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ORIGINAL

PREVALENCE OF ELECTROCARDIOGRAPHIC ALTERATIONS IN ATHLETES ASSOCIATED WITH CARDIOVASCULAR RISK PARAMETERS

PREVALENCIA DE ALTERACIONES ELECTROCARDIOGRÁFICAS EN DEPORTISTAS ASOCIADAS A PARAMETROS DE RIESGO CARDIOVASCULAR

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ABSTRACT

Sport induces cardiac adaptations that are manifested with specific electrocardiographic alterations. This study was carried out in view of the need to identify the relationship between these electrocardiographic alterations with cardiovascular and demographic variables and physical exercise performed. **Methodology:** a descriptive cross-sectional study in 370 individuals, 211 men and 159 women (36 ± 13 years) that were distributed in three groups: male athletes, female athletes, and non-athlete men and women. **Results**: 51.08% of the studied subjects presented electrographic alterations, more frequent in athletes. Demographic and cardiovascular variables and the time of physical exercise performed were significantly associated with certain electrocardiographic alterations; the risk of presenting any of the alterations in athletes could be estimated based on the variables set out. **Conclusion**: There are associations between specific electrocardiographic alterations and cardiovascular, demographic and type of exercise variables that could classify athletes according to cardiovascular risk profiles.

KEY WORDS: Sports medicine, medical examinations, risk factors, electrocardiogram, cardiovascular risk.

RESUMEN

El deporte induce adaptaciones cardiacas que se manifiestan con alteraciones electrocardiográficas. Este estudio se realizó ante la necesidad de identificar la relación existente entre estas alteraciones electrocardiográficas con variables cardiovasculares, demográficas y tiempo de ejercicio físico. **Metodología**: estudio descriptivo trasversal en 370 individuos, 211 hombres y 159 mujeres (36 ±13 años) que se distribuyeron en tres grupos, hombres deportistas, mujeres deportistas, y hombres y mujeres no deportistas. **Resultados**: El 51,08% de los sujetos estudiados presentaron alteraciones electrográficas, siendo más frecuentes en deportistas. Determinadas alteraciones electrocardiográficas en deportistas; se asociaron significativamente a las variables planteadas pudiendo estimar el riesgo de presentar alguna de las alteraciones electrocardiográficas en función de estas variables. **Conclusión:** Existen asociaciones entre alteraciones electrocardiográficas y variables cardiovasculares, demográficas y tiempo de ejercicio realizado que podrían clasificar a los deportistas según perfiles de riesgo cardiovascular.

PALABRAS CLAVE: Medicina deportiva, exámenes médicos, factores de riesgo, electrocardiograma, riesgo cardiovascular.

1. INTRODUCTION

The search for knowledge about the characteristics of the athlete's heart (Bazan & Colacilli, 2014) has led to the affirmation that sport induces a series of physiological, morphological and functional adaptations on the cardiovascular system that in many athletes manifest themselves with specific electrocardiographic alterations(Gómez-Puerto et al., 2011; Uberoi et al., 2011). However, little research has been done to date on the relationship of these electrocardiographic findings to the gender and age of the athletes, time and type of physical exercise performed or to cardiovascular and anthropometric variables included in the medical examinations prior to sports practice (Consejo Superior de Deportes, 2011; Fernando Yáñez, 2012; Moreno Pascual, 2012). Hence, a study was designed with the aim of finding out the prevalence of specific electrocardiographic alterations found in athletes in a specific type of physical exercise and to analyse their relationship with demographic variables, cardiovascular variables and the time of physical exercise performed**.**

2. METODOLOGY

2.1 Study design and population

A descriptive cross-sectional study was performed. The study population consisted of male and female athletes aged between 18 and 65 years, who met the selection criteria and who came for a medical examination for sports practice, in two study areas: professionals of the Spanish Armed Forces and athletes of the Atlético de Madrid women's football team. Data collection was conducted over 12 months.

2.2 Selection criteria

All subjects who met the following inclusion criteria were included in the study: 1) Persons of both genders aged 18-65 years who agreed to participate in the study. 2) Based on WHO (Organización Mundial de la Salud, 2010) recommendations, subjects were considered "athletes" if they met the criterion of doing at least 150 minutes of sport per week at the time of the study and in the six months prior to the study, in sports with a high dynamic and low static component. Men who met these criteria were assigned to group 1 (male athletes) and women to group 2 (female athletes). 3) Men and women who did not meet the above criteria in their sport were assigned to group 3 "non-athletes". People were excluded from the study if they had cardiovascular disease or other pathologies in acute phase, under study or not stabilised, and pregnant women were not selected.

2.3 Sample size

Considering an estimated prevalence of 80% of electrocardiographic abnormalities in athletes reported in the literature (Boraita Pérez & Serratosa Fernández, 1998; Pelliccia et al., 2000), a random sample of 274 individuals was sufficient to estimate with a confidence of 95% and a precision of +/- 5 percentage units. The expected replacement rate was 10%.

