletal pathology in runners with different BMIs: it described fewer knee problems for overweight athletes, but a higher proportion of leg injuries.[56]

Conclusions

The ultradistance runners in the study demonstrated parameters that indicate a good state of health, plus healthy training habits in line with the latest WHO recommendations. Therefore, we could say that although the actual race is not risk-free and can be harmful, the lifestyle and the training habits required to be able to take part in a race with these characteristics can be considered as beneficial.

It was also stated that there was no relationship between the characteristics and physical exercise habits of this group and the risk of developing electrocardiographic disorders, although the relationship between the number of participations in ultramarathons and a pathological ECG was close (p=0.053), suggesting a possible association between these factors. Some studies have described that the stress represented by these extreme races induces an acute phase reaction in the body, and a rise in some myocardial damage markers.[24] Could it be that this situation, which is transitory in principle, might cause irreversible damage to the heart in the long term? As mentioned, this conclusion cannot be drawn from this study, although it might be interesting to investigate this relationship in the future.

The same occurs with the musculoskeletal issue, where no significant associations have been observed, except for those described between the musculoskeletal injuries and the training intensity (the proportion of training carried out over the anaerobic threshold), proposing the possibility that participants with more competitive objectives are the same athletes who train with greater intensity, thereby increasing the risk of musculoskeletal issues; and the BMI where, considering the sports habits among the study sample and that the formula for the BMI (weight/height*2) does not consider muscle mass, the hypothesis is proposed that a stronger, and therefore heavier, muscle is in this case the factor that protects the athlete from injury. Consequently, it would also be interesting to study this possible relationship in future works.

Although aware of its limitations, this work might be useful to ease the way for future studies in search of increasing the knowledge which is still limited around the participants of this sporting discipline, as there are still more questions than answers on this topic. What will happen with these athletes in the future? Will there be considerable long-term damage?

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Conflict of interest

The authors do not declare a conflict of interest.

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