2.4 Sampling and recruitment

Participants (n=370) were recruited through a non-probability consecutive sampling technique. Subjects were selected according to the inclusion criteria as they underwent sports medical examinations in the corresponding health services. The men, professionals in the armed forces of the three armies and different destinations, who fulfilled the criteria to be considered athletes constituted group 1 "male athletes" (n=175). Female footballers who met the criteria to be considered athletes made up group 2 "female athletes" (n=123). In order to reduce the variability between the two groups of athletes by the type of sport performed, it was found that in both groups (1 and 2) the subjects performed sports with a high dynamic and low static component, according to Mitchel's classification (Mitchell et al., 2005). Group 3 "non-athlete men and women" (n=72) consisted of men from the professional armed forces and women footballers who did not meet the criteria for sporting practice.

2.5 Study variables

The dependent variables under study were the electrocardiographic findings found in the individuals in the sample. Data were also collected from all subjects and considered as independent variables (see table 1).

Table 1. Dependent and independent variables

	ELECTROCARDIOGRAPHIC ALTERATIONS
DEPENDENT VARIABLES	PACE DISORDERS: Sinus bradycardia (SB) HB<60, Regular rhythm P wave, QRS normal PR Interval. Sinus arrhythmia (SA): 60>HB<100, Irregular rhythm, irregular relative risk interval, P-wave, QRS normal PR interval. ATRIOVENTRICULAR CONDUCTION DISORDERS: First degree atrioventricular block (AV block) Normal HR, regular rhythm, P wave and QRS normal, PR interval >0.20 sec. VENTRICULAR CONDUCTION DISTURBANCES: Nonspecific ventricular conduction delay (NRCVD or IRBBB grade I): QRS normal size (up to 110 ms). Normal axis, QRS notches in V1, V2 and leads II, III and to VF. Incomplete right bundle branch block (IRBBB grade II): Narrow QRS (110-119 ms), rSr' waves in V1 V2. Axis>90º. EARLY REPOLARISATION: ST elevation (STELE): ST elevation >/2mm (J-point) ≥0.1mm Inverted T-wave (ITW): Inverted >/1mm in two or more leads
INDEPENDENT VARIABLES	1. DEMOGRAPHIC VARIABLES: Age (years) Gender (male, female) 2. PHYSICAL ACTIVITY: Exercise time (minutes/week) Type of physical exercise performed (dynamic, static) 3. CLINICAL VARIABLES: 3.1 Cardiovascular background: History of syncope (yes/no) 3.2 Body composition parameters: Body fat mass (BFM in Kg.) Fat free mass (FFM in Kg.). 3.3 Cardiovascular parameters: Heart rate (HR in beat/min) Systolic blood pressure (SBP in mmHg) Diastolic blood pressure (DBP in mmHg)

2.6 Data collection

Before starting the data collection, they were informed of the study, given the informed consent form and were given an appointment on a later day, indicating that they should come in a basal state (fasting, after having urinated, without having done any physical exercise in the 12 hours prior to the measurements). On the second day, the first data collected were obtained from the clinical history; age, gender, history of syncope, time and type of weekly physical exercise performed. Next, a physical examination was performed to obtain cardiovascular parameters; heart rate (HR), heart rhythm, systolic blood pressure (SBP), diastolic blood pressure (DBP) and body composition parameters; body fat mass (BFM) and fat free mass (FFM).

2.7 Method

The entire physical examination was performed with the patient barefoot and in underwear. Following the recommendations of the Spanish Group of Cineanthropometry (GREC) (Sillero Quintana, 2005), weight was measured in kg and height in cm. From these data, together with age and gender, body composition was estimated by electrical bioimpedance (Alvero-Cruz et al., 2011), obtaining the data of BFM and FFM. Subsequently, following current protocols (Aparicio Torres et al., 2012), a 12-lead EKG was performed at rest, and the heart rate and rhythm were obtained from the electrocardiographic recording. Following the recommendations of the European Heart Association (Sharma et al., 2017) for the interpretation of the electrocardiogram in athletes, the existence of electrocardiographic alterations was determined. The last diagnostic procedure performed was the measurement of blood pressure by auscultatory method (Mancia et al., 2013).

2.8 Statistical analysis

Categorical variables were expressed as frequencies and percentages. Differences in the percentage distribution of these variables were analysed using the chi-square (χ^2) test or Fisher's exact test as appropriate. Continuous variables were described as mean ± standard deviation and tested for normal distribution with the Kolmogorov-Smirnov test in order to apply the appropriate parametric or non-parametric tests (t-Student if the variable follows a normal distribution and Mann-Whitney U test otherwise).

Logistic regression analysis was used to estimate the risk of the appearance of electrocardiographic abnormalities according to those variables that in the bivariate analyses had shown statistical significance and/or were of special clinical relevance. The odds ratio indicating this risk adjusted for age and gender were presented. For all tests the statistical significance value $p<0,05$ (bilateral) was considered. Significant differences were assumed at α values of 5%, i.e. $p<0,05$ for a 95% confidence interval. Data were analysed by the IBM SPSS Statistics 25 statistical package.

3. RESULTS

3.1 A descriptive analysis of the variables studied in the different study groups

The study included 370 subjects, 211 men and 159 women, with a mean age of 36 ±13 years, establishing three evaluation groups; group 1: male athletes (n=175), group 2: female athletes (n=123), group 3: male and female non-athletes (n=72). The characteristics of the participants in the different study groups are shown in table 2.

Table 1. Characteristics of the participants. Values are expressed as mean and standard deviation. Contrast test: Mann-Whitney U test *Values of p<0.05 are statistically significant.

	NON-ATHLETES	ATHLETES		ATHLETES		
				MEN	WOMEN	
Participants	72	298	p	175	123	p
Age (years)	46 ± 9	34 ±12	0.000	40 ±11	26 ± 9	0.000
BFM (Kg.)	12.7±8.4	1.4 ±4.9	0.000	2.3±5.2	0.0±4.1	0.000
FFM (Kg.)	6.9±6.4	4.6±5.4	0.001	6.4±5.8	2.0±3.6	0.000
HR (beat/min)	68.1±9.2	56.5±8.7	0.000	55.4±9.1	58.1±7.9	0.002
SBP (mmHg)	122.9±14.9	112.7±13.9	0.000	116.6±12.9	107.3±13.6	0.000
DBP (mmHg)	77.3±8.8	67.7±9.1	0.000	70.8±8.4	63.2±8.2	0.000
Ex. Time (min/week)	0.0	266.5±119.9	0.000	227.0±100.4	322.8±123.2	0.000

BF (body fat), FFM (fat-free mass), HR (heart rate), SBP (systolic blood pressure), DBP (diastolic blood pressure), Ex. Time (weekly exercise time in minutes/week)

3.2 Electrocardiographic alterations in the different groups studied

Electrocardiographic abnormalities were present in 51.1% (n=370) of the subjects evaluated, with a higher prevalence in the athlete group (61.7%) than in the "non-athletes" (9.7%) (p<0.05). In "athletes" a higher presence of electrocardiographic alterations was observed in "female athletes" 63.40% (n=123) compared to "male athletes" 59.42% (n=175) (p<0.05). When comparing the results of gender-specific electrocardiographic abnormalities, sinus arrhythmia (SA), non-specific right ventricular conduction delays (NRVCD) and inverted T-wave (ITW) are more frequent in female athletes (p<0.05), while incomplete right bundle branch block (IRBBB) and ST elevation (STELE) are more frequent in males (p<0.05) (see table 3).

Table 3. Electrocardiographic alterations specific to the gender of the athlete. Values are expressed as absolute frequency and percentage. Chi-square (χ^2) test *: Values of p<0.05 are statistically significant.

ELECTROCARDIOGRAPHIC ALTERATIONS		FEMALE ATHLETE (N=123)		MALE ATHLETE (N=175)		P VALUE
		n	%	n	%	
SB	Yes	76	61.8	121	69.1	
	No	47	38.2	54	30.9	0.214
IRBBB	Yes	4	3.3	21	12.0	
	No	119	96.7	154	88.0	0.010*
AV Block	Yes	2	1.6	10	5.7	
	No	121	98.4	165	94.3	0.131
NRVCD	Yes	30	24.4	9	5.1	
	No	93	75.6	166	94.9	0.001*
SA	Yes	39	31.7	11	6.3	
	No	84	68.3	164	93.7	0.001*
ITW	Yes	9	7.3	3	1.7	
	No	114	92.7	172	98.3	0.032*
ST ELEV.	Yes	2	1.6	12	6.9	
	No	121	98.4	163	93.1	0.001*

*SB (sinus bradycardia), SA (sinus arrhythmia), AV Block (first degree atrioventricular block), IRBBB (incomplete right bundle branch block), NRVCD (non-specific right ventricular conduction delays), ST ELEV. (ST elevation), ITW (inverted T-wave). Values are expressed as absolute frequency and percentage. Chi-square test. *: Values of p<0.05.*

3.3 Factors involved in the electrocardiographic parameters observed in athletes

When analysing the results of the bivariate analysis, we observed that each specific electrocardiographic abnormality in athletes was associated with different factors (see table 4).

Table 4. Factors associated with electrocardiographic abnormalities observed in athletes. Values are expressed as mean and standard deviation. Contrast test: Mann-Whitney U test *Values of p<0.05 are statistically significant.

EKG ALTERATIONS		%	EX. TIME MIN/WEEK	HR BEAT /MIN	SBP MMHG	DBP MMHG	BF KG	FFM KG	AGE YEARS	HISTORY SYNCOPE
SB	YES	66.10	291.4±111.5*	51.5±5.1*	110.6±13*	66.6±8.1*	0.3±4.4*	4.8±5.5	34 ±12	1.5%
	NO	33.9	218.0±67.3	66.2±5.6	116.9±14.8	70.5±8.5	3.5±5.2	4.1±5.3	35 ±13	4%
SA	YES	16.77	362.6±79.3*	55.3±6.1	107.7±11.2*	64.3±5.7*	-0.3±4.0*	2.1 ± 4.8*	23 ± 5 *	0.0%
	NO	83.23	247.1±94.5	56.7±9.2	113.8±14.2	68.4±9.6	1.7±5.0	5.1. ± 5.4	36 ±12	2.8%
AV Block	YES	4.19	312.5±100.8	54.6±7.7	118.8±14.8	71.7±9.1	1.3±5.4	8.0 ± 5.7*	42 ± 11 *	0%
	NO	95.81	264.6±117.4	56.6±8.8	112.5±13.9	67.5±9.1	1.4±4.9	4.4 ± 5.4	33 ± 12	2.4%
IRBBB	YES	8.38	288.4±92.5	52.0±7.7*	114.3±15.6	66.8±6.6	0.8±4.0	5.7 ± 3.7	36 ± 12	4%
	NO	91.62	264.5±112.1	56.9±8.7	112.6±13.8	67.8±9.3	1.4±5.0	4.5 ± 5.5	34 ±12	2.2%
NRVCD	YES	13.08	375.9±75.7*	55.7±6.9	106.4±12.8*	62.7±11.3*	0.0±3.3	3.0±3.8	24 ± 7 *	0%
	NO	86.2	250.0±96.7	56.6±9.0	113.7±13.9	68.4±8.6	1.6±5.1	4.8±5.6	35 ±12	2.7%
STELE	YES	4.69	278.6±112.7	55.8±11.1	114.3±11.4	67.9±7.3	1.1±3.8	7.1±5.2*	40 ±12	14.3% *
	NO	95.1	265.9±104.4	56.5±8.6	112.7±14.1	67.7±9.2	1.4±4.9	4.5±5.4	34 ±12	1.8%
ITW	YES	4.02	348.3±125.8*	55.8±8.0	112.5±19.9	63.8±9.1	-1.5±3.6*	2.6±6.0	27 ± 10*	0.0%
	NO	95.98	263.1±108.7	56.5±8.8	112.8±13.7	67.9±9.1	1.5±4.9	4.7±5.4	35 ±12	2.4%

SB (sinus bradycardia), SA (sinus arrhythmia), AV Block (first degree atrioventricular block), IRBBB (incomplete right bundle branch block), NRVCD (non-specific right ventricular conduction delays), ST ELEV. (ST elevation), ITW (inverted T-wave). Values are expressed as n (%) or mean ± standard deviation.

Sinus bradycardia (SB) was present in 66.10% (n=298) of the "athletes" studied and was associated with longer exercise time and lower BFM, SBP and DBP (p<0.05). The second most frequent finding was respiratory sinus arrhythmia (SA), 16.77% (n=298) of which were present. Like SB, it was significantly related to athletes with longer exercise times and lower BFM, FFM, SBP, DBP, but significantly more frequent in younger athletes (p<0.05). First degree atrioventricular block (AVB1) occurred in only 4% (n=298) and was associated with older athletes with higher FFM (p<0.05). Incomplete right bundle branch block (IRBBB) was present in 8.38% of the "athletes" (n=298), with only a significant association with lower HR (p<0.05). The presence of non-specific right ventricular conduction delay (NRVCD) was present in 13.08% (n=298). It was significantly more frequent in younger "athletes" with higher exercise times and lower SBP, DBP ($p<0.05$). ST elevation was present in 4.69% (n=298) of them. This finding only showed a significant association with " athletes" with higher FFM and a history of syncope ($p<0.05$). The 4.02% (n=298) presented inverted T-wave (ITW) being significantly ($p<0.05$) more frequent in younger athletes, with longer exercise times and lower MG figures.

3.4 Estimation of the risk of presenting electrocardiographic alterations in athletes according to the variables proposed

Using logistic regression analysis, we analysed whether the independent variables (exercise time, HR, SBP, DBP, BFM, FFM, history of syncope) increased the probability of an "athlete" presenting any of the electrocardiographic abnormalities. It was observed that only some of them were presented as risk factors or protective factors for the presence of the electrocardiographic alterations found (see table 5).

Table 5. Estimation of the risk of electrocardiographic alterations in athletes according to the variables considered. 95% CI: 95% confidence interval, aOR: adjusted odds ratio by age and gender. *Values of p<0.05 are statistically significant.

EKG ALTERATIONS		EX. TIME MIN/WEEK	HR BEAT/MIN	SBP MMHG	DBP MMHG	BFM KG	FFM KG	H. SYNCOPE
SB	OR	1.60 (1.35-1.89) *	0.41 (0.31-0.53) *	0.66 (0.54-0.81) *	0.42 (0.28-0.62) *	0.85 (0.80-0.90) *	1.02 (0.97-1.07)	0.44 (0.09-2.08)
SA	OR	1.24 (0.97-1.59)	0.96 (0.92-1.019)	1.00 (0.76-1.31)	1.11 (0.65-1.90)	0.98 (0.90-1.06)	0.94 (0.87-1.03)	0.00 (0.00-…)
AV Block	OR	1.72 (1.17-2.53) *	0.97 (0.91-1.04)	1.16 (0.75-1.80)	1.18 (0.55-2.54)	0.96 (0.85-1.09)	1.08 (0.97-1.19)	0.00 (0.00-…)
IRBBB	OR	1.33 (1.03-1.72) *	0.94 (0.89-0.99) *	0.97 (0.70-1.35)	0.63 (0.37-1.06)	0.95 (0.87-1.04)	1.00 (0.93-1.08)	1.98 (0.21-18.73)
NRVCD	OR	1.54 (1.14-2.07) *	0.98 (0.93-1.03)	0.88 (0.65-1.19)	1.06 (0.60-1.87)	0.97 (0.89-1.06)	1.04 (0.95-1.13)	0.00 (0.00-…)
ST ELEV	OR	1.32 (0.95-1.83)	1.00 (0.94-1.07)	0.89 (0.58-1.39)	0.64 (0.32-1.26)	0.95 (0.85-1.07)	1.04 (0.95-1.15	7.72 (1.17-50.96) *
ITW	OR	1.31 (0.86-2.00)	0.98 (0.91-1.06)	1.24 (0.82-1.89)	0.73 (0.31-1.76)	0.087 (0.77-1.02)	0.98 (0.85-1.13)	0.00 (0.00-…)

SB (sinus bradycardia), SA (sinus arrhythmia), AV Block (first degree atrioventricular block), IRBBB (incomplete right bundle branch block), NRVCD (non-specific right ventricular conduction delays), ST ELEV. (ST elevation), ITW (inverted T-wave).

According to the results, an athlete's risk of SB increased with the duration of weekly physical exercise performed, such that increases of one hour/week increased the risk of SB by 1.60 times (95% CI=1.35-1.89). However, reductions in BFM, SBP and DBP were presented as "protective" factors for this alteration, such that reductions of 1kg/m of BFM increased the risk of SB by 1.77 (95% CI=0.80-0.90) times. A 1cm Hg reduction in SBP increased the risk by 1.55-fold (95% CI=0.54 -0.81) and a 1cm Hg reduction in DBP increased it by 2.38-fold (95% CI=0.28 -0.62). Considering these data, the risk of first degree atrioventricular block was only increased by the duration of physical exercise performed. Thus, increases of one hour/week increased the risk of first degree atrioventricular block by 1.72 times (95% CI=1.17-2.53). Similarly, the risk of IRBBB also increased with exercise duration, for every one hour/week increase, the risk increased 1. 33 times (95% CI 1.03-1.72). However, decreases in HR behaved as a protective factor, for every one bpm decrease in HR, the risk of IRBBB was increased 1.06 times (95% CI=0.89 -0.99).

Based on the results, the risk of NRVCD was only increased by the duration of exercise, one hour/week increments increased the risk of this finding by 1.54 times (95% CI: 1.14-2.07). An interesting finding is that the risk of ST elevation was observed to be 7.72 times higher in those individuals who had a history of syncope during exercise (95% CI: 1.17 - 50.96). No significant risks of SA or ITW could be established according to the different variables.

4. DISCUSSION

Existing studies and literature on the different electrocardiographic alterations linked to sport provide sufficient evidence on the characteristics and frequency of presentation of these patterns in large populations of athletes. However, there is little research on the presence of these electrocardiographic alterations according to gender, age and simple to measure clinical variables that form part of the routine screening performed in the health examinations of athletes. The uniqueness of this research is based on these bases. The data obtained in the present study are consistent with those shown in other studies that associate the presence of electrocardiographic abnormalities with sport (Chandra et al., 2014). It was therefore logical that we found a much higher frequency of findings in "athletes" compared to "non-athletes" in our sample. The electrocardiographic alterations according to the gender of the athlete showed a higher frequency of findings in "female athletes" compared to "male athletes", contrary to what has been described in various studies (Boraita Pérez & Serratosa Fernández, 1998; Pelliccia et al., 2000) which, although scarce, find a greater presence of electrocardiogram alterations in "male athletes". We observed that the " female athletes" in our study had significantly longer exercise times than the men, which would justify the greater presence of electrocardiographic alterations in the women of our study linked to the practice of sport (Andre & III, 2019).

In relation to the BS of the athlete, several mechanisms are responsible, but fundamentally it is due to an increase in vagal tone in relation to the sympathetic tone that physical exercise provokes (Calderon et al., 2020). Recent research supports the influence of the parasympathetic nervous system on reductions in BFM (Molfino et al., 2009). It is a known fact that obesity is associated with increases in BP (Artham et al., 2009; Horwich et al., 2001), therefore, reductions in MG could be associated with reductions in BP, a circumstance that supports our research by observing that the risk of SB in the athletes in our sample increased with the reduction of both parameters; BP and BFM, both of which are protective factors for BS. As for differences between the genders, it has been previously reported that SB is more frequent in male athletes (Boraita Pérez & Serratosa Fernández, 1998; Pelliccia et al., 2000), which could be partly explained by the absence of oestrogenic action in them. On the other hand, oestrogens in women would favour the tendency to present elevated HR (Bernal & Moro, 2006). However, in the present study, no significant differences were found for the presence of SB between male and female athletes. This contrary data may be due to the fact that the women in this study had significantly longer exercise times, which could be conditioning the presence of HR similar to theirs. These data are compatible with the idea that sports practice generally reduces HR figures in both men and women. However, given that women are more likely to have higher HR, it would be necessary for them to spend more time exercising in order to achieve the physiological reduction in HR associated with sport. Therefore, SB was profiled in men and women of any age, with high exercise times as the only risk factor that would in turn condition body composition characteristics and cardiovascular parameters (AKYOL et al., 2020).

SA in "athlete" was significantly associated with the same covariates as SB. It occurred in individuals with the same trends in body composition and cardiovascular risk parameters, with lower MG and BP. This could be explained by a common causal factor; vagal hypertonia mediated by prolonged exercise in both findings (Drezner et al., 2013). However, SA occurred more frequently in "young female athletes", with our sample behaving in the same way as in other studies (Drezner et al., 2013; Nieto-Jimenez et al., 2020; Sofi et al., 2008). We are therefore faced with an electrocardiographic alteration associated with the time of physical exercise performed, which will be profiled in an individual with common typological characteristics and cardiovascular parameters similar to athletes with SB, but with a different feature, the influence of female gender and age in its presentation. ASR in "athlete" was significantly associated with the same covariates as SB. It occurred in individuals with the same trends in body composition and cardiovascular risk parameters, with lower BFM and BP. This could be explained by a common causal factor; vagal hypertonia mediated by prolonged exercise in both findings (Drezner et al., 2013). However, SA occurred more frequently in "young female athletes", with our sample behaving in the same way as in other studies (Drezner et al., 2013; Nieto-Jimenez et al., 2020; Sofi et al., 2008). We are therefore faced with an electrocardiographic alteration associated with the time of physical exercise performed, which will be profiled in an individual with common typological characteristics and cardiovascular parameters similar to athletes with SB, but with a different feature, the influence of female gender and age in its presentation.

In relation to AV Block, some studies point to a higher frequency of atrioventricular conduction disorders in the form of AV Block in male athletes (Gómez-Puerto et al., 2011). The presence of AV Block in relation to gender showed no differences in the individuals in our sample. Other studies (Bernal & Moro, 2006) have also found no differences. This variability with respect to gender in different investigations can be explained by the fact that the appearance of AV Block is subject to high physical training, but with an individual susceptibility to the presence of AV Block (Boraita Pérez & Serratosa Fernández, 1998). Thus, AV Block could be profiled in male and female athletes with high exercise times as a risk factor, but its presence could depend on the individual susceptibility of the athlete. Ventricular conduction disturbances, depending on the ECG changes present, are classified by some authors (Gómez-Puerto et al., 2011) as incomplete right bundle branch block (IRBBB) and non-specific right ventricular conduction delays (NRVCD). Our findings are compatible with those shown by other studies (Gómez-Puerto et al., 2011), and highlight that IRBBB is more frequent in male athletes. These results may be explained in part by the fact that in men, as a consequence of sports practice, an increase in concentric right ventricular mass may occur, leading to a delay in depolarisation (Nieto-Jimenez et al., 2020). This is a characteristic feature of athletes in disciplines with a high dynamic component (Susano et al., 2014), as is the case in our research. This type of exercise in turn causes low heart rates, which could be the cause of possible ventricular block in the form of incomplete right bundle branch block (Langdeau et al., 2001). Thus, IRBBB could be seen in male athletes, with high exercise times as a risk factor that could be associated with an increase in concentric ventricular mass and low heart rates, both of which are the cause of this characteristic finding in male athletes. Apart from the higher frequency of IRBBB in men our study revealed a significant association so far little studied; NRVCD as a "female athlete" specific disturbance. This fact can be explained by research that points to the presence of dents in the QRS but with normal duration of the complex and normal axis in women even in situations of ventricular hypertrophy (Bernal & Moro, 2006) associated with the eccentric growth of the ventricular mass that physical exercise causes in them, so this finding could be profiled in female athletes, with high physical exercise times as a risk factor for the presence of this finding. We are therefore faced with electrocardiographic alterations in IRBBB and NRVCD that are representative of the same electrical phenomenon in the heart, ventricular conduction disorders, with a common cause: morphologically unequal ventricular growth determined by gender, which causes different electrocardiographic alterations.

Finally, early repolarisation disorders in the electrocardiographic forms of ST-elevation and inverted T-wave occurred in different athlete profiles. ST elevation was found in a male athlete, with a higher FFM, a typical feature of male dimorphism (Gil Gómez & Verdoy, 2011), but it was not associated with high exercise times. The only risk factor found that determined the presence of this alteration was the risk of having suffered syncope during sports practice. Syncope in "male athletes" may be the symptom that reveals mainly cardiac pathologies, which in most cases are the origin of sudden cardiac death (González Armengol et al., 2011). Recent research points to a "non-benign" phenomenon of early repolarisation (Pellizzón & Gonzalez, 2012), observing associations of ST elevation with patients who presented idiopathic ventricular fibrillation in young male individuals and without cardiac structural alterations (Derval et al., 2011; Jurado Román et al.). The fact that the individuals in our study with a history of syncope had this electrocardiographic abnormality supports the most recent lines of research linking young male athletes with a history of syncope to the presence of ST elevation. These aspects could be associated with a potential risk of idiopathic ventricular fibrillation which has been identified as a cause of sudden cardiac death. Therefore, this finding could be a presentation of early repolarisation not associated with sports practice but predictive of possible cardiac pathology. On the other hand, ITW was found in young female athletes, with high exercise times, which led to lower levels of BFM. Very recent studies confirm the presence of this finding as a particular feature of " female athletes" due to the eccentric distribution that the increase in ventricular mass presents in them (Pelliccia & Adami, 2017). If ventricular depolarisation is slower, giving typical electrocardiographic features such as those mentioned above in the form of non-specific ventricular conduction delays, it is logical to think that ventricular repolarisation presents electrocardiographic alterations in these cases. This alteration, representative of the same event, early repolarisation, could however be profiled in female athletes associated with the characteristics of cardiac adaptation of women to physical exercise, but not with pathological processes.

5. CONCLUSION

The prevalence of electrocardiographic alterations in athletes is high, and is significantly associated with age, gender, time spent exercising and cardiovascular variables. Sports medical evaluations make it possible to identify these factors and classify athletes according to cardiovascular risk profiles with the aim of preventing sudden death in athletes.

REFERENCES

AKYOL, O., CEYHAN, T., & CAPAPÉ, C. (2020). The second record of marlin sucker, Remora osteochir (Echeneidae) from the Turkish waters (eastern Mediterranean Sea). *FishTaxa*, *17*, 12-14.

Alvero-Cruz, J., Correas Gómez, L., Ronconi, M., Fernández Vázquez, R., & i Manzañido, J. (2011). La bioimpedancia eléctrica como método de estimación de la composición corporal: normas prácticas de utilización. *Revista Andaluza de Medicina del Deporte*, *4*(4), 167-174.

Andre, R., & III, R. C. D. (2019). Acute Type B Dissection. *Vascular & Endovascular Review*, *2*(1).

Aparicio Torres, M., Florez Almonacid, C. I., Galván Ledesma, J., Lara Lara, D., Pérez Lorente, I., & Repullo Leiva, D. (2012). Realización de un electrocardiograma. *Hospital Universitario Reina Sofía Córdoba, Dirección de Enfermería. coord. Manual de protocolos y procedimientos generales de enfermería [Internet]. Córdoba: Hospital Reina Sofia; [citado 5 de agosto de 2020]. Ficha RD2. Rev 23 jun 2010.*

Artham, S. M., Lavie, C. J., Milani, R. V., & Ventura, H. O. (2009). Obesity and hypertension, heart failure, and coronary heart disease—risk factor, paradox, and recommendations for weight loss. *Ochsner Journal*, *9*(3), 124-132.

Bazan, N., & Colacilli, M. (2014). Adaptaciones cardiovasculares al ejercicio. En: Paidotribo, editor. Bases Fisiologicas del Ejercicio. Barcelona. 401-408.

Bernal, O., & Moro, C. (2006). Arritmias cardiacas en la mujer. *Revista española de cardiología*, *59*(6), 609-618.

Boraita Pérez, A., & Serratosa Fernández, L. (1998). El corazón del deportista: hallazgos electrocardiográficos más frecuentes. *Revista española de cardiología*, *51*(5), 356-368.

Calderon, F. J., Cupeiro, R., Peinado, A. B., & Lorenzo-Capella, I. (2020). Heart rate variability and exercise, is there a physiological basis? *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte*, *20*(78), 299-320.

Chandra, N., Bastiaenen, R., Papadakis, M., Panoulas, V. F., Ghani, S., Duschl, J., Foldes, D., Raju, H., Osborne, R., & Sharma, S. (2014). Prevalence of electrocardiographic anomalies in young individuals: relevance to a nationwide cardiac screening program. *Journal of the American College of Cardiology*, *63*(19), 2028-2034.

Consejo Superior de Deportes. (2011). Comisión de Control y Seguimiento de la Salud y el Dopaje, Grupo de Trabajo. Sistema de reconocimientos médicos para la práctica del deporte [Internet]. Madrid: CSD [citado 31 de marzo de 2019]. Disponible en http://femede.es/documentos/DocumentoRMD01-12.pdf

Derval, N., Simpson, C. S., Birnie, D. H., Healey, J. S., Chauhan, V., Champagne, J., Gardner, M., Sanatani, S., Yee, R., & Skanes, A. C. (2011). Prevalence and characteristics of early repolarization in the CASPER registry: cardiac arrest survivors with preserved ejection fraction registry. *Journal of the American College of Cardiology*, *58*(7), 722-728.

Drezner, J. A., Fischbach, P., Froelicher, V., Marek, J., Pelliccia, A., Prutkin, J. M., Schmied, C. M., Sharma, S., Wilson, M. G., & Ackerman, M. J. (2013). Normal electrocardiographic findings: recognising physiological adaptations in athletes. *British Journal of Sports Medicine*, *47*(3), 125-136.

Fernando Yáñez. (2012). Evaluación médica previa a la práctica deportiva para deportistas aficionados y de nivel competitivo. *Rev Médica Clínica Las Condes*, *23*(3), 236-243.

Gil Gómez, J., & Verdoy, P. J. (2011). Caracterización de deportistas universitarios de fútbol y baloncesto: antropometría y composición corporal. *E-balonmano. com: Revista de Ciencias del Deporte [Internet][citado 9 de noviembre de 2019]*, *7*(1), 39-51.

Gómez-Puerto, J. R., Viana-Montaner, B. H., Rivilla, M. L., Romo, E., & Da Silva-Grigoletto, M. E. (2011). Hallazgos electrocardiográficos más frecuentes en deportistas de la provincia de Córdoba. *Revista Andaluza de Medicina del Deporte*, *4*(3), 97-104.

González Armengol, J. J., López Farré, A., & Prados Roa, F. (2011). Síncope de esfuerzo y riesgo de muerte súbita en deportistas jóvenes: perspectiva clínica y genética. *Emergencias 23*(1), 47-58.

Horwich, T. B., Fonarow, G. C., Hamilton, M. A., MacLellan, W. R., Woo, M. A., & Tillisch, J. H. (2001). The relationship between obesity and mortality in patients with heart failure. *Journal of the American College of Cardiology*, *38*(3), 789-795.

Jurado Román, A., Rubio Alonso, B., Díaz Antón, B., Molina Martin, J., Martín Asenjo, R., & Coma Sanmartín, R. Repolarización precoz y fibrilación ventricular idiopática. Revisión y presentación de un caso. Cuad Estimul Card [Internet]. 2012 [citado 14 de noviembre de 2020]. *5*(14), 3-14.

Langdeau, J. B., Blier, L., Turcotte, H., O'Hara, G., & Boulet, L. P. (2001). Electrocardiographic findings in athletes: the prevalence of left ventricular hypertrophy and conduction defects. *The Canadian journal of cardiology*, *17*(6), 655-659.

Mancia, G., Fagard, R., Narkiewicz, K., Redon, J., Zanchetti, A., Böhm, M., Christiaens, T., Cifkova, R., De Backer, G., & Dominiczak, A. (2013). Guía de práctica clínica de la ESH/ESC para el manejo de la hipertensión arterial (2013). *Hipertensión y riesgo vascular*, *30*(Suppl 3), 4-91.

Mitchell, J. H., Haskell, W., Snell, P., & Van Camp, S. P. (2005). Task Force 8: classification of sports. *Journal of the American College of Cardiology*, *45*(8), 1364-1367.

Molfino, A., Fiorentini, A., Tubani, L., Martuscelli, M., Rossi Fanelli, F., & Laviano, A. (2009). Body mass index is related to autonomic nervous system activity as measured by heart rate variability. *European journal of clinical nutrition*, *63*(10), 1263-1265.

Moreno Pascual, C. (2012). Examen de aptitud deportiva. *Pediatr Integr*, *16*(8), 605-616.
Nieto-Jimenez, C., Pardos-Mainer, E., Ruso-Álvarez, J., & Naranjo-Orellana, J. (2020). Carga de entrenamiento y VFC en una atleta femenina: Estudio de caso. *Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte*, *20*(78), 321-333.
Organización Mundial de la Salud. (2010). Recomendaciones mundiales sobre actividad física para la salud. Ginebra OMS. *Libr Cat*, 1-58.
Pelliccia, A., & Adami, P. (2017). The Female Side of the Heart. *JACC Cardiovasc Imaging*, *10*(9), 2017-2019.
Pelliccia, A., Maron, B. J., Culasso, F., Di Paolo, F. M., Spataro, A., Biffi, A., Caselli, G., & Piovano, P. (2000). Clinical significance of abnormal electrocardiographic patterns in trained athletes. *Circulation*, *102*(3), 278-284.
Pellizzón, O. A., & Gonzalez, M. D. (2012). Síndrome de repolarizacion precoz: Un fenomeno electrocardiográfico benigno o" no tan benigno". Su relación con la muerte súbita cardíaca. *Revista de la Federación Argentina de Cardiología*, *41*(1), 8-12.
Sharma, S., Drezner, J. A., Baggish, A., Papadakis, M., Wilson, M. G., Prutkin, J. M., La Gerche, A., Ackerman, M. J., Borjesson, M., & Salerno, J. C. (2017). International Recommendations for Electrocardiographic Interpretation in Athletes. *Journal of the American College of Cardiology*, *69*(8), 1057-1075.
Sillero Quintana, M. (2005). Las Medidas Antropométricas. En: INEF Madrid, editor. Teoría de Kinantropometría. Madrid: INEF Madrid. p. 7-42.
Sofi, F., Capalbo, A., Pucci, N., Giuliattini, J., Condino, F., Alessandri, F., Abbate, R., Gensini, G. F., & Califano, S. (2008). Cardiovascular evaluation, including resting and exercise electrocardiography, before participation in competitive sports: cross sectional study. *Bmj*, *337*, 1-4.
Susano, L., Alvarez Cadena, J., Rodríguez, H., & Castro H et al. (2014). Miocardiopatía del atleta. *Rev Mex Cardiol*, *25*(2), 356-368.
Uberoi, A., Stein, R., Perez, M. V., Freeman, J., Wheeler, M., Dewey, F., Peidro, R., Hadley, D., Drezner, J., & Sharma, S. (2011). Interpretation of the electrocardiogram of young athletes. *Circulation*, *124*, 746-757.